Oral Presentations

OP01: MIS Lumbar Endoscopy

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A001: The effects of smoking in patients undergoing open versus minimally invasive lumbar spinal fusion

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Introduction: The negative perioperative effects of smoking and nicotine use on patients undergoing lumbar fusion have been extensively studied including increased risk of non-union, infection, delayed wound dehiscence, and adjacent segment pathology. There is limited data comparing the effects of current smoking on patient-reported outcome measures (PROMs), complication rates, and mortality for open versus minimally invasive transforaminal lumbar interbody fusion (MI-TLIF) in treating degenerative lumbar pathologies. The purpose of this study was to (1) characterize the demographics of current smokers undergoing open vs. MI-TLIF, (2) characterize the effects of smoking on PROMs perioperatively following surgery, and (3) compare the impact of MI-TLIF on smokers in terms of PROMs and complication rates. **Material and Methods:** A retrospective review identifying patients who underwent one- or two-level open or MI-TLIF for degenerative lumbar pathology was performed. Patient demographics, current smoking status, and Patient-Reported Outcomes Measurement Information System (PROMIS) and Oswestry Disability Index (ODI) scores were collected longitudinally. Patients were separated into two study groups for comparison based on surgery technique and smoking status. Descriptive and inferential statistics were performed. **Results:** A total of 220 patients (MI-TLIF, $n = 38$; open-TLIF, $n = 182$) were included. Average follow-up time was 23.2 months. MI-TLIF patients had a lower body mass index (MI-TLIF: 29 ± 5.4, Open-TLIF: 31.9 ± 5.7, $p = 0.004$) and a greater proportion of current smokers. (MI-TLIF: 32%, Open-TLIF: 12%, $p = 0.011$). Similar long-term outcomes were observed across surgical techniques for ΔPROMIS-Overall (MI-TLIF: 7.4 ± 4.9, Open-TLIF: 5.4 ± 7.0, $p = 0.390$), and ΔODI (MI-TLIF: -29.0 ± 14.3, Open-TLIF: -22.7 ± 19.8, $p = 0.331$). Smokers have worse preoperative outcomes measures for PROMIS-Overall (Smoker: 23.4, Non-Smoker: 28.6, $p = 0.001$), PROMIS-Physical Function (Smoker: 33.3, Non-smoker: 37.7, $p = 0.004$), PROMIS-Mental Function (Smoker: 36.3, Non-smoker: 43.8.7, $p < 0.0001$), and ODI (Smoker: 54.1, Non-smoker: 44.9, $p = 0.016$). Smokers demonstrate comparable clinical improvement at long term follow up for ΔPROMIS-Overall (Smoking: 9.3 ± 9.4, Non-smoker: 5.1 ± 6.3, $p = 0.052$), and ΔODI (Smoker: -31.3 ± 24.1, Non-smoker: -22.0 ± 18.5, $p = 0.117$). Subgroup analysis of smokers demonstrated no difference across surgical techniques for ΔPROMIS-Overall (MI-TLIF: 9.3 ± 8.3, Open-TLIF: 9.2 ± 10.2, $p = 0.987$), and ΔODI (MI-TLIF: -36.0 ± 22.5, Open-TLIF: -29.8 ± 25.7, $p = 0.718$). There were fewer total complications amongst smokers who underwent MI-TLIF which approached statistical significance (MI-TLIF: 0%, Open-TLIF: 18%, $p = 0.116$). Subgroup analysis of non-smokers undergoing MI-TLIF demonstrated significant benefits in ΔPROMIS-Physical Function (MIS: 13.0 ± 2.3, Open: 8.1 ± 8.7, $p = 0.002$). **Conclusion:** Smoking and nicotine use is known to increase perioperative complications amongst spinal fusion patients. Our findings suggest current smokers have worse preoperative outcome measures than non-smokers for PROMIS and ODI but demonstrate comparable long-term improvement regardless of surgical technique. Minimally invasive techniques may confer protection against perioperative complications amongst current smokers and demonstrate clinical benefit particularly in physical function amongst non-smokers.

1499

A002: Readmission after full endoscopic lumbar discectomy - A nine years single centre retrospective analysis

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Introduction: In the era of minimally invasive spinal surgery (MIS) procedures, endoscopic spine surgeries are transforming the way conventional spinal procedures are done. Previous studies agree that endoscopic spine surgeries have shorter hospitalization and faster recovery time when compared to conventional open surgery. However, post-surgical readmissions in these new techniques have yet to be well characterized. **Material and Methods:** To evaluate the readmission rate of patients after full endoscopic lumbar discectomy surgery. All the adult patients who underwent full endoscopic lumbar discectomy surgery between 2014 and 2023 were included in this retrospective analysis. The rate and reasons for readmission at 30- and 90-days were assessed. We compared our results with existing literature on post operative readmissions in full endoscopic lumbar spine surgeries. **Results:** 578 patients underwent Endoscopic lumbar discectomy during this period. The rate of readmission following full endoscopic lumbar discectomy was 4.32%. The causes for readmission were due to persistent back pain/leg pain and recurrence of radicular symptoms. The 30-day readmission were commonly due to recurrent disc prolapse, Residual compression / incomplete discectomy. Recurrent disc prolapse and spondylodiscitis were the main causes for readmission within 90 days. **Conclusion:** The use of minimally invasive endoscopic techniques for the treatment of lumbar spine pathology does not result in increased 30-d and 90-d readmission rates when compared to the open approaches. In the early stages of the learning curve, there was a significant readmission rate due to residual compression/incomplete discectomy when compared with the latter.

2248

A003: Does endoscopic discectomy provide better clinico-radiological outcomes than open discectomy in early post-operative period? Cross sectional analysis of multifidus muscle atrophy, creatinine phosphokinase levels and its correlation with early clinical outcomes

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Introduction: Patients experiencing surgical site low back pain in early post-operative period after open lumbar discectomy is not uncommon. This may be attributed to the amount of muscle damage involved in the procedure. To minimize this morbidity, endoscopic lumbar discectomy has been introduced providing excellent results. However, there is lacunae in the literature regarding the cross-sectional analysis of muscle damage and comparison between both the procedures. The purpose of this study is to analyse the invasiveness of both endoscopic lumbar discectomy and open lumbar discectomy, through cross sectional analysis of multifidus muscle morphology along with observing creatine phosphokinase levels after the procedure and its correlation with clinical outcomes. **Material and Methods:** Prospective trail including 42 patients undergoing lumbar discectomy surgery (either open or endoscopic) was conducted. Cross-section area (Total and Lean) of multifidus muscle in T2-weighted axial images were measured pre-operatively and post-operatively in both groups. CPK levels and VAS (Back) data were collected, Percentage of muscle injury or atrophy was calculated and compared between both the groups. **Results:** VAS back score in open group increased significantly on 1st POD (5.6 ± 1.7 to 7.2 ± 1.3) when compared to endoscopy group. Lean Cross sectional area has decreased from 86.18 ± 10.2 (pre-op) to 55.02 ± 9.4 (post-op) (p-value ≤ 0.0001). Multifidus muscle damage increasing to 32% after open discectomy vs 5% after endoscopic discectomy. Creatinine Phosphokinase (CPK-MM) levels were significantly increased in open group on 1st POD when compared to endoscopy group. **Conclusion:** Multifidus muscle atrophy is higher in open discectomy when compared to endoscopic discectomy. Higher reduction of cross sectional area after open discectomy correlates to surgical site low back pain. This is the first study in the literature which compares multifidus muscle atrophy and CPK levels between open and endoscopic discectomy.

1319

A004: Learning curve of endoscopic lumbar spine surgery - A systematic review and meta-analysis of individual participant data

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Introduction: There are learning curves associated with every surgical procedure, with profound implications for patient safety and surgical efficiency particularly during the earliest cases of a new procedure. The literature in surgical learning curves is highly heterogenous, and frequently poorly done.

Endoscopic spinal surgery is a procedure that is difficult to learn and unfamiliar to many certified spinal surgeons. While it has been shown to hold many advantages over open spinal surgery, patients may be exposed to greater risk of the many devastating complications of spinal surgery during the early part of the learning curve. It is not clear the number of cases required to attain procedural competence in these cases. The aim of this meta-analysis was to aggregate the individual participant data available in the literature using a standardised parametric methodology in order to define the learning curve of endoscopic lumbar spine surgery. **Material and Methods:** Searches of PubMed and EMBASE were conducted, and the records screened in duplicate against the eligibility criteria. Articles that reported ordered case series with measures of surgical performance (e.g. operating time, open conversions) or outcomes (e.g. surgical complications, patient-reported quality of life) for each individual participant were included. The learning curve was defined by conducting non-linear (exponential decay for continuous data) or logistic (for binary data) mixed-effects meta-regressions to investigate how surgical performance and outcomes changed over the course of the learning curve. For non-linear exponential decay curves, the performance was deemed to have plateaued when the curve reached 99% of the asymptote. **Results:** Our searches returned 913 records, of which 118 full-text articles were screened, and 36 studies deemed eligible for final inclusion. The methods used to analyse learning curves were highly heterogenous, among them including non-parametric methods (e.g. CUSUM, non-parametric regressions), simple linear regression, spline regressions. A single mixed-effects exponential decay curve was fitted for operating times of 15 surgeons performing endoscopic lumbar discectomies. This exponential decay curve was able to describe the learning curve, including the starting performance, the plateau performance, and the learning rate. The plateau in operating speed was expected after 29.1 cases. However, the risk of surgical complications in 16 surgeons (such as concordant dysaesthesia, dural tear) remained substantially raised for far longer – more than 80 cases. The risk of conversion to open surgery in 7 surgeons, and the risk of the need for reoperation in 6 surgeons, remained substantially raised for 60 and 132 cases respectively. The risk of poor patient-reported outcome, on the Macnab scale in 3 surgeons, remained substantially elevated for around 60 cases. **Conclusion:** The plateau is operating speed in endoscopic lumbar discectomy is expected after 29 cases. However, the risk of surgical complications and poor surgical outcomes remain raised for substantially longer. The number of cases required for both safe and efficient surgery may need to be considered when designing proctoring regimens for surgeons who wish to incorporate endoscopic spinal surgery into their practice. In addition, work to mitigate the surgical learning curve is warranted.

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A005: Can a large-footprint interbody cage be safely placed with endoscopic/percutaneous TLIF? A prospective case-series study

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Introduction: Endoscopic/percutaneous transforaminal lumbar interbody fusion (TLIF) is a relatively novel technique that uses Kambin's triangle to place an interbody device into the disk. It has recently seen an increasing adoption despite having limitations, like the learning curve of endoscopy and requiring a small and usually expensive interbody cage specifically designed to fit through the neuroforamen. However, large-footprint interbody devices, like those used in anterior and lateral approaches (ALIF/XLIF), report the best long-term clinical/radiologic outcome. Yet, these could conflict with neural structures if placed through neuroforamen due to its size. Aim of this study is to evaluate the feasibility, the clinical and radiologic outcome, as well as post-operative complications of trans-Kambin TLIF using a large-footprint interbody cage. **Material and Methods:** This is a prospective case series study. Inclusion criteria comprised degenerative disk disease, foraminal stenosis and spondylolisthesis up to grade II. Exclusion criteria comprised infection, tumor and vertebral body fracture. Surgically, a wide foraminoplasty was performed either percutaneously with manual reamers and/or endoscopically with a high-speed burr. After percutaneous disk preparation, a large-footprint expandable titanium interbody cage (size 39x13x15mm; Vertaconnect, Signus GmbH, Germany) was placed into the intervertebral disk through Kambin's triangle with a newly developed delivery device to protect the neural structures. Demineralized Bone Matrix (DBM) was employed as graft. Posterior fixation was completed with percutaneous transpedicular screws. Visual Analogic Scale (VAS) and Oswestry Disability Index (ODI) scores were evaluated pre-operatively and post-operatively at hospital discharge, as well as 1, 3, 6, 12 and 24 months. Post-operative radiologic evaluation was performed with a standing X-ray and CT scan of the lumbar spine at hospital discharge and at 12 months. Statistical analysis was performed with Student's T-Test and statistical significance was defined for $p < 0.01$. **Results:** 40 patients (20 (50%) female) were included with a mean age 61 ± 11.9 years. A total of 53 cages were placed, including 9 two-level cases and 2 three-level cases. Total mean follow-up was 21.6 ± 3.7 months. VAS back scores

improved from 7.1 ± 2.2 pre-op to 1.8 ± 2.3 post-op at latest follow-up (p < 0.01). VAS leg scores improved from 6.5 ± 3.1 pre-op to 1.5 ± 2.0 post-op at latest follow-up (p < 0.01). ODI scores improved from 32.2 ± 8.1 pre-op to 13.3 ± 9.7 post-op at latest follow-up (p < 0.01). The fusion rate of the interbody cages was 90%. Post-operative complications included one case of pseudo-arthrosis that required revision surgery and two (5%) asymptomatic cases with a radiologically migrated cage. Two patients (5%) presented a post-operative motor weakness that recovered partially in the follow-up. Ten patients (25%) presented with transitory post-operative radiculitis that completely resolved within the first 6 post-operative weeks. **Conclusion:** Large footprint expandable interbody devices can be safely delivered into a lumbar disk via Kambin's triangle with significant improvement in clinical outcome and a 90% fusion rate at almost 2 years follow-up. An extensive foraminoplasty and a neural shielding device are mandatory to avoid injury of neural structures in the neuroforamen.

1529

A006: Comparison of fusion rates after unilateral vs. bilateral instrumentation following lumbar fusion surgery (TLIF) for a single level lumbar degenerative pathology

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Introduction: Lumbar fusion surgery traditionally involves bilateral pedicle screw instrumentation through various modalities from free-hand to Robotic placement. There are few studies in the literature on Unilateral instrumentation in the TLIF procedure. This retrospective study aims to compare the radiological outcomes of unilateral and bilateral instrumented TLIF in a selected series of patients. **Material and Methods:** We retrospectively analyzed patients operated with unilateral pedicle screw fixation (Uni-TLIF) and bilateral pedicle screw fixation (TLIF) in Lumbar Interbody Fusion Surgery with a minimum of 2 years of follow-up. Patients were evaluated at regular intervals for functional and radiological outcomes. Fusion rates were assessed using Bridwell interbody fusion grading at 6 months, 1 year, and 2 years after surgery. **Results:** 42 patients were in included in the study out of which 20 patients underwent Uni-TLIF. The fusion rate in Uni-TLIF was 95.4% and 97.2% TLIF; this was not statistically significant between groups. Our study shows that there was a significant improvement in VAS and ODI in both groups at 2 years follow-up, complication rates between the groups were similar. In the Uni-TLIF group, there was a significant reduction of blood loss during surgery, duration of surgery, early mobilization after surgery, and duration of hospital stay. **Conclusion:** Unilateral pedicle screw fixation in Lumbar fusion surgery is comparable

with bilateral pedicle screw fixation in terms of patient-reported clinical outcomes and fusion rates. The fusion rate after Uni-TLIF is similar to that of TLIF in long-term follow-up. The surgeon should be aware of the potential limitations of this technique. We have studied single level lumbar pathology in a small series, It needs further studies in multilevel fixations with large series and longer follow-up.

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A007: Comparative analysis of endoscopic L5-S1 foraminoplasty vs biportal endoscopic L5-S1 fusion

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Introduction: For patients with foraminal stenosis at the L5-S1 level, there are two surgical options: simple L5-S1 foraminoplasty and L5-S1 fusion. With advancements in endoscopic surgery, L5-S1 foraminoplasty has become a readily accessible surgical technique. However, symptom relief is often short-lived, and there is a frequent recurrence of foraminal stenosis or symptom relapse due to sinking down. As an alternative, biportal endoscopic fusion at L5-S1 can promote symptom improvement. However, it may be challenging to apply for patients who dislike fusion procedures and can lead to fusion-related complications. Therefore, we aimed to compare which surgical approach yields better short-term results for L5-S1 foraminal stenosis. **Material and Methods:** Patients with L5-S1 foraminal stenosis were divided into two groups: one group underwent L5S1 foraminoplasty via a paraspinal approach from 2017 to 2019 (18 patients), and the other group underwent biportal endoscopic L5-S1 fusion with facet sacrificing approach from 2021 to the present (19 patients). Both groups were evaluated using VAS Back, VAS Leg, ODI, and Mc Nab criteria before and after surgery, and post-surgical complications were recorded. VAS back, VAS leg and ODI score are compared using with student T test. McNab criteria was compared with the Man Whitney U statistical test. **Results:** Foraminoplasty group: Patients underwent foraminoplasty via a paraspinal approach between 2017 and 2019. The average age was 69 ± 11.6 years, and the mean follow-up period was 46 ± 11 months. Pre-surgery VAS Back improved from 2.9 ± 2.6 to 0.5 ± 0.9 post-surgery, VAS Leg improved from 6.7 ± 1.8 to 5.3 ± 3.1 post-surgery, and ODI decreased from 33.2 ± 8.2 to 20 ± 10.4. Mc Nab criteria showed excellent results in 2 cases, good in 7, fair in 5, and poor in 5. Fusion group: Patients had a facet sacrificing approach for biportal endoscopic L5-S1 fusion. The average age was 65.2 ± 11.4 years, and the mean follow-up period was 14.3 ± 9.3 months. Pre-surgery VAS Back improved from 4.2 ± 3.0 to 2.3 ± 2.6 post-surgery, VAS Leg improved from 6.8 ± 2.9 to 1.8 ± 1.4 post-surgery, and ODI decreased from

30.9 ± 6.9 to 16.9 ± 13.1. Mc Nab criteria showed excellent results in 9 cases, good in 6, fair in 2, and poor in 1. Statistically, there was no significant difference in VAS Back improvement between the two groups. However, the Fusion group showed statistically significant improvements in VAS Leg, ODI, and Mc Nab criteria compared to the Foraminoplasty group. The most common complication in the foraminoplasty group was symptom recurrence, while the fusion group experienced complications related to multi-segmental fusion, including junctional problems. **Conclusion:** In conclusion, the clinical improvement in the foraminoplasty group was inferior to that in the fusion group. While there is a possibility of junctional problems with fusion, biportal endoscopic facet-sacrificing TLIF surgery proves to be a valuable technique for L5S1 fusion, with a lower recurrence of symptoms compared to the foraminoplasty group.

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A008: Comparison of the radiographic and clinical outcomes of biportal endoscopy-assisted lumbar interbody fusion with oblique lateral interbody fusion

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Introduction: The biportal technique used for endoscopic spine surgery is highly flexible, applicable for both visualizing and working, and is suitable for fusion surgery. We performed biportal endoscopy-assisted lumbar interbody fusion (BE-LIF), where two expandable cages are inserted through both sides of the Kambin's safety triangle. The triangle is enlarged by resecting only the superior articular process, allowing the preservation of the posterior components and enabling interbody fusion without exposing the dura. Oblique lateral interbody fusion (OLIF) is the standard technique for fusion surgeries; it has strong realignment power, uses a large cage, and has good clinical results with indirect decompression. BE-LIF has some advantages over OLIF because of its posterior approach. For example, it is unnecessary to change the operative position of the patient, which may hurt their vital organs; however, the radiographic and clinical outcomes of BE-LIF is not clear. We aimed to compare the clinical and radiographic outcomes of BE-LIF with those of OLIF. **Materials and Methods:** From 2018 to 2022, 42 adult patients who underwent single-level interbody fusion for L4/5 lumbar degenerative spondylolisthesis were enrolled. A retrospective assessment of 42 patients was performed at least 1 year after the index operation. The patients were divided into the BE-LIF (n = 22) and OLIF (n = 20) groups. Visual Analog Scale scores for back pain, leg pain, and leg numbness, and the Japanese Orthopedic Association Back Pain Evaluation Questionnaire (JOABPEQ) were used as clinical outcome measures. The following radiographic parameters were evaluated and the change between the preoperative and final follow-up values was analyzed: degree of spondylolisthesis, segmental lordosis (SL), lumbar lordosis (LL), pelvic tilt (PT), and sagittal vertical axis (SVA). **Results:** Regarding the radiographic analysis, BE-LIF was superior to OLIF in terms of the change in disc height (6.5 ± 1.8 mm vs. 2.3 ± 1.2 mm, p < 0.001). However, regarding the changes in the other parameters, the degree of spondylolisthesis (47.4% ± 21.9% vs. 48.1% ± 29.2%, p = 0.90), LL (2.2° ± 5.9° vs. 2.7° ± 4.7°, p = 0.76), PT (0.0° ± 3.7° vs. −1.3° ± 4.6°, p = 0.36), PI-LL (-2.8° ± 6.6° vs. -7.5° ± 10.1°, p = 0.10), and the SVA (-6.8 ± 32.5 mm vs. 0.8 ± 30.8 mm, p = 0.05) were comparable between the two groups. At the final follow-up, the improvement rate in back pain (66.4 ± 33.4 vs. 60.6 ± 38.7, p = 0.63), leg pain (69.9 ± 38.8 vs. 71.4 ± 41.2, p = 0.90), and leg numbness (72.0 ± 35.1 vs. 78.0 ± 30.1, p = 0.58) were comparable between groups. Regarding the JOABPEQ, only the social function disorder was significantly improved in the OLIF group (23.9 ± 19.6 mm vs. 37.6 ± 21.5, p = 0.04). **Conclusion:** BE-LIF improves the disc height significantly more than OLIF for L4/5 lumbar degenerative spondylolisthesis. Its clinical outcomes are inferior in only one category: JOABPEQ. BE-LIF can provide satisfactory outcomes similar to those of OLIF, having powerful realignment potential.

1157

A009: Efficacy of the erector spinae plane block with sedation for unilateral biportal endoscopic spine surgery and comparison with other anesthetic methods

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Introduction: Erector spinae plane block (ESPB) is a new regional anesthesia. Unilateral biportal endoscopic (UBE) spine surgery, a minimal invasive technique, has been performed under not only general anesthesia (GA) but regional anesthesia including spinal anesthesia (SA). The aims of this study were to evaluate the efficacy of ESPB with sedation for UBE lumbar decompression and compare it with GA and SA. **Material and Methods:** A retrospective age matched case–control study design was performed. Three groups (20 patients in each group) of patients who underwent UBE lumbar decompressions under each anesthetic method (GA, SA, or ESPB) were formed. The total anesthesia time excluding operation time, postoperative analgesia effects, hospital days, and complications related to anesthetic methods were evaluated. **Results:** In the ESPB group, all the operations were performed without change of anesthetic methods and without anesthetic complications. But there were no anesthetic effects in the epidural space, which

resulted in additional intravenous fentanyl usage. The mean of time from initiation of anesthesia to completion of surgical preparation was 23.3 ± 4.7 min in the ESPB group, which was shorter than 32.3 ± 10.8 min in the GA (p value = 0.001) or 33.3 ± 6.7 min in the SA group (p < 0.001). The proportion of patients requiring first rescue analgesia within 30 min was 30% in the ESPB group, which was lower than 85% in the GA (p < 0.001), but no significant different with 10% in the SA (p = 0.11). The mean of total hospital days in the ESPB was 3.0 ± 0.8, shorter than 3.7 ± 1.8 in the GA (p = 0.02) or 3.8 ± 1.1 in the SA group (p = 0.01). There was no case of postoperative nausea and vomiting in the ESBB even without prophylactic anti-emesis. **Conclusion:** ESPB with sedation is a viable anesthetic option for UBE lumbar decompression.

OP02: Lumbar Degenerative: The Role of MISS Techniques in Lumbar Degenerative Pathology

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A010: Surgical technique preference profile of direct decompression techniques among AO Spine members for lumbar degenerative spondylolisthesis. Insights from AO Spine KF Degen Spondylolisthesis Survey

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Introduction: Lumbar degenerative spondylolisthesis is a common condition addressed by spine surgeons across the globe. Compared to the open laminectomy, evolution in the minimally invasive (MIS) decompression surgery techniques using endoscopes and tubular/bladed retractors has changed the practice pattern for decompression for degenerative spondylolisthesis among surgeons. This study analyzes the utilization rate of open versus MIS techniques among the AO spine members for direct decompression of lumbar degenerative spondylolisthesis. **Methods:** Utilizing an electronic survey, AO Spine international members were presented with a case of L4-L5 grade I degenerative spondylolisthesis and queried about their treatment choices for decompression and their decision to offer fusion. Data collected included age, region of practice, training background, years of experience, practice setting, case volume, and treatment decisions. Comparative analysis of the responder characteristics was performed using Pearson's chi-squared test. **Results:** A total of 479 responses were collected, and 54% of surgeons opted for the direct decompression method in their management, while the rest chose indirect decompression resulting from instrumentation and fusion. We noted a comparable distribution of the responder demographics across age, region of practice, training background, years of experience, practice setting, and case volume. Of 258 responders who opted for direct decompression, only 7% chose endoscopic decompression, 33% chose MIS decompression using tubular/bladed retractors, and 60% chose open decompression. We noted a significant association between female surgeons opting for open decompression techniques (p < 0.05). However, we did not find any other significant relationship between the other responder characteristics analyzed that determined surgeon's preference of direct decompression technique. We also noted that the choice of decompression technique significantly affected surgeon decision to fuse following decompression (p < 0.01). Only 26% of those who chose endoscopic decompression opted for fusion for the given case. In comparison, 73% and 95% of those who decided decompression with MIS techniques and open decompression opted to fuse following decompression (p < 0.01). **Conclusion:** MIS endoscopic techniques are not widely used as the decompression method of choice for L4-L5 degenerative spondylolisthesis, and open decompression through laminectomy remains the most common technique for direct decompression among spine surgeons. However, surgeons who opt for endoscopic decompression are less likely to fuse than surgeons who perform other decompression techniques. Hence, further studies are need to clarify which type of decompression is the most appropriate for particular situation in patients with degenerative spondylolisthesis.

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A011: Can robotic pedicle screw placement reduce perioperative complications requiring re-operation and invasiveness? Analysis of 1,633 patients undergoing lumbar fusion utilizing propensity score matching

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Introduction: Navigation and robotic technologies have emerged as an alternative option to conventional freehand techniques for pedicle screw insertion. However, the effectiveness of these technologies in reducing the perioperative complications of spinal fusion surgery remains limited due to the small cohort size in the existing literature. To investigate whether utilization of robotically navigated pedicle screw insertion can reduce the perioperative complications of spinal fusion surgery—including reoperations—with a sizeable cohort. **Material and Methods:** Patients' data were collected including age, sex, race, body mass index (BMI), upper-instrumented vertebra (UIV), lower-instrumented vertebra (LIV), number of screws inserted, and primary procedure name. Patients were classified into the following two groups: freehand group and robot group. Outcome measures included perioperative complications including readmission, reoperation, its reasons, estimated blood loss, operative time, and length of hospital stay (LOS). The variable-ratio matching was utilized to create the matched cohorts by propensity score and compared the outcomes between the two groups. **Results:** A total of 1,633 patients who underwent primary instrumented spinal lumbar fusion surgery were initially identified (freehand 1,286; robot 347). After variable ratio matching was performed with age, sex, BMI, fused levels, and upper instrumented vertebrae level, 694 patients in the freehand group and 347 patients in robot groups were selected. The robot group showed less EBL (418.9 ± 398.9 vs. 199.2 ± 239.6 ml; $p < 0.001$), shorter LOS (4.1 ± 3.1 vs. 3.2 ± 3.0 days; $p < 0.001$) and similar operative time (212.5 vs. 222.0 min; $p = 0.151$). Otherwise, there was no significant difference in readmission rate (3.6% vs. 2.6%; $p = 0.498$), reoperation rate (3.2 % vs. 2.6 %; $p = 0.498$), and screw malposition requiring reoperation (5 cases, 0.7% vs 1 case, 0.3%; $p = 1.000$). **Conclusion:** Perioperative complications requiring readmission and reoperation were similar between freehand and robotic surgery. Robot-guided pedicle screw insertion can enhance surgical efficiency by reducing intraoperative blood loss and length of hospital stay without extending operative time.

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A012: Impact of preoperative age-adjusted sagittal imbalance on radiographic and clinical outcomes following one-level minimally invasive transforaminal lumbar interbody fusion for degenerative spondylolisthesis

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Introduction: Prior studies investigating the use of minimally invasive transforaminal lumbar interbody fusion for treatment of degenerative lumbar conditions and concomitant sagittal deformity have not stratified patients by preoperative pelvic incidence–lumbar lordosis mismatch, which is the earliest parameter to deteriorate in mild sagittal deformity. The present study sought to determine the impact of preoperative pelvic incidence–lumbar lordosis mismatch on clinical outcomes and sagittal balance restoration among patients undergoing one-level minimally invasive transforaminal lumbar interbody fusion for degenerative spondylolisthesis. **Material and Methods:** Patient-reported outcomes and radiographic parameters were measured preoperatively and at all follow-up visits. Patient-reported outcomes included the Oswestry Disability Index, Visual Analog Scale Back/Leg, Short Form-12, and Patient-Reported Outcomes Measurement Information System. Minimal clinically important difference was evaluated. Radiographic parameters included pelvic incidence, lumbar lordosis, pelvic tilt, and sagittal vertical axis. Patients were grouped based on preoperative pelvic incidence–lumbar lordosis mismatch according to age-adjusted alignment goals. Univariate analysis was used to compare changes in radiographic parameters and patient-reported outcomes between groups preoperatively and the most recent follow-up visit. **Results:** Eighty patients were included (L4-5: 82.5%). Mean clinical and radiographic follow-up were 17.0 ± 7.9 months and 8.27 ± 2.9 months, respectively. Mean age was 63.2 ± 11.7 years and body mass index was 27.7 ± 5.8 kg/m2. Overall, 47 (58.8%) of patients exhibited preoperative pelvic incidence–lumbar lordosis mismatch. There were significantly more patients with grade II spondylolisthesis in the unbalanced group (27.7% vs. 3.0%, $p = 0.004$). Patients with preoperative sagittal imbalance did not exhibit significant improvement in alignment parameters postoperatively. These patients also showed worse pelvic incidence-lumbar lordosis (16.0 ± 11.2 vs. 0.54 ± 10.9, $p < 0.001$), pelvic tilt (25.9 ± 6.9 vs. 18.7 ± 6.4, $p < 0.001$), and sagittal vertical axis (49.4 ± 36.6 vs. 22.8 ± 34.6, $p = 0.013$) at long-term follow-up. Both groups demonstrated significant improvements in all patient-reported outcomes ($p < 0.05$) except for Short Form-12 Mental Component Score. Achievement of minimum clinically important difference for Visual Analog Scale Back was significantly greater among patients with preoperative sagittal imbalance (85.7% vs. 65.5%, $p = 0.045$). **Conclusion:** Minimally invasive transforaminal lumbar interbody fusion did not restore sagittal alignment in patients with preoperative pelvic incidence-lumbar lordosis mismatch. All patients showed comparable clinical outcomes at ≥ 6 months

postoperatively. Thus, patients with sagittal imbalance may undergo one-level minimally invasive transforaminal lumbar interbody fusion if there is sufficient clinical and radiographic evidence that symptoms are arising from a particular spinal level, provided that the sagittal imbalance is relatively mild.

2365
A013: Anterior retroperitoneal approach in posterior lumbar interbody pseudarthrosis revision surgery

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Introduction: Pseudarthrosis (PSA) is one of the most feared complications in lumbar interbody fusion (LIF). Revision surgery, which occurs between 6 to 36% of cases, should correct any previous technical errors by restoring the biological and biomechanical environment and avoiding further complications. **Material and Methods:** The aim of our study was to evaluate the possible advantages of a new access route, such as the anterior retroperitoneal approach using the ALIF (Anterior Lumbar Interbody Fusion, group A) or XLIF (Extreme Lateral Interbody Fusion, group X) techniques, in lumbar interbody pseudarthrosis (LIP) revision surgery. We performed a retrospective analysis of the clinical, radiological and surgical data of 33 patients (23 for group A and 10 for group X) who underwent surgery between January 2017 and May 2022 with a minimum follow-up of 6 months. **Results:** Group A - We observed a significant improvement in L1-S1 lordosis (p = 0.003); segmental lordosis of the index level (p < 0.001); L4-S1 lordosis (p < 0.001); L5-S1 lordosis (p = 0.001); anterior, posterior, and mean height of the index disc space (p < 0.001); pelvic tilt (PT) (p = 0.039) and sacral slope (SS) (p = 0.039). A positive correlation was observed between PT post-operative values and follow-up values of VAS-leg (r = 0.469) and ODI (r = 0.517) and a negative correlation with the satisfaction rate (r = -0.471). Therefore, high PT values correspond to high VAS-leg and ODI values and a patient dissatisfaction. Furthermore, an inverse correlation was observed between post-operative SS and the follow-up values of ODI (r = -0.511): therefore, high SS values correspond to lower ODI values. Group X - We observed a significant improvement in the segmental lordosis of the index level (p = 0.005); anterior (p = 0.005), posterior (p = 0.009), and mean (p = 0.005) height of the index disc space. A positive correlation was observed between the L1-S1 post-operative lordosis and the satisfaction rate (r = 0.646). Therefore,

high L1-S1 lordosis values correspond to an increase in patient satisfaction. CT scans at last follow-up showed an interbody fusion rate of 95.7% for group A and 90% for group X. The clinical outcomes were investigated with Roland Morris Disability Questionnaire (RMDQ), Oswestry Disability Questionnaire (ODI) and Visual Analogue Scale (VAS), administered to patients at admission time and last follow-up: they all showed a significant improvement (p < 0.001 group A, p < 0.05 group X). **Conclusion:** Lumbar interbody pseudarthrosis represents a demanding and insidious challenge in revision vertebral surgery. Anterior retroperitoneal approach represents an effective salvage option in terms of intraoperative complications rate, lordosis and clinical improvement. ALIF technique remains the preferred approach for L5-S1 level, while the XLIF technique can be a valid alternative, in particular for the L3-L4 level and above.

1235
A014: Clinical outcomes after MIS decompression in degenerative scoliosis over 20 degrees

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Introduction: Posterior spinal surgery for degenerative scoliosis can be concerning due to the potential risk of exacerbating iatrogenic deformity caused by the disruption of paravertebral muscles in the lumbar spine, which may lead to unfavorable outcomes. Minimally invasive (MI) lumbar decompression has been a treatment option for these patients with stenosis. However, the clinical outcomes of MI decompression in patients with severe Cobb angle remain uncertain. The aim of this study was to investigate the clinical outcomes of MI lumbar decompression in patients with degenerative scoliosis exceeding 20 degrees. **Material and Methods:** We conducted a retrospective analysis to assess the outcomes of MI lumbar decompression in patients with lumbar spinal canal stenosis and Cobb angle ≥ 20 degrees. Demographic data, radiographic data (including spinal alignment and cross-sectional area of psoas muscle), and surgical variables (surgical levels and their relationship with Cobb angle) were collected. Decompression either within or across the end vertebrae was defined as decompression related to scoliosis. The analyzed patient-reported outcomes and measures (PROMs) included ODI, VAS back pain, and VAS leg pain at the two postoperative time points: ≤ 3 months

and ≥ 1 year. Patients were divided into two groups based on their Cobb angle: ≥ 20° (S group) and < 20° (NS group). The variable-ratio propensity score matching was employed to create the matched NS group to the S group, and we compared the PROMs and their MCID achievement between the matched groups. Additionally, logistic regression analysis was conducted to identify the factor associated with MCID achievement of ODI among the S group at 1 year postoperatively. **Results:** A total of 256 patients who underwent MI lumbar decompression surgery were included. The S group included 41 patients (16%), which showed characteristics of older age (73.3 vs. 66.6 years), higher proportion of females (68% vs. 35%), greater prevalence of osteoporosis (22.0% vs. 9.9%), lower normalized total cross-sectional area of psoas muscle (705.9 vs. 785.9), and higher ODI score (43.3 vs. 36.6). After propensity score matching using these variables, there were no significant differences in PROMs at preop and ≤ 3 months postop timepoint between the two groups. However, at 1-year postoperative follow-up, the S group exhibited poorer ODI score (26.2 vs. 19.2; p = 0.049) and VAS back (3.9 vs. 2.3; p = 0.002). MCID achievement rate of ODI was significantly lower in the S group at the 1-year postop time point (31.0% vs. 54.5%, p = 0.047). Regression analysis within the S groups revealed the scoliosis-related decompression (Odds ratio 0.12, p = 0.034) and higher preoperative ODI (Odds ratio 1.09, p = 0.007) were independent factors associated with the achievement of MCID in ODI. **Conclusion:** Patients with a Cobb angle ≥ 20° who underwent MI lumbar decompression demonstrated poorer outcomes in ODI and VAS back compared to those with < 20°. Furthermore, our analysis identified lower preoperative ODI score and scoliosis-related decompression as independent factors associated with the failure to achieve MCID in ODI for patients with a Cobb angle ≥ 20°.

1790
A015: Neuroforaminal bone growth leads to slower improvement following minimally invasive transforaminal lumbar interbody fusion

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Introduction: Although neuroforaminal (NF) bone growth has been reported to occur after transforaminal lumbar interbody fusion (TLIF), its impact on the degree and rate of improvement following surgery has not been studied. **Material and Methods:** This retrospective cohort study included patients who underwent primary one- or two-level minimally invasive TLIF (MI-TLIF) for degenerative lumbar pathology and had a minimum of 1-year follow-up. Iliac crest bone graft, local autograft, or allograft was used in all cases. Cases with bone morphogenetic protein (BMP) use (n = 10) were excluded. NF bone growth was assessed on the postoperative 1-year CT scan by a radiologist and patients were accordingly stratified into two groups (NF bone growth – yes or no). The NF bone growth area was measured on the sagittal and axial sections. Percentage occupancy of the neuroforamen by bone growth was measured on the sagittal section. Outcome measures were: 1) patient-reported outcome measures (PROMs) (Oswestry Disability Index, ODI; Visual Analog Scale back and leg, VAS; 12-Item Short Form Survey Physical Component Score, SF-12 PCS), and 2) minimal clinically important difference (MCID) achievement. Two postoperative timepoints were defined – early (< 3 months) and late (> 6 months). Outcome measures were compared between the two groups with univariate analyses. A subgroup analysis was done to compare outcomes between patients who had > 25% and < 25% foraminal occupancy of bone growth. **Results:** 114 patients were included. 30 patients (26%) had NF bone growth. The average bone growth area was 38.1 mm^2 and 41.1 mm^2 on sagittal and axial sections, respectively. Average percentage occupancy of the neuroforamen was 26.3% (range: 11 - 55%) (< 25%: 16 patients, > 25%: 14; > 50%: 2). NF bone growth was more frequently found in two-level fusion compared to one-level (50% vs. 23%, p = 0.03). Patients with NF bone growth were found to have significantly higher ODI compared to those without NF bone growth at < 3 months (28.6 vs. 20.9, p = 0.03). Patients with NF bone growth did not show significant improvement in ODI (28.6 vs. 37 preoperatively, p = 0.06) and SF-12 PCS (38.7 vs. 34.7 preoperatively, p = 0.06) at < 3 months. No significant difference was found in VAS back and leg between the groups at < 3 months. At > 6 months, the significance of differences in ODI and SF-12 PCS were not retained and both groups showed similar and significant improvement in all PROMs. The MCID achievement rates for PROMs showed no significant difference between the two groups at < 3 and > 6 months. The subgroup analysis showed that < 25% and > 25% foramen occupancy groups both did not show significant improvement in ODI and SF-12 PCS at < 3 months. None of the patients had a reoperation for symptoms related to NF bone growth. **Conclusion:** 26% of patients showed NF bone growth following MI-TLIF. However, the average was a small area of 0.4 cm^2 and > 50% of foramen occupancy was seen only in 2 patients. Patients with NF bone growth (both < 25% and > 25%) were found to have a slower but eventually similar improvement in disability and physical function.

1674
A016: Endoscopic unilateral laminectomy for bilateral decompression in degenerative spondylolisthesis

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Introduction: Degenerative spondylolisthesis is an important cause of chronic low-back and radicular pain in the adult US population. Open approaches are considered the gold standard for management, however, endoscopic surgery is gaining increased traction due to lower complication rates, shorter hospital stay, reduced trauma to the surrounding anatomy, and minimized iatrogenic destabilization. Reports of clinical and radiographic outcomes in patients with severe stenosis in the setting of degenerative spondylolisthesis are scarce. To advance the literature on endoscopic spine surgery, the clinical and radiographic outcomes of 73 patients with low-grade degenerative spondylolisthesis with severe stenosis, who underwent endoscopic unilateral laminectomy for bilateral decompression (ULBD), are presented. **Methods:** Patients with low grade degenerative spondylolisthesis who underwent an endoscopic ULBD at six spine centers in North America were included in this study. All patients had at least a three month follow up. X-ray, CT, and/or MRI examinations were carried out routinely before surgery to identify the pathology and grade of spondylolisthesis. Patient reported outcomes were collected whenever possible. **Results:** This study included 73 patients from six centers. Sixty-two patients were diagnosed with grade 1 spondylolisthesis while 11 were diagnosed with grade 2 spondylolisthesis. Postoperatively 70 patients reported improved symptoms and pain resolution while three patients reported significantly worse pain. Mean VAS bac, VAS leg and ODI scores showed a statistically significant improvement at 3 and 9-months when compared to the preoperative period. Radiographically, no patient in our study had progression of grade of spondylolisthesis. **Conclusion:** Patients with low-grade degenerative

spondylolisthesis causing severe stenosis can safely be treated with endoscopic ULBD.

1384
A017: Minimally invasive treatment of adjacent segment disease in patients with previous lumbar fusion: systematic review of the literature and report of 1 case treated with combined technique in single position

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Introduction: While lumbar fusion is nowadays considered the standard treatment for degenerative spine pathology, a significant proportion of patients will develop Adjacent Segment Disease (ASD) in the years following surgery, often requiring additional treatment. Currently, the exact mechanism of the pathogenesis of ASD remains unknown. In this study we provide a review of the current literature on the treatment of ASD with minimally invasive techniques to highlighting the current utility of these techniques. **Material and Methods:** We report the case of a patient with a complex ASD both cephalad and caudal to a previous lumbar fusion, treated with combined anterior and lateral minimally invasive surgery. We performed a systematic review of published literature describing cases of minimally invasive spine surgery in patients suffering from ASD using the PubMed, Embase, and Cochrane Library databases. Studies describing adult patients (>18 years old) diagnosed with symptomatic ASD and treated with minimally invasive surgery were included. Demographic, clinical, affected levels, surgical approach and outcome data were extracted. **Results:** Nine studies accounting for 167 patients were reviewed. Patients were 18-81 years old and 55.08% were females. A single-level previous fusion was most common (40.04%), followed by 2-level (39.55%) and 3-level fusions (12.34%), with one sole case with 5-level fusion reported (0.74%). Interval to first lumbar fusion to reoperation ranged from 1-15 years. Preoperative neurological assessment revealed a sensory deficit in 22 patients (13.17%), and a motor deficit in 34 cases (20.35%). The most common index level was L3-L4 (37.12%). LLIF was the most common procedure (72.25%) and a stand-alone procedure was performed in 54.49%. At the first immediate postoperative evaluation, motor deficits showed a clear tendency toward improvement, whilst regarding sensory deficits remained without change. Complications were reported

in 8.98% of cases, of which one resulted in major complication (0.59%). The overall population reoperation rate was 13.17%. **Conclusion:** The incidence of patients suffering from ASD requiring additional surgical treatment may receive a significant benefit from minimally invasive spine surgery techniques such as LLIF, TLIF and ALIF, which are primarily based on indirect decompression of affected neural structures, avoiding complications related to traditional surgical management, also being able to provide a greater bone-fusion area and thus a greater rate of lumbar fusion and stabilization. Other advantages are less operative time, as well as less blood loss and shorter hospital stay. Although stand-alone procedures may be associated with a slightly increased reoperation rate in comparison to circumferential fusion, some patients may require a posterior instrumentation to increase segmental stability.

2535
A018: Open vs. MIS decompression and fusion for L4-L5 degenerative spondylolisthesis: results of an AO global survey of spine surgeons

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Introduction: Degenerative lumbar spondylolisthesis (DLS) is one of the most common causes of chronic low back pain and mainly occurs at the L4-L5 level. In severely symptomatic cases and in the presence of neurological deficits, surgical treatment is often indicated to decompress the neural structures and stabilize the slipped segment. To date, although several approaches and techniques have been described, there is no consensus on the best treatment strategy. The aim of this study was to evaluate the global practice pattern of surgical approach selection based on patients' characteristics and the extent/severity of the pathology. **Material and Methods:** A survey issued by AO Spine Knowledge Degenerative was sent out to AO Spine members across the world. Participants' country of practice, gender, age, years of practice, specialty, practice setting and information about spine surgery fellowship were retrieved, as well as surgical case volume. Then, three clinical cases of L4-L5 grade 1 DLS were presented: central stenosis without instability in an elderly (case 1), bilateral foraminal stenosis with instability in a

young woman (case 2), and unilateral foraminal stenosis with mild instability in a middle-aged woman (case 3). Participants were then asked about the type of surgical approach among open surgery (laminotomy or laminectomy + medial facetectomy), MIS (laminotomy with tubular or specular/bladed retractors), endoscopic MIS (uniportal or biportal), or indirect decompression. Chi-squared test was performed to evaluate statistical significance. **Results:** The survey was distributed online to over 6000 AO Spine members between July 27 – September 8, 2023. 943 responded and 479 completed the survey. Questions pertained to decision-making parameters and surgical technique preferences in the treatment of grade 1 L4-L5 DLS. Participants were from North America (8.6%), Latin America (16.2%), Europe & Southern Africa (33.4%), Middle East & North Africa (10.9%), Asia Pacific (30.9%). Most surgeons were male (95.8%), aged between 35 and 44 (36.7%), and practicing for at least 5 years (76%). Most respondents were orthopaedic surgeons (62%), practiced in an academic hospital (39.9%), and completed a post-graduate spine surgery fellowship (55.3%). In case 1, 59.2% chose open decompression, 24.2% MIS decompression, 4.2% endoscopic decompression, and 12.4% indirect decompression. With regards to case 2, 59.4% selected an open approach, 20% MIS, 4.2% endoscopic decompression, and 16.3% indirect decompression. In case 3, 33.4% preferred open decompression, 18.5% MIS decompression, 4% endoscopic decompression, and 44% indirect decompression. All these differences were statistically significant ($p < 0.0001$). Significant differences emerged after comparing the choice of the surgical approach among different AO Spine regions for case 1 ($p = 0.136$) and 2 ($p = 0.0048$), but not for case 3. **Conclusion:** In patients with grade I L4-L5 DLS, open decompression was the preferred surgical approach in case of both central stenosis and bilateral foraminal stenosis with instability, followed by MIS and indirect decompression. In the case of unilateral foraminal stenosis with mild instability, indirect decompression was the most selected surgical strategy. Although on the rise, endoscopic decompression has been employed in a small amount of cases.

OP03: Cervical Deformity

1370
A019: Surgical treatment strategy for difficult-reducible atlantoaxial dislocation

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Introduction: Atlantoaxial dislocation (AAD) is a condition that affects the conjunction between the base of the skull and the upper spine. The causes can be concluded as the bone factors, the ligament factors and the other factors. The bone

factors include the mal-development of the CVJ bones such as occipitalized atlas or basilar invagination, mal-developed facet joints, the fracture of breakage of the atlas or odontoid. The ligament factors include the floppy ligaments as a result of some genetic diseases (such as Down syndrome). The other factors include joint deformity result from inflammation re-action (such as rheumatoid arthritis). Those could not be reduced completely after skeletal traction test are "difficult reducible" cases. A transoral atlantoaxial release surgery was traditionally considered necessary to convert "irreducible" to "reducible". Our surgical strategy for difficult-reducible at-lantoaxial dislocation is based on the intraarticular manipu-lation through a single stage posterior approach followed by cage implantation intraarticularly. Only very few cases need a transoral surgery. **Material and Methods:** Clinical data of 244 patients with difficult-reducible atlantoaxial dislocation underwent surgical treatment in the Department of Neuro-surgery, Xuanwu Hospital from January 2017 to February 2022 were retrospectively reviewed, with an average age of 42.1 ± 10.9 years. Most cases were treated with one-staged posterior atlantoaxial joint distraction and cage implantation, a few had undergone ventral decompression. All cases were followed up, postoperative improvement of clinical symptoms and radiology parameters were analyzed. **Results:** A total of 240 patients (98.3%) had undergone one-staged posterior atlantoaxial joint distraction and cage implantation. Lateral facet joint bony fusion was found in 9 patients and was cut off with an osteotome. Transoral odontoidectomy was performed in 4 cases (1.7%) with fused atlanto-odontoid joint. All pa-tients had at least 12 months of follow-up. Postoperative CT showed complete reduction of ADI was achieved in 194 patients (79.5%). Postoperative ADI decreased significantly compared with preoperative $[(2.1 \pm 1.4)$ mm v.s. (5.0 ± 1.5) mm, $p < 0.05]$. The postoperative vertical distance between odontoid process and the Chamberlain's line decreased sig-nificantly compared with preoperative $[(4.6 \pm 2.1)$ mm v.s. (10.9 ± 2.2) mm, $p < 0.05]$. The average JOA score 6 months postoperative improved significantly (10.98 to 14.40, $p < 0.05$). 220 patients (90.1%) had atlantoaxial intra-articular bony fusion at 1 year follow-up. **Conclusion:** Most difficult-reducible atlantoaxial dislocations can be well managed by posterior one-staged atlantoaxial joint distraction and Cage implantation.

2036
A020: External validation of the modified cervical deformity frailty index for predicting outcomes after cervical deformity surgery

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Introduction: While multiple frailty measures exist, none have been externally validated for patients with cervical deformity (CD) undergoing corrective surgery. This study aimed to val-idate the modified Cervical Deformity Frailty Index (mCDFI), developed by the International Spine Study Group (ISSG), and its ability to predict major complications and non-routine dis-charge in this population. **Material and Methods:** This study included adults ($\geq$ 18 years) undergoing surgery for CD at two U.S. tertiary centers from 2012-2020. CD was defined as $\geq$ 1 of the following: C2-C7 coronal Cobb $> 10°$, C2-7 sagittal vertical axis > 4 cm, chin-brow vertical angle $>25°$. Patients were stratified by the original mCDFI scale (0-1) as no frailty (NF, < 0.3) or mild/severe frailty (F, > 0.3). The mCDFI model was externally validated to predict major complications. Decision tree analysis was used to recalibrate the mCDFI. Optimal classification trees, trained (80:20), predicted hardware com-plications and non-routine discharge. **Results:** This study in-cluded 84 patients (62% women; median age 65 years) who underwent surgical correction for adult cervical deformity (ACD), of which 72% had an Ames-ACD apex. Patients were stratified by frailty: 90.5% no frailty and 9.5% frail. Overall, 39% had a postoperative complication, including 45% me-chanical failures. Proposed models for predicting mechanical failures and non-routine discharges had an out-of-sample AUC of 0.83 and 0.70. The tree-based model validated known risks and demonstrated frailty by mCDFI as an independent variable elevating risk of mechanical failure and non-routine discharge. **Conclusion:** Frailty was an independent predictor of increased risk for mechanical failure and non-routine discharge. Preop-erative frailty assessment should be considered to improve patient counseling and resource allocation, thereby optimizing outcomes for frail patients.

341
A021: Accuracy and safety of using customized guiding templates for cervical pedicle screw insertion in severe cervical deformity, fracture, and subluxation

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Introduction: To assess accuracy and safety of self-developed customized three-dimensional printing guiding templates for cervical pedicle screws (CPSs) insertion surgery. **Material and Methods:** From July 2016 to August 2023, 146 CPSs were implanted in 21 patients with the assistance of cus-tomized guiding templates. Customized guiding templates

were manufactured from acrylonitrile-butadiene- styrene plastic material using a three-dimensional printer after establishing pedicle screw trajectories for each vertebra with the assistance of a virtual surgical planning software program, developed by our team, for the insertion of CPSs. **Results:** CPSs were evaluated using the following grading system: grade 0 (contained), grade 1 (exposure), grade 2 (perforation), and grade 3 (penetration). Each patient underwent postoperative computed tomography to evaluate accuracy of screw position. Of 159 screws, 139 were graded 0, and 5 were graded 1; no screws were graded 2 or 3. No vascular or nerve injuries were noted after the operations. **Conclusion:** CPSs, which provide strong biologic strength, are especially suitable for treating osteoporosis and severe deformity. However, CPSs insertion remains a challenging procedure with high incidences of vascular and nerve injuries reported. The results of this study indicate that use of customized guiding templates can improve safety of CPSs insertion surgery.

1652

A022: A CT-based analysis on occipito-atlantal (C0-1) compensation in children with atlanto-axial rotatory fixation and dislocation (AARFD)

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Introduction: Atlanto-axial rotatory fixation and dislocation (AARFD) represents the end-stage status of chronic atlanto-axial rotatory fixation in pediatric patients. The occipito-atlantal (C0-1) joints frequently rotate in compensation to the rotational separation of C1-2, in an effort to restore the normal visual axis. However, the relationship between C0-1 compensation and C1-2 rotation in these patients had not been described in detail in the literature. Particularly, it remained unclear whether there was a threshold of C1-2 rotational separation above which C0-1 compensation became significant and how surgical correction of C1-2 rotation would affect C0-1 compensation postoperatively. **Materials and Methods:** We retrospectively analyzed the pre-operative CT scans of 40 patients with AARFD (duration of symptom onset between 2 and 132 months). 19 patients had post-operative CT scans at 1-year follow-up. We measured the angles subtended by the occipital bone (C0 angle), C1 (C1 angle) and C2 (C2 angle) and calculated the rotational separation angles of C1-2, C0-1 and C0-2. Based on the normal C0-1 range of rotation for children, patients were divided into the physiological group ($|C0-1| \leq 3°$, n = 13) and the compensation group ($|C0-1| > 3°$, n = 27). Piecewise linear regression models were used to predict when C0-1 compensation began to occur with increasing C1-2 rotational separation and when would follow-up C0-1 restore to normal with decreasing

residual C1-2 following surgical correction, and multivariate regression was employed to establish the relationship among pre-operative C0-1, follow-up C1-2, and follow-up C0-1. **Results:** The mean C1-2 angle differed significantly between the physiological ($15.27 \pm 2.48°$) and the compensation ($34.70 \pm 2.25°$) groups (p < 0.001). The 95% CI of C1-2 angle of the physiological and compensation groups was 9.9~20.7° and 30.1~39.3°, respectively. The ROC curve analysis revealed that the optimal threshold of C1-2 separation for when C0-1 compensation began to occur was 20.1°, over which there was a linear correlation between C0-1 compensation and C1-2 separation (R = 0.860). Following surgical reduction of C1-2 rotation, the C0-1 angle in the compensation group also decreased (p = 0.017). However, there was a significant difference (p = 0.048) in the residual C0-1 at follow-up according to whether follow-up C1-2 was less or greater than 10°. Follow-up C0-1 did not restore to the physiological state of less than 3° in patients with residual C1-2 greater than 10°, which was the inflection point of piecewise linear regression for follow-up C0-1 and follow-up C1-2. The multivariate regression model for follow-up C0-1 was established as follow-up C0-1 = 0.638 + 0.422 * pre-operative C0-1 - 0.420 * follow-up C1-2 (p < 0 .001, adjusted R^2 = 0.797). **Conclusion:** Among patients with AARFD, non-physiological C0-1 compensation ($|C0-1| > 3°$) began when the C1-2 rotational separation angle exceeded 20.1°, and the amount of C0-1 compensation was significantly correlated with the extent of C1-2 separation (R = 0.860). C0-1 improved significantly following surgical correction of C1-2 rotation, and the residual C0-1 could be determined by the pre-operative C0-1 and the follow-up C1-2 angles. We recommended correcting the C1-2 rotation to less than 10° in order to ensure a physiological range of rotation for C0-1 post-operatively.

1544

A023: Surgical management of Klippel-Feil syndrome with basilar invagination: a retrospective review of 16 cases

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Introduction: Klippel-Feil syndrome (KFS) is a rare congenital disorder characterized by cervical vertebral fusion and a spectrum of associated anomalies. Among KFS patients, a significant subset presents with basilar invagination (BI) and assimilated C1 vertebrae, which can lead to compression of the brainstem and upper cervical cord, resulting in neurological deficits. Surgical intervention, involving decompression and occipitocervical reconstruction, is often necessary. However, the highly varied anatomical presentations of KFS pose unique challenges, particularly in selecting an appropriate posterior occipitocervical fixation strategy. This retrospective review aims to analyze the outcomes of 16 surgical cases of KFS with

BI and C1 arch assimilation. We assess the diverse anatomical variations encountered in this patient population, as well as the surgical approaches and techniques employed to address the complex pathology. **Material and Methods:** This retrospective review, conducted from 2019 to 2023 at a tertiary care spine center, The study cohort comprised 16 patients, including six women and ten men, with ages ranging from 26 to 52 years.Detailed preoperative imaging assessments were integral to our evaluation, encompassing anteroposterior view, lateral view, and open mouth view radiography, as well as thin-slice computed tomography (CT) scans with reconstruction views and magnetic resonance imaging (MRI). The study utilized various radiological parameters, i the basion-axial interval (BAI), basion-dental interval (BDI), clivus canal angle (CCA), Chamberlain line (CL), Wackenheim line (WL), and McRae line (ML). All patients in this series underwent Occipitocervical fixation and Decompression procedures. The challenging anatomical variations inherent to KFS necessitated the use of navigation assistance to optimize surgical precision and safety. **Results:** Symptoms were alleviated in all 16 patients (100.00%). Eight of them required foramen magnum decompression. The mean clivus canal angle improved from 128 preoperatively to 156 postoperatively. There were no evidence of hardware failure at 6 months post operative period. **Conclusion:** Our retrospective review enhances understanding of KFS with BI and C1 arch assimilation, guiding better treatment decisions and refining surgical approaches for improved patient outcomes and quality of life.

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A024: Surgical outcomes of 37 cases of dropped head syndrome

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Introduction: Dropped head syndrome (DHS) is characterized by chin-on-chest deformity which leads to difficulty of horizontal gaze and neck pain. Surgical strategy for DHS has not been established yet. In this study, we investigated the surgically treated DHS patients, and the impact of thoracolumbar spinal alignment on surgical outcomes of the DHS patients. **Material and Methods:** We included DHS patients who underwent corrective surgery in our facility from 2014 to 2022. We investigated the spinal sagittal alignment parameters (C2-7A, CSVA, T1slope, SVA, TK, LL, PI, PT), surgical methods, distal junctional failure, and revision surgery. Patients were divided in two groups, group M (PI- LL > 10, local kyphosis due to OVF > 30) and group G (others). The surgical outcome of each group was compared. **Results:** This study included 37 DHS patients (8 male and 29 female, mean age 74.8) The average

follow-up periods were 27.2 month. 30 patients underwent cervicothoracic corrective surgery, and seven patients were treated with thoracolumbar corrective surgery. Postoperative complications were 1 severe dysphagia and 1 surgical site infection. Implant failure occurred in two cases because of distal junctional fractures. In comparison of two groups, group G included 24 patients and group M 13 patients respectively, significant differences were observed in CSVA (G vs M, p value; 64.5 vs 74.7, p = 0.02), T1slope (34.5 vs 54.2, p < 0.01), SVA (-26.4 vs 75.7, p < 0.01), LL (56 vs 20.2, p < 0.01), PT (21.9 vs 32, p = 0.02), PI-LL (-3.3 vs 25.8, p < 0.01). Conversely, there was no difference in C2-7A (-43.6 vs-41.1, p = 0.88), TK (41.8 vs 40.8, p = 0.75). In group G, all 24 patients underwent cervicothoracic surgery. Although distal junctional kyphosis was observed in 7 patients (29.2%), extension of the fixation was required in only one patient. Overall surgical outcome of group G was excellent with improvement of horizontal gaze difficulty in all patients. In group M, 6 patients underwent cervicothoracic surgery resulting in distal junctional failure 2cases, recurrent of horizontal gaze difficulty 2cases, and additional lumbar corrective surgery in one patient. On the other hand, surgical outcomes of 7 patients with thoracolumbar corrective surgery were excellent with no instrumentation failure and horizontal gaze difficulty were improved in all cases. Moreover, significant improvement was observed in C2-7A, CSVA, and T1slope without direct surgical correction. **Conclusion:** Surgical outcome of group G was excellent with cervicothoracic surgery. On the other hand, surgical outcome of group M with cervicothoracic surgery was poor, while excellent outcome was observed in patients of group M with thoracolumbar corrective surgery. Considering these results, thoracolumbar spinal alignment which representing compensatory function for dropped head, has notable impacts on surgical outcomes. Surgeons should pay more attention to thoracolumbar spinal alignment and take them into consideration to determine surgical plans for patients with DHS.

1469
A025: Exo-endoscopic anterior C1-C2 fixation: a minimal invasive technique. Anatomic study with surgical implications

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Introduction: Although posterior C1-C2 fixation remains the gold standard technique in clinical practice in most cases (fractures, infections, tumors), sometimes an anterior approach can be helpful to obtain a C1-C2 fusion: in acute fractures

involving both the C1 ring and the odontoid where an occipito-cervical fusion can be avoided, in patients affected by arthritis rheumatoid or craniovertebral junction disease in which an odontoidectomy and anterior C1 arch removal is performed or in all the clinical cases in which the anatomy of the patients or concomitant diseases contraindicate a posterior approach or the prone position. The aim of this anatomical study is to provide the feasibility of a combined exo-endoscopic anterior cervical fixation of C1-C2. **Materials and Methods:** In three specimens an exo-endoscopic anterior C1-C2 fixation using transarticular screws was performed. In one case endonasal C1 anterior arch removal and odontoidectomy was performed to simulate a clinical case. The skin incision and the neck fascia and muscles dissection were accomplished under the magnification of the exoscope. Atlanto-axial transarticular screws were positioned under endoscopic view. CT scan of the neck was obtained after surgery to check the screws positioning. All the technical steps are described. **Results:** Anterior cervical C1-C2 transarticular fixation were obtained in all cases. The skin incision was 3 cm. The exoscope provides an excellent visualization of all the dissection steps. The entry point of the screws, 1 mm lateral to the dens and 1 mm medial to the C1-C2 articular process, is easily identifiable with the endoscope even after odontoidectomy and C1 anterior arch removal. The screws were placed under endoscope view and checked with X-ray scan. **Conclusion:** Cervical anterior transarticular atlanto-axial fixation seems feasible under combined exo-endoscopic view. After C1 anterior arch removal and odontoidectomy, this technique could be used to avoid a second step for posterior C1-C2 fixation. Maintaining the same supine position, it may reduce the surgical time, resulting in a better post-operative course. Since 2015 an endoscopic endonasal atlantoaxial transarticular screw fixation technique was described; however, the use of this technique in clinical practice is not simple to achieve to the point that there is no report of its use in the literature. This is probably because it is necessary to have dedicated instruments including screw holders and burr inclined at 30-45 degrees. Furthermore, the oblique downward access route makes it difficult to insert instruments from the nasal cavity, the ethmoid limits the lateral inclination of the screws and the hard palate limits the downward inclination.

1170
A026: Posterior and anterior fusion as correction of craniocervical and atlantoaxial instability using O-arm system versus X-ray procedures - A single centre review of 270 patients

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Introduction: A prospective analysis of the surgical treatment and results of 270 patients with benign and malignant craniocervical, atlantoaxial lesions operated during 12 years period (2011-2022) at our department was performed. The aim of the analysis was to assess, the fusion rate and the clinical outcome in patients after correction of craniocervical and atlantoaxial instability, comparing O-Arm System procedures versus C-arm procedure. **Material and methods:** We analyzed 175 patients with traumatic lesions, 21 patients with inflammatory lesions, and 74 patients with craniocervical tumors. We performed 312 operations. Because of craniocervical/cervical instability we made anterior or/and posterior screw fixation and fusion in all of 270 patients. In order to improve screw placement accuracy, we performed intraoperative O-Arm in 228 cases (84.4%). In 42 cases (15.6%) we used C-arm. **Results:** We analysed the significant operative outcome factors: the operative duration was 2h. in O-Arm operations and 4h in X-ray procedures and the blood loss was 220 ml in O-Arm and 500 ml in C-Arm procedures. The mean screw length (prognostic fusion rate factor) in C1/C2/C3 vertebras was 30 mm in O- Arm procedures and 24 mm in C-Arm procedures. The most common operative complications were: CSF leak - in 2 cases, postoperative infection - in 8 cases, screw misplacement - in 3 C-arm procedures, and 2 cases of early operative mortality. The 24-monts follow-up of 230 patients showed good recovery in 74% of patients, moderate disabling - 14% of patients, severe disabling - 5% of patients, vegetative state - 3% of patients, death - 4% of patients with malignant lesions or in bad general condition. **Conclusions:** Early and emergency correction of craniocervical and atlantoaxial instability facilitated neurological recovery by preserving the existent neurological function. Using of O-Arm increase significant operative screw placement accuracy, and preserve intraoperative nerve and vertebral artery injury. The fusion rate in O-arm procedures is 88% and 71% in C-Arm procedures. The clinical outcome in O-arm procedures is better than C-Arm procedures. The complications rate in O-arm procedures was significantly reduced (6,5%) comparing to C-arm procedures (14%). Recently because of the improvement of neuroimaging techniques, surgical techniques and neurointensive care the results of treatment of these lesions are recently better.

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A027: Chronic opioid therapy prior to elective spine surgery: what is the role of preoperative weaning protocols?

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Introduction: Recent clinical trials have questioned the efficacy of chronic opioid therapy (COT) for chronic musculoskeletal conditions. Further, both animal and human studies

show that post-operative opioid intake increases the risk for development of chronic pain. In spine surgery, COT has been associated with lower quality of life, increased disability, and poor outcomes. Recent studies on patients with musculoskeletal disorders show that preoperative opioid use is a strong predictor of prolonged post-operative opioid use. **Material and Methods:** The objective of this study was to develop and test the feasibility of pre-operative opioid tapering protocols. Patients eligible for inclusion were those aged > 18 years undergoing elective spine surgery within 6 months of enrollment while on chronic opioid therapy (COT), with exclusions being made for pregnant individuals, incarcerated individuals, those with disabilities, patients with acute spine trauma, and those undergoing surgery for metastatic spine conditions. The primary outcome measure was post-operative opioid use. Secondary objectives involved patient-related outcome measures. Postoperatively, patients were monitored at 2 weeks, 6 weeks, 3 months, and 6 months. Patients were randomly assigned to one of two groups: the intervention group, which underwent opioid therapy tapering using a multidisciplinary intervention toolkit, and the control group, which did not receive any active COT therapy. **Results:** This study included 154 patients (32 intervention, 122 control). The average ages of the intervention and control groups were 58.4 and 60.4 years old, respectively (p = 0.40), and their average BMI values were 30.7 ± 6.7 and 32.2 ± 7.2 (p = 0.31). The intervention group demonstrated higher rates of smoking (n = 8, 25%), psychiatric comorbidity (n =15, 49%), and substance abuse (18.8%) than did the control patients. Rates of self-reported chronic pain were similar between the intervention (31.3%) and control (28.7%) groups (p = 0.77). Both the control and intervention group demonstrated similar rates of postoperative opioid use, with 44% of the intervention group and 42% of the control group continuing opioid use beyond 3 months postoperatively. Preoperative patient-reported outcome measures including ODI and VAS scores were worse in the intervention group than the control group, and the intervention group exhibited less postoperative improvement in VAS and PROMIS scores compared to the remainder of the cohort. **Conclusion:** Overall, the methods employed in this study including a multidisciplinary intervention toolkit did not decrease chronic opioid use postoperatively. Resumption of postoperative narcotic use could result in short term effects and renewed dependence in the postoperative period and may provide one explanation for these findings. Rather than focusing on consumption reduction or weaning, efforts should be directed towards transitioning patients to multimodal pharmacology, providing access to psychiatric/mental health care, and optimizing other medical and surgical factors to facilitate a more comprehensive recovery.

OP04: Cervical Trauma

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A028: Supplementary posterior fusion after primary anterior discectomy and fusion for subaxial traumatic spine injuries

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Introduction: Traumatic subaxial fractures account for more than half of all cervical spine injuries. The optimal surgical approach is a matter of debate and may include anterior, posterior or a combined anteroposterior (360°) approach. **Purpose:** To identify predictors of the need for supplementary posterior fusion (PF) in patients initially treated with an anterior approach (ACDF) for traumatic subaxial cervical spine fractures. **Material and Methods:** A consecutive cohort study of all adult patients undergoing primary ACDF for traumatic subaxial cervical spine fractures between 2006 and 2018 was undertaken and 341 patients were included. Baseline clinical and radiological data for all included patients were analyzed and 11 cases undergoing supplementary posterior fixation were identified. **Results:** The most common trauma mechanisms were motor vehicle accidents (31%) falls from height (29%) and same-level falls (27%). The most common injuries were anterior longitudinal ligament (ALL) disruptions (87%) followed by traumatic disc ruptures (63%) and vertebral body

fractures (59%). The preoperative ASIA-IS grades were: E (44%), D (28%), C (16%), B (5.3%) and A (5.3%). Patients were operated at a median of 2.0 days from the trauma, undergoing 1-level (78%), 2-levels (16%) and ≥ 3-levels (6.2%) ACDF. A delayed supplementary PF was performed in 11 cases (3.2%, 10, 1-level and 1, 3-level ACDF) within a median of 20 days from the index surgery. In all cases, supplementary PF was performed due to construct failure. A median of 5-levels [4-7] were treated with PF. One patient worsened neurologically after ACDF and before PF. In the univariable regression analysis, higher age (p = 0.017), shorter height (0.031), posterior longitudinal ligament (PLL) injury (p = 0.004), injury to ligamentum flavum (p = 0.005), bilateral facet joint luxation (p < 0.001) and traumatic cervical spondylolisthesis (p = 0.003) predicted the need for supplementary PF. No correlation was seen to the number of treated levels. In the multivariable regression model, higher age (p = 0.015), PLL-injury (p = 0.048) and bilateral facet joint luxation (p = 0.010) remained as independent predictors for the need to perform supplementary PF. **Conclusion:** ACDF is a safe and effective approach for treatment of subaxial cervical spine fractures in the vast majority of cases. However, primary anteroposterior (360°), or only posterior fixation at index surgery should be considered in patients with high age, bilateral facet joint luxation and traumatic PLL disruption.

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A029: Efficacy, safety & reliability of single anterior approach for sub-axial cervical spine dislocation

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Background: Though there is ongoing controversy regarding the best treatment option for cervical spine dislocation (CSD), anterior cervical surgery with direct decompression is becoming widely accepted. However, managing all cases of subaxial CSD entirely by a single anterior approach is rarely seen in the published literature. **Methods:** The study comprised patients with subaxial CSD who underwent surgical stabilization utilizing a single anterior approach. Most of the CSD was reduced and anterior cervical discectomy and fusion (ACDF) were performed. Anterior cervical corpectomy and fusion (ACCF) were done in unreduced dislocations. The patient's neurological condition, radiological findings, and functional outcomes were assessed. SPSS version 25.0 (IBM Corp., Armonk, NY) was used for statistical analysis. **Results:** The total number of operated cases was 64, with an average of

42 months of follow-up. The mean age was 34.50 ± 11.92 years. The most prevalent level of injury was C5/C6 (57.7%). Reduction was achieved in 92.2% of cases; only 7.8% of patients needed corpectomy. The typical operative time was 84.25 ± 9.55 minutes, with an average blood loss of 112.12 ± 25.27 ml. All cases except complete spinal cord injury (CSI) were improved neurologically (87.63%). The mean Neck Disability Index (NDI) was 11.14 ± 11.43, and the preoperative mean visual analog score (VAS) was finally improved to 2.05 ± 0.98 (p < 0.05). In all cases, fusion was achieved. The most common complication was transient dysphagia (23.4%). After surgery, no patient developed or aggravated a neurological impairment. Implant failure was not observed at the final follow-up except for two cases where screws were pulled out partially. **Conclusion:** Based on the results of this study, a single anterior approach is a safe and effective procedure for subaxial CSD treatment with favorable radiological, neurological, and functional outcomes.

Keywords: traumatic cervical spine injury; anterior cervical corpectomyand fusion (ACCF); subaxial cervical spine dislocation (CSD); anterior cervical discectomy and fusion (ACDF); single anterior approach

2598
A030: Odontoid screw fixation in the elderly: functional, radiological, and adverse outcomes compared to hard collar immobilisation

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Introduction: Odontoid fractures are prevalent among elderly patients, particularly given their predisposition toward low-energy falls. Evidence comparing the efficacy of odontoid osteosynthesis and cervical orthosis of odontoid fractures remains sparse and heterogeneous with no studies comparing long-term outcomes. Herein, we compare the long-term functional and radiological outcomes of odontoid osteosynthesis and hard collar orthosis in elderly patients (≥ 65 years) with an acute odontoid fracture. **Materials and Method:** A matched case-control study, included patients ≥ 65 years with an acute odontoid fracture, collecting medical records from a single centre (August 2015 to August 2022). Cases had odontoid screw fixation; controls received hard collar immobilisation and were matched based on age range, frailty scores, Charlson Co-morbidity Indexes (CCI), and fracture morphology. Retrospective data recorded included: adverse events, surgical complications, mortality, revision rates and causes of revisions. Prospectively, patients completed

functional outcome measures: Visual Analogue Scale (VAS), Neck Disability Index (NDI), EQ-5D-5L and Dysphagia outcome and severity scale (DOSS). Radiological imaging was reviewed to assess union rate and screw positioning. Primary outcomes were VAS, NDI, EQ-5D-5L and DOSS scores and radiological union rates. Secondary outcomes were mortality rate and in hospital adverse events. Statistical tests included the Student t-test, Chi-square test and Fisher's exact test. Normality was assessed using the Shapiro-Wilk test. **Results:** Of 72 eligible patients (38 non-operative and 34 operative [15 posterior and 2 anterior]), 100% had admission data; 89% of surviving patients were contacted. Age, frailty score, CCI and mean GCS on admission were non-significant between groups. The long-term morbidity scores showed no significant difference between groups (13.28 (±10.6) vs 17.6 (±12.37), p = 0.09 [NDI], 6.76 (±4.6) vs 7.4 (±5.1), p = 0.58 [EQ-5D-5L], 2.26 (±2.21) vs 3.4 (±2.99), p = 0.06 [VAS], 5.50 ((±1.54) vs 6.11 ((±1.36) p = 0.29 [DOSS]). Non-union rates were 47% (operative) and 40% (non-operative) (p = 0.39). 14.7% of cases had a revision due to incomplete fixation or screw loosening. The operative group had significantly greater incidence of adverse events, length of stay (LOS) and number of days in ICU. Mortality rates were 26% (operative) and 29% (non-operative), which was not significant at any time point (6% vs 0%, p = 0.5 [in-hospital]; 9% vs 5%, p = 0.8 [1-year]; and 12% vs 21%, p = 0.4 [follow-up]). **Conclusion:** When compared to conservative immobilisation with cervical orthosis, odontoid screw fixation revealed no significant improvement in functional outcome, union rate and mortality. Moreover, odontoid osteosynthesis in the elderly carries an increased incidence of adverse events and high revision rates likely due to osteoporotic bone or stiffness of the cervical spine. Odontoid fractures pose a high morbidity risk in the elderly and future large-scale randomised controlled trials are imperative to establish whether odontoid osteosynthesis is beneficial for this growing population of complex patients.

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A031: Closed skeletal traction for unilateral locked facet can expedite realignment but does not affect time to decompression or AIS grade conversion at minimum three-month follow-up

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Introduction: Flexion-distraction force vectors can produce locked facet in the cervical spine. Concurrent rotation results in unilateral locked cervical facet (ULCF). Restoring spinal alignment is critical as dislocation results in spinal cord and nerve root compression. Closed skeletal traction (CST) is often attempted prior to surgical decompression and fusion but has variable success. The relationships between CST outcome (successful vs. unsuccessful closed reduction) with time from injury to surgery and postoperative MRI and with neurological outcome are not known. **Material and Methods:** We retrospectively queried a database of patients who were treated for ULCF at a single Level I Trauma Center. Patients underwent CST followed by definitive surgery, consisting of decompression and fusion and, if CST was not successful, open surgical reduction. Routine practice at our institution is to verify decompression with postoperative MRI. Demographic, radiographic, and surgical data were collected. **Results:** Among 172 patients with cervical facet injuries, 46 patients met criteria with ULCF and had attempted CST followed by surgery. Mean age was 45.6 ± 17.7, 34 patients (72.3%) were male, and C6-7 was the most common level of injury. Median admission ASIA motor score was 39. Twenty-six patients (55.3%) had a successful CST (mean weight 59.8 ± 33.5lbs). Common radiographic findings included fractures (43 patients, 91.5%) and epidural hematoma (15 patients, 31.9%). Seven cases (14.9%) had diffuse idiopathic skeletal hyperostosis (DISH). Patients who were successfully reduced with CST achieved realignment sooner (mean 5.5 ± 3.5 hours after arrival vs. 13.3 ± 8.0 hours for unsuccessful CST requiring open reduction, p = 0.0023). Patients with fractures involving the superior vertebral body of the locked level (OR = 0.054, p = 0.014) and DISH (OR = 0.116, p = 0.050) had significantly reduced odds of successful CST. AIS grade A (OR = 5.630, p = 0.059) and contralateral perched facet (OR = 15.967, p = 0.052) trended towards increased odds of successful CST. There was no association between CST outcome and time interval from injury to surgery (p = 0.752). There was no association between CST outcome and time interval from injury to verification of spinal cord decompression with postoperative MRI (p = 0.303). Improvement in ASIA motor score and AIS grade was assessed in patients with minimum three months follow-up [(AIS Grade E was excluded from this analysis); 27 patients had median follow up of 5.9 months and 3.3 months for successful and unsuccessful CST, respectively (p = 0.179)]. There was no significant difference in AIS grade improvement between the two cohorts. There was a trend towards improved ASIA motor score with successful CST (27.43 vs 11.82, p = 0.067). **Conclusion:** Morphological and clinical variables may help predict success of CST. Although successful CST was associated with shorter time from injury to reduction, it was not associated with shorter time from injury to surgery or postoperative MRI, or with AIS grade improvement at minimum three months.

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A032: Evaluation of clinicoradiological outcome between iliac crest tri-cortical graft and cage with local graft in anterior cervical fusion surgeries for single level three column sub- axial cervical injuries. a prospective cohort study

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Introduction: Traumatic sub-axial cervical spine injury is a potentially fatal disease leading to lasting disability from the neurological deficit and even leads to mortality. In adults, 39% - 53% spinal cord injury occurs in the cervical region. Of that 60-75 % injuries occur in the sub-axial cervical spine, of which, 45-50% occur in the C5-C7 region. Fall from height is the main cause of cervical spine injury in developing country like India. Cervical spine injuries can be managed either conservatively (skeletal skull traction, cervical braces, and halo vest) or operatively. Reduction and stabilization of the injured segment are the main principles in the treatment of unstable cervical spine injuries. Surgery can optimally reduce, stabilize, and directly decompress the cord and the exiting roots, which provide an opportunity for neurological recovery. Surgery enables early mobilization and avoids complications associated with conservative management. It can be managed by anterior approach, posterior approach, or combined. Anterior cervical fusion surgeries in unstable c-spine injuries can be done using tri-cortical iliac crest autograft or by using a cage with local graft as interbody material supplemented by an anterior c- plate. **Material and Methods:** Ours is a prospective comparative cohort study conducted at a tertiary care university teaching hospital from January 2020 to November 2021. The subjects were grouped in either group A (ACFS with cage) or group B (ACFS with iliac crest graft) based on surgeon's preference. ACFS includes both ACDF and ACCF. Clinical (VAS, ASIA grade and score, NDI and SCIM-3) and radiological (segmental Sagittal alignment and C2-7 cobb's angle) outcomes were compared between the two groups. **Results:** The mean follow up period was 14 ± 4.5 months. There was a significant improvement in VAS (neck) at the last follow-up in both groups and also a statistically significant improvement in NDI post-operatively within each groups. Pre-operative and 6 months SCIM in Group A and Group B were 52.18 ± 36.31, 87.33 ± 22.06 and 47.65 ± 37.08, 82.40 ± 26.90 respectively. There was a significant difference between the 2 groups in terms of change in SSA (t = 2.721, p = 0.012), CCA (t = 2.969, p = 0.006), subsidence(mm) (t = 3.218, p = 0.004), with the mean being highest in the Group A in all of them. Interbody fusion was achieved in 100% of the cases. Dysphagia was the most common complications in those patients who survived and completed the 6 months follow up. **Conclusion:** Anterior cervical fusion surgery using a cage with local graft as interbody material supplemented by an anterior c-plate in sub-axial cervical injury showed comparable fusion rates as tri-cortical iliac crest graft and a satisfactory clinical outcome with little donor site morbidity. Therefore, Anterior cervical fusion surgery using a cage with local graft as interbody material supplemented by an anterior plate can supplement traditional interbody fusion with autologous bone graft in sub-axial cervical spine injuries.

1051

A033: Acute surgery for traumatic cervical spinal cord injury in Norway. A population based study

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Introduction: Traumatic cervical spinal cord injury (cSCI) is the most feared complication of cervical spine injury and is associated with significant mortality and life-long morbidity. Optimal outcome depends on adequate acute care and rehabilitation. Early surgery (within 24 h) is regarded a key issue for neurological outcome. We all strive for early surgery, but what fraction of the patients with cSCI is operated within 24h? We here present population based real world data of time from injury to surgery in a health care system optimized for early surgery with well-organized interhospital transport system and 24/7 service for acute neck surgery at the regional neurotrauma center. **Materials and Methods:** This is a population-based retrospective database study (with prospectively collected data) from the South-East Norway health region with 3.1 million inhabitants. We included all consecutive cases diagnosed with a traumatic cSCI between 2015 and 2022. Extracted from the registry was information regarding demographics, injury description, time of injury, primary triage at local hospital or neurotrauma center, transfer to neurotrauma center, time of admittance neurotrauma center, time of cervical surgery, surgical method, and use of neuronavigation. **Results:** The study cohort included 387 patients with traumatic cSCI. Their median age was 64 years, 75% were males, and 49% were $\geq$ 65 years (WHO definition of elderly). cSCI was seen in all age groups, had a small peak in patients aged 20-25 years, and a major peak in patients aged 55-90 years. Males dominated in all age groups, except for the age group 20-25 years. Level of major spinal cord pathology on MR was C0-C2 in 11% and subaxial in 89%. Type of cSCI was Central Cord Syndrome (CCS) in 43% and non-CCS in 57%. CCS was more common subaxially than in C0-C2 region, and was strongly associated with preinjury degenerative cervical spinal stenosis. 370/387 of the patients (96%) were admitted to the neurotrauma center, of these 33% were admitted directly from scene of accident and 67% after triage at local hospital. Acute cervical surgery (fixation and/or decompression) was done in 290/387 (75%). We applied navigation

assisted screw placement in 29%. Surgical approach was anterior in 45%, posterior in 35% and 360° in 20%. Time of acute surgery was within 24h in 43% and within 48h in 65%. Patients with non-CCS compared to CCS were operated earlier (54% versus 26% within 24h). Arrival at neurotrauma center > 24h after injury was registered for 33% of the acute surgery patients. Other factors delaying surgery were severe head injury, physiological unstable patient, and diverging opinions regarding timing of decompression for CCS. **Conclusions:** The fraction of patients with traumatic cSCI undergoing acute surgery within 24h was lower than expected, especially for patients with CCS. Two targets for improvements are time to arrival at neurotrauma center and more clear in-house recommendations for timing of surgery for patients with CCS.

1517
A034: Clinical features of activity induced atlantoaxial rotatory fixation

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Introduction: Atlantoaxial rotatory fixation (AARF) is a common condition associated with painful torticollis in pediatric patients, although trauma can also cause AARF. However, only few reports in the literature discuss cases of trauma-induced AARF. In this study, we aimed to evaluate the clinical features of activity-induced AARF. **Material and Methods:** We conducted a retrospective review of patients with AARF who were treated at our hospital between April 2011 and July 2023. We excluded patients with third-party actions at the point of injury. We collected data on age, sex, Fielding classification, treatment duration and method, and outcomes. We divided the patients into three categories: those with trauma-induced AARF, inflammatory disease-induced AARF, and AARF of unknown origin. Statistical significance was set at p < 0.05. **Results:** Overall, a total of 147 patients with AARF were included in this study [aged 1 - 13 years: 73 boys and 74 girls; average age: 5.6 years]. The trauma group included 32 (21.8%) cases [18 boys and 14 girls; average age: 6.0 years; range: 2-11 years]; the inflammation group included 58 (39.5%) cases [23 boys and 35 girls; average age: 5.2 years; range: 1 - 13 years]; and the

unknown origin group included 57 (38.8%) cases [32 boys and 25 girls; average age: 6.0 years; range: 2 - 13 years]. Of 31 (61.3%) cases of trauma, 19 occurred during activities, 6 (19.4%) occurred during slips or falls, and 6 (19.4%) occurred during daily life. The activity group consisted of 12 boys and 7 girls, with an average age of 6.8 years (range, 3-11 years). All cases were classified as Fielding type 1 or 2. The types of activity were as follows: gymnastics and horizontal bar and mat exercises (3 cases, 15.8%); soccer (2 cases, 10.5%); basketball, swimming; use of a trampoline, vaulting horse, or kickboard; sumo-wrestling; and fencing (1 case, 5.3%); and hopping/jumping and/or frolic play (4 cases, 21.1%). Of the 19 patients in the activity group, 14 (73.7%); of the 58 patients in the inflammation group, 52 (89.7%); and of the 57 patients in the unknown origin group, 46 (80.7%) were followed to the point of cure. The median and interquartile range (IQR) of treatment duration was 6.5 days (IQR: 4.25 - 12.75 days) in the activity group, 11.5 days (IQR: 6.0 - 20.0 days) in the inflammation group, and 10 days (IQR: 4.0 - 19.0 days) in the unknown origin group. There was no significant difference in treatment duration between the groups. Three patients (15.8%) in the activity group were treated with rest only. Fifteen patients (78.9%) required color fixation, and one patient (5.3%) required Glisson's traction during hospitalization. No patient required surgical treatment under general anesthesia. **Conclusion:** Our study revealed that AARF can be caused by trauma during general activities. Activity-induced AARF occurred at a higher age than inflammation-induced AARF. However, the duration of treatment did not differ significantly between the activity group and the inflammation and unknown origin groups.

1379
A035: At risk tackling techniques and effectiveness in English Premiership Rugby

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Introduction: Head-down tackling has been shown to be associated with higher rates of head and neck injuries, as well as lower rates of successful tackles, compared to head-up tackling in American football. In rugby, head and neck injuries have been associated with tackles in which the tackler's head is positioned in front of the ball carrier. However, no prior studies have investigated the incidence or effectiveness of other tackling

techniques in professional rugby unions. The purpose of the study is to assess the tackling techniques used in English Rugby Premiership matches and to analyze the rates of successful tackles using these techniques. **Material and Methods:** In a retrospective cohort study, three reviewers analyzed 1,000 consecutive solo defensive tackling attempts made during the 2022-2023 season in six English Rugby Premiership matches. Slow-motion replays were used to assess the success of the tackling attempt, the tackling method, and the head position in relation to the offensive player's waist at the point of contact. The Chi-Square test or Fisher's exact test was used to analyze categorical data, while the two-tailed Student's t-test or the Mann-Whitney U test was used for continuous data. A p-value of < 0.05 was considered statistically significant. **Results:** The mean interrater reliabilities across all groups were good with a kappa of 0.715. Head-up and head-down tackling occurred in 848 tackle attempts (84.8%) and 152 tackle attempts (15.2%), respectively. Head-up tackles were successful in 80.7% of the tackle attempts compared to 71.1% of the head-down tackle attempts ($p = 0.0072$). Tackles were made at or above the level of the offensive player's waist in 807 tackle attempts (80.7%) and below the waist in 193 tackle attempts (19.3%). Tackles at or above the waist were successful in 80.7% of the tackle attempts compared to 73.1% of tackles below the waist ($p = 0.0193$). There were 698 tackles using the inside shoulder technique (69.8%), 215 arm technique (21.5%), 87 head across the bow technique (8.7%), and 0 head-to-head technique (0%). Inside shoulder technique had the highest successful tackle rate of 90.8%, compared to 44.2% with arm technique ($p < .0001$), and 72.4% with head across the bow technique ($p < .0001$). The inside shoulder technique resulted in head-up tackling in 84.4% compared to 59.8% with head across the bow ($p < .0001$) and 94.9% with arm tackling ($p = 0.0001$). There were four recorded injuries to the tackler in this cohort: two neck injuries, one shoulder injury, and one wrist/hand injury. **Conclusion:** Head-up tackling technique, tackles made at or above the level of the offensive player's waist, and inside shoulder technique are more efficient in producing successful tackles. Head-down tackling and tackling below the waist are associated with poor tackling methods including head across the bow, which have lower tackling success rates.

2549
A036: Tracheostomy for cervical spine trauma in the national inpatient sample: predictors and timing

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Introduction: Significant respiratory dysfunction from loss of respiratory drive, inadequate airway protection or inability to control respiratory musculature may necessitate invasive mechanical ventilation (IMV) in 41.1-57% of patients with cervical spinal cord injury. Using data from multiple systems across the USA, we sought to understand the characteristics in tracheostomy and to identify patterns that may lead to improved patient outcomes. **Material and Methods:** We used the Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project's (HCUP) National Inpatient Sample (NIS), 2016 to 2020. We identified cervical spine fracture and/or cord injury using ICD-10 diagnosis codes. Cervical spine fracture level was classified into C1-C2, C3-C5, and C6-C7. Spinal cord injury was classified into complete, incomplete, and unspecified. We also used these codes to identify surgical intervention. Similarly we determined whether patients received tracheostomy and dichotomized to <7 (early) or >7 (routine) days. We additionally examined time to tracheostomy, inpatient mortality, and discharged alive status by hospital day from admission. **Results:** 6722 patients underwent IMV alone without progression to tracheostomy while 2373 eventually underwent tracheostomy in this sample. Patients that ultimately underwent tracheostomy were younger (52.2 vs 58.8, $p < 0.001$) and more likely to have spinal injury from C3-C5 (22% tracheostomy rate vs 16 $p < 0.001$) compared to above or below. They were more likely to have complete or incomplete spinal cord injuries vs no injury ($p < 0.001$) and also more likely to have comorbid chest injuries (24% vs 17%, $p < 0.001$). 914 patients were in the early tracheostomy (ET) group vs 1561 in the routine group (RT). ET patients tended to be younger (49.1 years vs 55.2, $p < 0.0001$) and had higher Elixhauser comorbidity index (3.5 v 2.9, $p < 0.001$). They were more likely to have an associated mild to moderate TBI (49% vs 39%, $p < 0.001$). RT patients were more likely to have multiple system organ failure (41% vs 31%, $p < 0.001$) and were more likely to have undergone spine surgery (44% vs 39%, $p = 0.012$). Patients were more likely to undergo early tracheostomy if they were in facilities that were teaching hospitals ($p = 0.002$) but trauma volume, size of the hospital and region the hospital in the USA did not show difference. **Conclusion:** In this sample, younger patients with injuries at levels of the cervical spine controlling the diaphragm were more likely to eventually undergo tracheostomy. In addition, patients were more likely to undergo early tracheostomy if they had more comorbidities or an associated TBI. These results may drive decision making toward early trach and future studies will examine differences in outcomes amongst these groups when matched.

OP05: Basic Science - Biomarkers

686
A037: Suganon, a candiate for the treatment of inflammatory pain?

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Introduction: Evogliptin tartrate is a drug developed to control blood sugar in type 2 diabetes patients. This is known to inhibit DPP-4 and to increase incretin, such as GLP-1. They are closely related to inflammation as well as blood sugar, increasing GLP-1 is reduced the generation of various inflammatory cytokines, and inhibited DPP-1 are acted as an anti-inflammatory by inhibiting the disintegration of this GLP-1. This study is designed to identify the possibility of expansion of evogliptin (DA-1229) tartrate (No #13004), developed to control blood sugar in type 2 diabetes patients, as an inflammatory and inflammatory pain inhibitor. **Material and Methods:** Forty male Sprague-Dawley rats were divided into four groups (N = 10 in each): a native group, a complete Freund's adjuvant (CFA) inflammation model + Evogliptin tartrate (13.74 mg/ml/kg/1 time) (CFAE) group, a CFA + Vehicle (same volume of evogliptin tartrate/1 time) (CFAV) group, and a CFA +indomethacin (5mg/ml/kg/1 time) (CFAI) group. The CFA were injected subcutaneously at plantar of the rats, and each medication (evogliptin tartrate, vehicle, and indomethacin) were intake through feeding for 5 days. The rats were sacrificed 5 days after medication, and blood in heart and inflammatory tissue of the rat's plantar were obtained for checking the cytokine. Evogliptin tartrate effect to pain were evaluated by body weight of rats, paw thickness of the rat's plantar, paw withdrawal threshold, resting membrane potential of dorsal root ganglion (DRG), action potential firing of DRG, and cytokines (TNF-A and IL01B) level in plantar tissue and blood. **Results:** All CFA groups was lost the body weight comparing native group. Paw thickness of the rat's plantar, resting membrane potential of dorsal root ganglion (DRG), action potential firing of DRG, and cytokines (TNF-A and IL01B) level were increased, and body weight and paw withdrawal threshold were decreased in all CFA group. However, CFAE and CFAI group was recovered the paw thickness of the rat's plantar, paw withdrawal threshold, resting membrane potential of dorsal root ganglion (DRG), action potential firing of DRG, and cytokines (TNF-A and IL01B) level rather than CFAI group. Degree of recovery of CFAE group resembled to CFAI group. **Conclusion:** Evogliptin tartrate was showed a similar degree of anti-inflammatory and inflammatory pain improvement to Indomethacin, which was used as a max dosage. In addition, the hyper-depolarization of DRG cells by inflammatory diseases has been normalized in large part by evogliptin tartrate. It will be possible to expand the indication of this material as an anti-inflammatory drug in various inflammatory diseases or as a pain-suppression drug caused by inflammation.

1926
A038: Regulation of IL-1beta and inflammasome activity in the intervertebral disc by Link N through interaction with CD14

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Introduction: Intervertebral disc degeneration disease (IVDD) is a leading cause of chronic back pain due to abnormal sensory input by dorsal root ganglia neurons that innervate the disc. Recent studies have implicated the NLRP3 inflammasome in discogenic pain. The NLRP3 inflammasome is primed by Toll-like receptors (TLRs) present on the surface of cells that respond to various stimuli and is responsible for the processing of pro-inflammatory cytokines such as IL-1β through activation of caspase-1. TLRs typically require cofactors to efficiently respond to ligands including MD2 and CD14. The ligand diversity of TLRs is attributed to CD14. We have demonstrated that LN, a 16-residue peptide derived from link protein, regulates markers of inflammation and pain in IVDs both *in vitro* and *in vivo*, however, the mechanism(s) for this phenomenon remain unclear. In this study, we hypothesize that LN can regulate inflammasome activity through interaction with CD14. **Material and Methods:** Isolated human NP cells (hNPs) were incubated with LPS with and without LN for up to 72 hours. Western blotting was used to identify activation of Caspase-1, IL-1β, P-NFκB. QPCR was performed to determine changes in the expression of NLRP3, PYC, IL-6, IL1B and NGF. Peptide docking of LN to IL-1β (crystal structure, 9ilb) and CD14 (crystal structure, 1wwl) was determined using the CABS-dock web server. Models were created using PyMOL (Schrodinger, LLC). Biotinylated-LPS was incubated with human CD14 or in combination with unconjugated LPS, LN and pulled down using avidin-agarose beads to identify CD14 interactions. DRG neurons were isolated from lumbar regions L2-5 in 12-week-old C57BL/6 mice and cultured for 7 days with IL-1β with or without LN [1 μg/mL]. Cells were imaged for changes in intracellular Ca^{2+} either at resting state or following stimulation with capsaicin. **Results:** Western Blot demonstrated that LN inhibited LPS-induced NFκB and caspase-1 activation (n = 4, p < 0.01). Decreases in caspase-1 activation with LN were accompanied by reduced IL-1β maturation and secretion in NP cells (n = 4, p < 0.01). QPCR results demonstrated that LN can significantly decrease inflammasome marker expression (NLRP3, PYC, IL-1β, IL-6 and NGF; p < 0.05, n = 4). *In silico*

modelling suggested that LN can interact with CD14 in the LPS-binding pocket. Immunoprecipitation pull-down experiments corroborated the interaction of LN with CD14. When DRGs were incubated with IL-1β, basal intracellular Ca^{2+} levels were elevated when compared to controls (p < 0.001; n = 4) but significantly decreased when LN was present (p < 0.0001; n = 4). When DRG neurons were stimulated with capsaicin, IL-1β preconditioned neurons demonstrated a sustained increase in intracellular Ca^{2+}. Co-treatment with LN blunted the sustained Ca^{2+} increase induced by IL-1β. **Conclusion:** We postulate that LN may compete with CD14 ligands to mitigate Toll-like receptor activation. In addition to the inflammasome, we demonstrate a direct effect of LN on IL-1β-induced neuronal hypersensitivity. Future studies will be needed to address the mechanism of LN on inflammasome activation *in vivo*. These results may support the use of LN in the treatment of discogenic pain through the regulation of the inflammasome.

1650

A039: Pro-inflammatory adipokines linking obesity with heterotopic ossification of the posterior longitudinal ligament of the spine

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Introduction: Ossification of the posterior longitudinal ligament (OPLL) is a well-known cause of myelopathy in East Asians. OPLL commonly develops in the cervical spine, but it also occurs in the thoracic and lumbar spine. An epidemiological study showed that patients with multiple ossified lesions over the entire spine tend to be highly obese and have life-related diseases. This indicates that OPLL is attributable in part to obesity. In this study, we investigated the association of obesity-related adipokines (also called adipocytokines) with the development of OPLL. **Material and Methods:** Seventy-seven patients with symptomatic thoracic OPLL within 3 years of symptom onset were included. Current body mass index (BMI) and BMI increase from 20 years to maximum (ΔBMI) were investigated. The distribution and severity of OPLL was assessed by sagittal reconstruction computed tomography (CT) images of the entire spine. Serum levels of adipokines including leptin, adiponectin, and TNF-α and that of osteocalcin, bone formation marker, were measured in 77 patients with thoracic OPLL and 111 healthy controls. Propensity score matching was performed to minimize difference in baseline characteristics (age, sex and BMI) between the two groups, resulting in 58 pairs of patients. We compared the serum levels of adipokines between thoracic OPLL patients and healthy subjects. **Results:** BMI was negatively correlated with age at onset of symptoms and positively correlated with severity of paralysis (JOA score). The ossification index, a measure of the size and extent of ossified lesion, was significantly correlated with ΔBMI. Serum level of leptin and TNFα showed a positive correlation with BMI, while adiponectin was negatively correlated with BMI. Propensity score matching analysis showed that serum TNFα and osteocalcin levels in OPLL patients were higher than in healthy controls despite similar BMI. **Conclusion:** Our data showed that obesity is a risk factor for the earlier onset of symptoms and severer paralysis in patients with thoracic OPLL. This study also showed that the progression of obesity in adulthood is associated with the diffuse progression of OPLL. The observation that serum levels of TNFα and osteocalcin are higher in OPLL patients than in healthy controls at similar BMI suggests that chronic inflammation due to obesity may be an underlying condition that could predispose to the development or progression of OPLL. This aligns with earlier investigation reporting high serum level of CRP in patients with OPLL. The results of this study suggest that obesity and associated chronic inflammation may be a therapeutic target to suppress the progression of OPLL.

1580

A040: Heterogeneous osteoimmune profiles revealed by single-cell transcriptomics in osteoporotic patients who fail bisphosphonate treatment

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Introduction: Both postmenopausal and senile osteoporosis are caused by an imbalance between osteoclast and osteoblast activity, which considered as serious global healthcare problem with disability. However, mounting evidence suggests a role for the osteoimmune system in bone homeostasis. Bisphosphonate (BP) is antiresorptive agents but its treatment failure was reported as up to 40% indicating the clinical obstacles to treat the osteoporosis. **Material and Methods:** We performed microwell based single cell RNA sequencing (scRNA-seq) of peripheral immune cells from carefully selected three groups of postmenopausal women: non-osteoporotic, osteoporosis that improved after BP treatment, and osteoporosis that did not improve after BP treatment after long-term follow-up research after the prescription. Unsupervised clustering of the cells according to their transcriptomic profiles and cell-cell communication analysis were performed to delineate the differences between three groups. **Results:** We found an increase in

myeloid lineage cells in patients with osteoporosis (specifically, TCR+ macrophages). Furthermore, we observed significant variations in lymphoid lineage immune cells based on the osteoporotic condition, with a particularly fascinating finding of a substantial rise in NK cells in cases of BP failure compared to BP success. Moreover, we have identified specific biomarkers within the immune cells that show differences depending on the condition. Cell-cell interaction analysis revealed marked differences in osteoimmune networks suggesting the existence of osteoporotic- and BP-failure- specific cellular information flows, which can serve as a valuable source for further studies. **Conclusion:** These findings provide a microscopic atlas and biomarkers of postmenopausal osteoporosis and patients who failed BP, which will help us to better understand the role of immune heterogeneity in BP-failure and prognostic factors in pathology.

1127

A041: CCR2 monocytes as therapeutic targets for acute disc herniation in mouse models

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Introduction: Back and leg pain caused by disc herniation are major public health issues worldwide. Inflammatory mediators and ,acrophages are abundantly detected at sites of disc herniation, however, their origins and functions in the disease progression remain unclear. C-C chemokine receptor 2 (CCR2) is a monocyte specific receptor that plays a pivotal role in inflammation and immune cell trafficking. We hypothesize that the infiltration of monocytes into disc hernia sites differentiate into a diverse macrophage population and that disruption of monocytic infiltration by blocking CCR2 signaling can attenuate local inflammation and hyperalgesia following acute disc herniation. **Material and Methods:** To test this hypothesis, we employed genetic and pharmacological approaches to block the infiltration of monocytes in a mouse model of disc herniation. Specifically, we adopted a transgenic tamoxifen-induced CCR2-CreER; R26R-EGFP (Ai6) mouse strain to fate-map the influx of monocytes and monocyte-derived macrophages at disc hernia by immunostaining, FACS, and RT-PCR. We also employed a CCR2$^{RFP/RFP}$ mouse strain and a CCR2-specific antagonist PF-4136309 to study the impacts of CCR2$^+$ monocytes on local inflammatory responses, pain level, and disc degeneration. Data were shown as mean ± 95% CI. Differences between groups were analyzed by one-way ANOVA followed by Holm-Šídák's multiple comparisons test or t test. A p value < 0.05 was considered statistically significant. **Results:** CCR2$^+$ monocytes (GFP$^+$) increased at disc hernia sites over postoperative day (POD) 4, 6, and 9 in CCR2-CreER; Ai6 mice. F4/80$^+$ macrophages increased, and meanwhile CD11b$^+$ cells

trended downward. Co-localization analysis revealed both GFP$^+$CD11b$^+$ and GFP$^+$F4/80$^+$ constituted the majority of CD11b$^+$ and F4/80$^+$ cells at disc hernia sites. Furthermore, genetic depletion of CCR2 reduced infiltration of monocytes and macrophages, alleviated ipsilateral mechanical sensitivity, restored loss of disc height and changes in adjacent cortical bone for up to 1 month. Administration of a small molecule antagonist of CCR2 produced comparable results. **Conclusion:** Our findings suggest that circulating CCR2$^+$ monocytes play important roles in initiating and promoting the local inflammatory responses, pain sensitization, and degenerative changes after disc herniation. Thus, CCR2$^+$ monocytes may serve as therapeutic targets for disc herniation induced back and radicular pain. This study highlights a promising therapeutic strategy centered on modulating monocyte infiltration to alleviate the acute back and radicular pain triggered by disc herniation, offering potential relief to individuals suffering from this debilitating condition.

776

A042: Unlocking the targeting regulation of neuroinflammation after spinal cord injury-Bruton's tyrosine kinase (BTK) protein degradation

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Introduction: Spinal cord injury (SCI) precipitates a complex cascade of neuroinflammatory responses, significantly aggravating neuronal damage and hindering the potential for functional recovery. Recent advancements in molecular medicine have highlighted the instrumental role of Bruton's tyrosine kinase (BTK) in orchestrating inflammatory pathways implicated in neurodegenerative conditions. Leveraging the groundbreaking PROTAC (PROteolysis TAgeting Chimeras) technology, this study pioneers the development of a novel BTK protein degrader with the ambitious objective to significantly mitigate neuroinflammation and enhance neurological recovery in the aftermath of SCI. **Material and Methods:** This multifaceted investigation was stratified into two critical phases: an initial in-depth in silico analysis followed by comprehensive in vivo experimentation. During the in silico phase, state-of-the-art computational methodologies were employed to meticulously identify BTK binding domains, facilitating the design of highly specific PROTAC molecules capable of targeted BTK degradation. Subsequently, these molecules were synthesized utilizing advanced chemical techniques, followed by a meticulous evaluation process to assess their efficacy and selectivity in targeting

BTK. The subsequent in vivo phase capitalized on a well-established mouse model of SCI. The animals were systematically categorized into three distinct groups: a control group undergoing sham operations, an untreated SCI group, and a group receiving the innovative BTK degrader treatment. This latter group was administered the BTK degrader intrathecally for a period of 14 days post-injury, establishing a rigorous protocol to evaluate the potential therapeutic benefits of this novel approach. **Results:** The in silico component of the study successfully identified a series of PROTAC molecules demonstrating high binding affinity and selectivity towards BTK, thereby paving the way for subsequent in vivo analyses. The in vivo segment of the study revealed that the administration of the BTK degrader notably attenuated neuroinflammatory markers in the SCI group. This was evidenced by a substantial decrease in pro-inflammatory cytokines coupled with an elevation in anti-inflammatory markers within the spinal cord tissues, highlighting a promising shift towards a balanced inflammatory response. Furthermore, detailed histological evaluations unveiled a significant reduction in inflammatory cell infiltration, alongside preserved neuronal integrity in the treated group, suggesting a potential protective effect against neuronal damage. Moreover, the BTK degrader facilitated accelerated functional recovery, as substantiated by markedly improved scores in behavioral tests, indicating enhanced neurological function. **Conclusion:** This pioneering research vividly illustrates the immense potential harbored by PROTAC technology in developing a novel BTK protein degrader, a promising candidate to redefine the therapeutic strategy in managing neuroinflammation post-SCI. The BTK degrader exhibited promising therapeutic attributes, including diminished neuroinflammatory responses and facilitated neuronal recovery, fostering a promising avenue for future research. It is envisaged that ensuing studies will focus on optimizing the biochemical properties of the BTK degrader, further elucidating its mechanism of action and evaluating its efficacy in a more diverse array of animal models. This endeavor holds the promise to catalyze the transition towards clinical trials, potentially revolutionizing the therapeutic landscape for individuals afflicted with spinal cord injuries and ushering in a new era of hope and recovery.

1048

A043: Exosomal miR-140-5p inhibits osteogenesis by targeting IGF1R and regulating the mTOR pathway in ossification of the posterior longitudinal ligament

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Background: Ossification of the posterior longitudinal ligament (OPLL) is a disabling disease whose pathogenesis is still unclear, and there are no effective cures or prevention methods. Exosomal miRNA plays an important role in the osteogenesis of ectopic bone. Therefore, we focused on the downregulation of miR-140-5p in OPLL cell-derived exosomes to explore the mechanism by which exosomal miR-140-5p inhibits osteogenesis in OPLL. **Methods:** Exosomes were isolated by differential centrifugation and identified by transmission electron microscopy, nanoparticle tracking analysis, and exosomal markers. Exosomal RNA was extracted to perform miRNA sequencing and disclose the differentially expressed miRNAs, among which miR-140-5p was significantly down-regulated. The confocal microscopy was used to trace the exosomal miR-140-5p delivered from OPLL cells to human mesenchymal stem cells (hMSCs). The effect of exosomal miR-140-5p on osteoblast differentiation of hMSCs was assessed by alkaline phosphatase and Alizarin Red staining. Also, osteogenesis-related genes were analyzed. Luciferase reporter assay was utilized to identify the binding area between miR-140-5p and IGF1R. The IGF-1 induced phosphorylation of IGF1R/IRS1/PI3K/Akt/mTOR pathway was analyzed in hMSCs treated with exosomal miR-140-5p. Besides, micro-CT and immunohistochemistry of ectopic bone were performed to demonstrate the effect of exosomal miR-140-5p in vivo. **Results:** Exosomes were isolated by differential centrifugation and identified by transmission electron microscopy, nanoparticle tracking analysis, and exosomal markers. Exosomal RNA was extracted to perform miRNA sequencing and disclose the differentially expressed miRNAs, among which miR-140-5p was significantly downregulated. Confocal microscopy was used to trace the exosomal miR-140-5p delivered from OPLL cells to human mesenchymal stem cells (hMSCs). In vitro, we verified that exosomal miR-140-5p inhibited the osteoblast differentiation of hMSCs by targeting IGF1R and suppressing the phosphorylation of the IRS1/PI3K/Akt/mTOR pathway. In vivo, we verified that exosomal miR-140-5p inhibited ectopic bone formation in mice as assessed by micro-CT and immunohistochemistry. **Conclusions:** We found that exosomal miR-140-5p could inhibit the osteogenic differentiation of hMSCs by targeting IGF1R and regulating the mTOR pathway, prompting a further potential means of drug treatment and a possible target for molecular therapy of OPLL.
Keywords: OPLL, miR-140-5p, MSC, exosome

1827

A044: Pinpointing the specific macrophage phenotypes involved in intervertebral disc herniation regression

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Introduction: Lumbar disc herniation is one of the most common spine pathologies affecting 266 million individuals worldwide yearly. The spontaneous regression of lumbar disc herniation (LDH) is a clinically relevant phenomenon, and it has been mainly attributed to activation of immune cells that through inflammation and extracellular matrix remodeling stimulate hernia resorption. However, the exact mechanism is unknown. The objective of the current study is to 1) identify macrophage phenotypes (M1, M2a-d) and remodeling mechanisms within human surgical hernia explants from lumbar microdiscectomies; and 2) develop an in vitro co-culture model of phagocytosis using human surgical hernia explants and monocyte-derived macrophages, to better pinpoint the specific mechanisms behind physiological hernia regression. **Material and Methods:** This is an international study which included patients who underwent single or multi-level lumbar discectomy for disc herniations causing radicular leg pain. Demographic variables and pre-operative diagnoses were recorded. Disc tissue samples were collected from the surgeries and classified in three study groups: Group 1) protrusion, Group 2) extrusion contained by the posterior longitudinal ligament (PLL), and Group 3) extrusion not contained by the PLL. Samples were analyzed histologically by Alcian blue/Sirius red and by immunohistochemistry for CD68 (pan macrophage marker), CD163 (M2 macrophage marker), CD45 (B lymphocytes) and CD3 (T lymphocytes). Samples were also co-cultured in indirect transwell assays with monocyte-derived macrophages previously polarized towards M1, M2a and M2d phenotypes. The macrophage phenotypes and respective phagocytic activity were analysed by flow cytometry using pHrodo™ Red BioParticles™ conjugates. **Results:** A total of 21 explants were analyzed, with an average age of 45.0 ± 12.9 years, with 62% being male. Ten samples were classified as a protrusion, three were extrusions contained by the PLL and ten were extrusions not contained by the PLL. 38.1% were from L4-L5, 33.3% were from L5-S1, 14.3% were from L3-L4 and 9.5% were from L2-L3. Alcian blue/Sirius red staining identified higher collagen than proteoglycans content within the freshly collected explants. After 3 days co-culture with monocyte-derived macrophages, the explants maintained their structure and collagen/proteoglycans content remained unaltered. By flow cytometry viability analysis, we found that when M1, M2a and M2d macrophage are in presence of LDH explants, their overall viability is higher compared to monoculture and the explants modified the immune profile of the macrophages. Moreover, we found that the M2a phenotype present bigger cells and with a higher phagocytic profile than M1 and M2d, when in presence of LDH explants. **Conclusion:** The characterization of the immune profile of human hernia surgical explants and the analysis of macrophage phagocytic activity will be crucial for better designing a macrophage-based therapy for IVD herniation. We found that M2a macrophages show the highest potential towards such therapy. This study holds great promise for translational medicine aimed at accelerating spontaneous hernia regression or at inducing hernia regression in cases that would normally not regress spontaneously.

1624
A045: Analysis of the local expression of epigenetic candidate biomarker of adolescent idiopathic scoliosis progression

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Introduction: Adolescent idiopathic scoliosis (AIS) is a three-dimensional structural deformity of the spine affecting 2-3% of adolescents with still unknown etiopathogenesis. Curve progression prediction is fundamental for adequate clinical management and is currently based on clinical parameters like Cobb angle, main curve localization, Risser stage, and triradiate cartilage status. Epigenetic factors are emerging as promising candidates, but more research is needed since the available studies have mainly been carried out on peripheral blood or individual tissues, while the disease involves several different tissues and epigenetic regulation is tissue-dependent. To validate prospective epigenetic biomarkers of AIS progression we suggest an innovative methodology to characterize the gene expression of possible epigenetic modulators simultaneously on various tissues important for spine growth and stability. **Material and Methods:** A workflow covering the entire investigation protocol was established. After relevant literature search of epigenetic markers related to AIS progression, promising candidate genes were identified. Patients undergoing surgery for progressive AIS were recruited together with degenerative spinal disease patients used as controls. Peripheral blood, concave and convex bone tissue, concave and convex paraspinal muscles, and spinal ligament were collected from each

donor. Tissues were dedicated to RNA and DNA extraction and to histology. Total RNA extraction was followed by reverse transcription and semi-quantitative array-based real-time gene expression analysis. RNA expression levels are compared among different tissues of the same patient to look for tissue-specific regulation and to the same tissues of control subjects. The collection of genomic DNAs from each tissue sample allows for subsequent genetic analysis to demonstrate the presence of epigenetic mechanisms of gene expression regulation. **Results:** 28 nuclear genes and 5 miRNAs possibly undergoing epigenetic regulation during AIS progression were selected from those described in the literature as putative epigenetic markers. We designed a custom Taqman-based gene expression array to evaluate the local expression of these markers in different AIS tissues. Three housekeeping-genes were selected to be added to the array since they showed consistent expression in all the analyzed tissues and low-interindividual variability in the same tissue. Successful recovery of RNA and DNA was obtained from each tissue sample, whose histological characteristics were recorded by ematoxylin-eosin staining. RNA quality met the array-based experiment requirements (260/280 nm ratio ≥1.9) and mean RNA recovery ranged from about 1 to 40 μg (starting material from 20 to 200 mg tissue). Preliminary results confirmed successful amplification of RNA samples from all the analyzed tissue types through the designed custom array, with a wide range of relative expression, depending on the gene and on the tissue of origin. **Conclusion:** We validated an original workflow for the study of epigenetic regulation of AIS progression. The proposed workflow has the potential to highlight differential local expression of putative epigenetic curve progression markers to achieve a deeper understanding of the molecular mechanisms involved in disease development and identify reliable AIS progression biomarkers.

OP06: Lumbar Degenerative: Prediction, Prognostics & Outcome Measures

1090
A046: The predictive effect of Global Alignment and Proportion Score (GAP Score) on postoperative imaging and mechanical complications in Chinese patients with degenerative lumbar scoliosis

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Introduction: The Global Alignment and Proportion Score (GAP Score) was proposed to evaluate the balance of the whole spine-pelvis in sagittal plane, and can effectively predict the occurrence of mechanical complications after spinal correction surgery. However, its external effectiveness has not yet been evaluated. Early research has shown that the spine parameters of Chinese people are not identical with western people, and initial studies include a wide range of spinal abnormalities and various types of ASD. **Materials and Methods:** Enrollment criteria of this study were an age of ≥ 18 years and at least 1 of the following: coronal Cobb angle of ≥ 20°, sagittal vertical axis of ≥ 5 cm, pelvic tilt of ≥ 25°, and thoracic kyphosis of ≥ 60°. GAP score parameters were relative pelvic version, relative lumbar lordosis, lordosis distribution index, relative spinopelvic alignment, and an age factor. Proximal and distal junctional kyphosis and/or failure, rod breakage, and other implant-related complications were considered mechanical complications. The predictive accuracy of the GAP score was analyzed using receiver operating characteristic (ROC) analyses. Associations between GAP categories and mechanical complications and revisions were analyzed using Linear-by-Linear Association. **Results:** A total of 84 patients with DLS were included in the study, with an average age of 62.54 years, including 16 males and 68 females. The average follow-up time was 44.27 months. Fifty seven patients (67.86%) suffered at least one mechanical complication, including PJK in 22 patients (26.19%), PJF in 2 patients (2.38%), rod breakage in 3 patients (3.57%), implant related complications in 43 patients (51.19%), DJK/DJF in 8 patients (9.52%). Patients were divided into the complication group and the non-complication group according to whether there were mechanical complications. The bone mineral density T-value of patients with mechanical complications was significantly lower than that of non-complication group (-2.04 ± 0.86 vs -1.46 ± 0.97, p = 0.043). The mean postoperative GAP score was 5.66 (range, 0 to13). There was no statistically significant difference between the 2 groups in pelvic incidence (PI), measured sacral slope (SS), relative pelvic version (RPV), RPV subgroups score, measured lumbar lordosis (LL), ideal LL, relative lumbar lordosis (RLL), RLL subgroups score, L4-S1 lordosis, lordosis distribution index (LDI), LDI subgroups score, measured global tilt (GT), ideal GT, relative spinopelvic alignment (RSA), RSA subgroups score, age, age subgroups score and GAP score. The GAP score demonsrated poor power to predict mechanical complications, with an AUC of 0.442 (SE = 0.069, p = 0.397, 95% CI = 0.308-0.577). The Linear-by-Linear Association test showed no linear trend with GAP scores and rates of mechanical complications. 15 patients (17.86%) had a proportioned spinopelvic state according to the GAP score, whereas 38 patients (45.24%) and 31 patients (36.90%) had moderately and severely disproportioned states, respectively. There was no significant difference between GAP-score categories with regard to all health-related quality-of-life measures. **Conclusion:** In a follow-up of minimum 2 years, 67.86% DLS patients undergoing long instrumented spinal fusion experienced at least 1 mechanical complication. Patients

with mechanical complications had lower BMD than the control group. GAP score could not be applicable to predict postoperative mechanical complications in this DLS group.

2194

A047: What segmental and global radiographic parameter influence decision making in treatment of lumbar degenerative spondylolisthesis?

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Introduction: Surgical treatment of lumbar spondylolisthesis remains highly varied (from direct decompression, indirect decompressions, to various fusion methods) due to the high heterogeneity of the clinical and radiographical presentations. The underlying concern amongst surgeons is to minimize risks of iatrogenic spinal deformities. In recent years, there has been increasing awareness and adoption of applying our understanding of local segmental and spinopelvic alignment in treating degenerative lumbar conditions. The aim of the current study was to assess which spinopelvic radiological parameters are deemed important by surgeons and whether demographics and practice pattern affects the use of those parameters. **Material and Methods:** Three lumbar spondylolisthesis cases were electronically presented to AOSpine international members to study surgeons' preferences for treatment considerations. Data collected includes demographics, training background, years of experience, and treatment decisions based on various radiographical findings, including segmental measures and global and spinopelvic parameters. Comparative analysis was performed using the Pearson Chi-Squared Test. **Results:** A total of 479 responses were collected with a response rate of 50.8%. The most critical parameter that alters treatment decisions among the surveyed surgeons was translation on dynamic X-rays, followed by SVA value and PI-LL mismatch. The least important factor for decision-making was radiographic differences between static MRI/CT and X-rays. 71.4% of the surgeons opined that global SVA measurements affect their decision of treatments, and most of them feel that SVA > 5 cm or SVA > 10 cm are thresholds that influence their decisions. Surgeons who are fellowship trained ($p = 0.01$) or in academics/university practices ($p = 0.05$) are likelier to use SVA value in treatment decisions. 69.7% of surgeons reported that PI-LL mismatch affects their treatment decisions. Those in academic/university practice ($p = 0.01$) and who had fellowship training (0.008) were most likely to consider PI-LL mismatch in their decision-making. There was no difference between orthopedics and neurosurgery in applying global SVA ($p = 0.14$) and PI-LL mismatch ($p = 0.06$) in their treatment decisions for lumbar spondylolisthesis. **Conclusion:** Treatment of lumbar spondylolisthesis in our study was influenced by translation on dynamic X-rays, global SVA alignment, and PI-LL mismatch. Fellowship-trained surgeons and in academic/university-affiliated practices are likelier to apply SVA measurement and PI-LL mismatch in their treatment decision for lumbar spondylolisthesis.

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A048: Comparison of clinical outcome and fusion rate between ALIF and endoscopic/percutaneous TLIF with a large-footprint interbody cage

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Introduction: Anterior lumbar interbody fusion (ALIF) is considered a gold-standard technique for lumbar fusion. Endoscopic/percutaneous transforaminal lumbar interbody fusion (TLIF) is a relatively novel technique that uses Kambin's triangle to place an interbody device into the disk. Recently, endo-TLIF allows delivering large-footprint interbody cages comparable in size to anterior and/or lateral interbody cages. Aim of this study is to evaluate and compare the the clinical outcome and fusion rate, as well as post-operative complications of ALIF and trans-Kambin TLIF using a large-footprint interbody cage. **Material and Methods:** This is a prospective, non-randomized case-control study. Inclusion criteria comprised degenerative disk disease, foraminal stenosis and spondylolisthesis up to grade II. Exclusion criteria comprised infection, tumor and vertebral body fracture. For the "ALIF group", anterior lumbar interbody fusion surgery was performed following the standard left retroperitoneal approach. For the "endo-group", endoscopic TLIF surgery was performed using an extensive manual and/or endoscopic foraminoplasty. After percutaneous disk preparation,

a large-footprint expandable titanium interbody cage (size 39x13x15 mm; Vertaconnect, Signus GmbH, Germany) was placed into the intervertebral disk through Kambin's triangle. Demineralized Bone Matrix (DBM) was employed as graft. Posterior fixation was completed with percutaneous transpedicular screws for both groups. Visual Analogic Scale (VAS) and Oswestry Disability Index (ODI) scores were evaluated pre-operatively and post-operatively at hospital discharge, as well as 1, 3, 6, 12 and 24 months. Post-operative radiologic evaluation was performed with a standing X-ray and CT scan of the lumbar spine at hospital discharge and at 12 months. Statistical analysis was performed with Student's T-Test and statistical significance was defined for $p < 0.01$. **Results:** A total of 71 patients (37 (52%) female) were included with a mean age 59 ± 12.5 years. The ALIF-group comprised 31 (44%) patients (4 double-level) and the endo-group 40 (56%) patients (9 double-level). Total mean follow-up was 18.3 ± 5.6 months. No significant differences in age and sex distribution were found between both groups. Post-operative VAS back, VAS leg and ODI scores at latest follow-up showed significant improvement ($p < 0.001$) compared to pre-operative scores for both groups, respectively. There were no significant differences of the pre- and post-operative scores between both groups, respectively. Fusion rate was radiologically assessed at 90% for the endo-group and 96% for the ALIF group at 12 months post-op with no significance. Post-operative complications for the endo-group comprised one case with pseudo-arthrosis and two (5%) asymptomatic cases with a radiologically migrated cage. For the ALIF-group, two cases (6%) with venous bleeding and two cases (6%) with retrograde ejaculation were reported. Transitory post-operative radiculitis was reported for six ALIF cases (19,6%) compared to 10 patients (25%) in the endo-group. All post-operative radiculitis completely resolved within the first 6 post-operative weeks. Two patients (5%) in the endo-group compared to one ALIF case (3%) reported a post-operative motor weakness that recovered partially during follow-up. **Conclusion:** ALIF and endoscopic/percutaneous TLIF with a large-footprint interbody cage achieved comparable clinical outcome and fusion rate. Both techniques present approach related complications that need to be considered during indication of surgery.

678
A049: Exploring factors of cage subsidence in TLIF surgery: effects of cage design, surgical technical characteristics, and clinical sequelae

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Introduction: Cage subsidence remains a common occurrence in Transforaminal Lumbar Interbody Fusion (TLIF) surgery. In this study, interbody devices were grouped by design and material characteristics into five groups: static PEEK, static Ti, Internal Expansion (Initial HxW $\neq$ Final HxW), Accordion Expansion (expand in height), and Shell and Shim Expansion (Initial HxW < Final HxW). This analysis factors in the effect of cage composition, design, geometry, and surgical technique on cage subsidence (intraoperative and postoperative). **Material and Methods:** In a single-center retrospective study, adult patients who underwent a 1-level open- or MIS-TLIF, with static or expandable cages, and 2-year follow-up were included. Patients were grouped as no subsidence, presence of intraoperative subsidence, and postoperative subsidence. Subsidence was defined by > 2mm endplate breach on lateral radiographs. Cage dimensions were classified by their pre-expansion and final length, width, height, and lordosis indicated from implant product codes. Surgical characteristics included approach, cage positioning, posterior instrumentation, and decompression/releases. Fusion grading was conducted using Bridwell's grading system. Independent sample T-tests and Chi-square analysis were used. **Results:** 342 patients were included. Intraop subsidence occurred in 71/342 (20.18%) patients. Of the patients who did not subside Intraop, 68/271 (24.9%) subsided Postop. Demographics were similar between the groups, except BMI was significantly higher in the Postop subsidence group. Intraop subsidence was associated with increased cage length, increased cage height, and smaller cage width. Banana cages (width > length) had significantly less Intraop subsidence than bullet cages (length > width). There were significantly fewer PEEK cages in both the Intraop and Postop subsidence groups, and significantly more titanium cages in the Postop subsidence group. There were significantly more accordion expansion IBFDs with Postop subsidence. There were no significant differences in subsidence regarding intraoperative cage positioning. There were no significant differences between the change in lumbar lordosis from pre- to post-op between the groups, though the change in segmental lordosis was significantly higher in the Postop subsidence group. The intraoperative subsidence group had a significantly higher fusion grade at 2 yrs postop. Complications analysis revealed significantly higher rates of persistent radiculopathy, adjacent segment disease, pseudoarthrosis, and reoperation within two years in the Intraop subsidence group. **Conclusion:** Cage geometry and material characteristics are more directly associated with Intraop subsidence than Postop subsidence. A trend toward smaller cage footprint was seen in patients with Intraop, but not with Postop subsidence. The higher rates of postoperative complications following intraop subsidence suggest a need for continued research between expandable cages and intraoperative subsidence.

1657
A050: A neural network for prediction of surgical success in lumbar spinal stenosis patients

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Introduction: Lumbar spinal stenosis is a very common and debilitating medical condition caused by degenerative spinal changes. Patients can experience severe leg and back pain, which may significantly reduce physical functionality. Development of these degenerative spinal changes is associated with aging with approximately 103 million people worldwide suffering from spinal stenosis annually [1]. When conservative therapy has failed, surgical intervention can relieve symptoms. However, the efficacy of an operation remains unsatisfactory with a success rate of 60-70% [2]. To improve the selection of surgical candidates, artificial intelligence may be used. In this study, a model is developed using a Deep Learning approach to predict surgical success based on pre-operative MRI scans. **Material and Methods:** We analysed a dataset of axial T2-weighted MRI scans from patients who underwent surgery for spinal stenosis as part of a randomized clinical trial [3]. Scans were resized to 256x256 pixels and augmented by random cropping to 224x224 pixels and applying random horizontal flips. A 70:15:15 split was employed for training, validation, and test sets. Surgical outcomes at the 26-week follow-up were labelled using dichotomized Zurich Claudication Questionnaire data. Our neural network architecture combined a pre-trained ResNet50 convolutional neural network (CNN) feature extractor with a Neural Image Assessment (NIMA) classifier [4]. Given the limited dataset size, we utilized transfer learning for model fine-tuning. We optimized the model using a weighted binary cross-entropy (BCE) loss function and an ADAM optimizer with a learning rate of 10^{-6}. Our model was implemented in Python 3.11.4 using the PyTorch backend. The model's performance was evaluated on the testset using metrics including accuracy, F1 score, precision, recall, and the area under the Receiver Operating Characteristic curve (AUC-ROC). Gradient-weighted Class Activation Mapping (Grad-CAM) heatmaps were generated to identify salient features in the MRI scans that influenced classification. **Results:** A dataset of 682 slices from 140 patients was analysed. The training, validation and testing sets contained 477, 103 and 102 slices, respectively. Median age was 66 years (interquartile range: 61-74). There were 77 men (55%) and 63 women (45%). At 26 weeks follow-up, 96 patients (69%) had a successful outcome. The accuracy of our model was 0.89. F1 score (0.89), precision (0.89), recall (0.87) and AUC-ROC (0.94) also supported the models robust performance. The review of Grad-CAM heatmaps revealed that the model focused on clinically and anatomically relevant structures in successful predictions, and on less relevant features such as paraspinal musculature or vertebral bodies in unsuccessful predictions. This further underpins the robustness of this model for its potential clinical and research use. **Conclusion:** The deep learning algorithm developed in this study has shown high success rate in predicting surgical success for patients suffering from lumbar spinal stenosis. The model shows promising potential for optimizing the efficacy of surgical procedures while minimizing healthcare costs and improving patient outcomes. Future endeavors will focus on external validation of the model. Other avenues include the exploration of multi-input architectures that incorporate sagittal scans as well as demographic and clinical data to further improve predictive accuracy. **References**1. Ravindra VM, Senglaub SS, Rattani A, Dewan MC, Härtl R, Bisson E, Park KB, Shrime MG. Degenerative Lumbar Spine Disease: Estimating Global Incidence and Worldwide Volume. Global Spine J 2018 Dec; 8(8): 784-794. doi: 10.1177/2192568218770769. Epub 2018 Apr 24. PMID: 30560029; PMCID: PMC6293435.2. Schenck CD, Terpstra SES, Moojen WA, van Zwet E, Peul W, Arts MP, Vleggeert-Lankamp CLA. Interspinous process device versus conventional decompression for lumbar spinal stenosis: 5-year results of a randomized controlled trial. J Neurosurg Spine 2021 Dec 24; 36(6): 909-917. doi: 10.3171/2021.8.SPINE21419. PMID: 34952518.3. Moojen WA, Arts MP, Brand R, Koes BW, Peul WC. The Felix-trial. Double-blind randomization of interspinous implant or bony decompression for treatment of spinal stenosis related intermittent neurogenic claudication. BMC Musculoskelet Disord 2010 May 27; 11: 100. doi: 10.1186/1471-2474-11-100. PMID: 20507568; PMCID: PMC2885320.4. Talebi H, Milanfar P. NIMA: Neural Image Assessment. IEEE Trans Image Process 2018; Aug 27; 8:3 998-4011. doi: 10.1109/TIP.2018.2831899.

1811
A051: The development of new scoring system to define the presence of instability and the need of fusion in degenerative lumbar spinal stenosis - Jakarta Instability Score (JIS)

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Introduction: Whether spinal fusion is performed in addition to a laminectomy for lumbar spinal stenosis (LSS) depends on the stability of the involved spinal segments. Spinal stability is defined as the ability of the spine to maintain its degree of motion

while simultaneously preventing pain, neurologic deficit, and abnormal angulation. However, until currently, there is no clear consensus regarding the definition of instability to perform fusion in the cases of LSS. We developed scoring system to identify spinal instability in LSS and evaluate the need of spinal fusion. **Materials and Methods:** This study consisted of three steps, the systematic review to find predictors of spinal instability in LSS, development of scoring system for spinal instability – the Jakarta Instability Score (JIS) through expert opinion and modified Delphi technique, and reliability and validity studies of the new developed scoring system. The systematic review was performed through PRISMA guideline. Expert opinion and modified Delphi technique were performed by experience spine surgeons in Indonesia who had been elected trough discussion. Reliability and validity testing were performed in our institutional hospitals, which included the board-certified Orthopaedic surgeon and Radiologist. **Results:** A total of 57 studies were included in the systematic reviews, and the predictors of instability in spinal stenosis were divided into clinical (presence of back pain as primary or secondary symptoms), static plain radiograph (presence of vacuum phenomenon, intervertebral disk collapse, subchondral sclerosis, and traction spurs), dynamic plain radiograph (horizontal translation and angulation), and magnetic resonance imaging/ MRI findings (facet joint effusion, fatty degeneration of multifidus, endplate degeneration, and disk degeneration). Through expert opinion and modified Delphi technique, JIS score was developed and consisted of the clinical component (back pain), dynamic radiograph component (horizontal translation and angulation), and MRI component (facet joint effusion), each of the component will be scored, and the total scoring would be from 0 to 14. The final scoring would classify patients into three groups: stable group (score of 0 to 4) in which the fusion is not needed, potentially unstable group (score of 5 to 8) in which the decision of fusion is based on surgeon's clinical judgment, and unstable group (score of 9 to 14) in which the fusion is needed. Final step of study concluded that this JIS had a good intra-observer and inter-observer reliability and validity. **Discussion and Conclusion:** The new developed JIS was a reliable and valid scoring system that could help to identify the presence of instability in LSS and can be used as a guideline to decide whether spinal fusion would be needed.
Keywords: Instability; lumbar spinal stenosis; scoring system; reliability and validity

2356

A052: Predicting two-year outcomes of lumbar spinal stenosis surgery: utility of the Modic change grading score

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Introduction: Modic changes (MC) are a common phenotypic finding on MRI in patients with low back pain (LBP). Of the various degenerative spine conditions, in particular, lumbar spinal stenosis (LSS) have been associated with a high prevalence of MC on MRI. In patients with LBP and degenerative spine conditions undergoing surgery, MC have been associated with worse patient-reported outcomes (PROs). However, study results have been heterogeneous, possibly due to the inter-study variation as to how the MC phenotype is defined. A clinically relevant MC grading type have been suggested by Udby and Modic et al. No previous studies have evaluated the association between MC grading and PROs following LSS surgery. **Material and Methods:** Patients from the Danish national spine registry, DaneSpine, scheduled for LSS surgery were identified. Lumbar MRI of patients with preoperative MC was selected for inclusion. MC was defined and graded according to the Udby and Modic et al. classification. In addition, preoperative and two-year postoperative data were collected including demographics (age, BMI, smoking etc.) and PROs consisting of pain scores - Visual Analogue Scale for back pain (VAS-BP) and leg pain (VAS-LP); and physical disability score - Oswestry Disability Index (ODI). **Results:** In total, n = 208 patients were included, 15% (31 pts) with MC grade A and 85% (177 pts) with MC grade ≥ B. There was no significant difference in preoperative age,BMI or smoking between the two groups - 68 vs. 67 years (p = 0.746); 27 vs. 28 kg/m^2 (p = 0.370); 19% vs 18% smokers (p = 0.546). There was no significant difference in preoperative pain or disability scores, VAS-back (VAS-BP) or leg pain (VAS-LP) and Oswestry Disability Index (ODI), p > 0.1. At two-year follow-up after LSS surgery, patients with MC grade ≥ B had significantly worse pain scores, VAS-BP - 32 vs. 44 (p = 0.045) and VAS-LP - 27 vs. 45 (p = 0.003). Physical disability was significantly worse at two-year follow-up in the MC grade ≥ B group, ODI score - 22 vs. 30 (p = 0.036). **Conclusion:** This is the "first study" to evaluate the association between the MC grading score and PROs in patients undergoing LSS surgery. MC grade ≥ B was associated with significantly worse pain scores and increased disability at two-year follow-up. We suggest, that future studies include the MC grading score in order to investigate the possible impact of MC phenotypes on PROs.

1680

A053: Spine-specific sarcopenia: distinguishing paraspinal muscle atrophy from generalized sarcopenia and frailty

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Introduction: Sarcopenia is a risk factor for increased morbidity and mortality in various patient populations. In spine surgery, atrophy of the paraspinal muscles (PM), especially the multifidus and erector spinae, has emerged as a critical parameter for clinical outcomes. Given the potential overlap and differences between general and spine-specific sarcopenia, there is a need for further investigation. Our study aims to compare the agreement between generalized sarcopenia measurements and spine-specific sarcopenia. **Material and Methods:** We conducted a retrospective cohort study in patients undergoing spinal fusion for degenerative pathologies. Patients with previous lumbar spinal fusion or poor image quality were excluded from the study. We used custom software written in MATLAB® to calculate the fatty infiltration (FI) of the PM. Generalized sarcopenia was evaluated with screening tools recommended by the European Working Group for Sarcopenia in Older People (EGWSOP): Short Physical Performance Battery (SPPB), grip strength (Jamar® Smart Hand Dynamometer), and the psoas index. The correlation was calculated using Spearman's rank correlation coefficient (rho). The strength of the correlation was evaluated according to established cut-offs: negligible: 0 - 0.3, low: 0.3 - 0.5, moderate: 0.5 - 0.7, high: 0.7 - 0.9, and very high ≥ 0.9. In a Receiver Operating Characteristics (ROC) analysis, the Area Under the Curve (AUC) of sarcopenia assessments to predict severe multifidus atrophy (FI ≥ 50%) was calculated. In a secondary analysis, factors associated with severe multifidus atrophy in non-sarcopenic patients were analyzed. **Results:** A total of 125 patients were included in the analysis. The multifidus and erector spinae FI showed significant correlations with generalized sarcopenia assessments, with grip strength exhibiting the highest correlation (rho = - 0.43 and – 0.32 respectively, p < 0.001). In the ROC analysis, the AUC for SPPB, grip strength and psoas index were 0.61, 0.71, and 0.72 respectively. The latter two were lower in female patients, with an AUC of 0.48 and 0.49. Facet joint arthropathy (OR: 1.26, 95% CI: 1.11 - 1.47, p = 0.001) and foraminal stenosis (OR: 1.54, 95% CI: 1.10 - 2.23, p = 0.015) were risk factors for severe multifidus atrophy, independent of age and sex. **Conclusion:** Our study demonstrates a low correlation between general and spine-specific sarcopenia assessments. The study findings highlight the risk of misdiagnosis when relying on these screening tools. Furthermore, this divergence suggests that general and spine-specific sarcopenia may have distinct etiologies.

1508
A054: The MRI based vertebral bone quality score is a predictor of pedicle screw loosening following short-segment posterior lumbar fusion

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Introduction: Poor bone density was reported to be a risk factor for pedicle screw loosening, and novel MRI based vertebral bone quality score was shown to be correlated to bone mineral density measured by DEXA. The study aimed to investigate the predictive ability of the MRI-based vertebral bone quality (VBQ) score for pedicle screw loosening following instrumented transforaminal lumbar interbody fusion (TLIF). **Material and Methods:** Data from patients who have received one or two-level instrumented TLIF from February 2014 to March 2015 were retrospectively collected. Pedicle screw loosening was diagnosed when the radiolucent zone around the screw exceeded 1mm in plain radiographs. The T1-weighted MRI sagittal images were used for calculation of the VBQ score. Univariate analysis and multivariate binary logistic regression analysis were performed. Receiver operating characteristic curve analysis assessed the predictive ability of the VBQ score on screw loosening. **Results:** Among the included 211 patients, 75 of them (35.55%) had pedicle screw loosening at the 24 month follow-up. Multivariable logistic regression analyses demonstrated that higher VBQ score (OR: 27.887 ± 0.514, 95% CI: 10.189-76.326), male sex (female to male 0.323 ± 0.483, 0.126-0.833), and longer fusion length (2.578 ± 0.545, 1.166-5.701) were significant influencing factors for pedicle screw loosening. The VBQ score significantly predicted screw loosening with an accuracy of 78.9%. **Conclusion:** A higher VBQ score was an independent risk factor for pedicle screw loosening following instrumented TLIF. The MRI-based VBQ score showed good predictive ability for screw loosening and could be used as an alternative option for preoperative bone quality evaluation.

OP07: Recent Advances in Adulty Deformity

957
A055: The effect of sagittal alignment on the development of proximal junctionl kyphosis

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Introduction: The incident of postoperative mechanical complications such as proximal junctional kyphosis (PJK) and adjacent segment disease remains an important concern of spine fusion surgery. Among modifiable factors associated with their development, planning sagittal alignment with specific targets garners significant attention. Despite existing proposed classifications targeting sagittal spinopelvic parameters to reduce PJK development, investigation on patient-specific optimal sagittal alignment is ongoing. Under-correction of lower lumbar lordosis (LLL) and overcorrection of upper lumbar lordosis (ULL) are known as reasons for PJK development. The aim of this study is to evaluate the effect of ULL overcorrection on PJK development and propose a mathematical formulation to identify the ULL overcorrection using a novel radiographic parameter. **Material and Methods:** Forty consecutive patients with UIV of T10 fused to the pelvis, without previous fusion surgery, were retrospectively reviewed. The measurements on postoperative spino-pelvic parameters such as pelvic incident (PI), pelvic tilt (PT), inflection point (IP) pelvic angle (IP_PA), and IP tilt angle (t_IP), as well as distance measurement between sacrum, lumbar apex and IP were performed. A mathematical formulation based on LLL and ULL was developed, which calculates the theoretical IP location and IP_PA corresponding to the actual postoperative t_IP. The theoretical and actual IP_PA were compared for PJK and Non-PJK groups. The receiver operating characteristic (ROC) curve analysis was performed. **Results:** The overall incidence of PJK was 45% (18/40). Positioning of upper instrumented vertebra (UIV) is one of the important factors in PJK development, which is affected by inflection point (IP). Inflection point had been positioned posteriorly with respect to the theoretical position for 11 patients (61.1%) among the PJK group, and just for 3 patients (13.6%) in non-PJK group. The result of ROC analysis showed that ULL overcorrection, with the proposed approach of IP positioning determination with an odd ratio of 9.95, can be considered a significant risk factor for PJK development. The sensitivity and specificity of this approach were 0.61 and 0.86, respectively. Using mathematical formulation, we achieved a theoretical PI-dependent IPPA. The mean difference between theoretical and actual IPPA for predicted PJK and NonPJK group was ($3.03o \pm 3.7$ o vs. $0.79o \pm 0.4$ o, p-value = 0.003). The main causes of PJK in 7 patients (38.8%) were undercorrection of LLL and the present of rigid un-instrumented upper thoracic (UT) segment with negligible amount of reciprocal change. On the other hand, demonstration of proper UT compensation in 3 NonPJK patients with ULL overcorrection prevents the development of PJK. **Conclusion:** The effect of sagittal alignment on the development of PJK was addressed through three reasons of ULL overcorrection, LLL undercorrection, and rigid un-instrumented UT. Utilizing a mathematical approach to determine proper PI-relevant IPPA, we were able to identify the ULL overcorrection in most PJK patients. Therefore, IPPA was introduced as a patient-specific radiological risk factor for PJK development. Considering proper IPPA can aid surgeons to preplan individualized sagittal alignment to mitigate the risk of PJK development.

1050

A056: The impact of lumbar lordosis correction loss on rod fracture following lateral lumbar interbody fusion for adult spinal deformity - analysis of the segmental lordosis change using computed tomography imaging

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Introduction: Advancements in surgical techniques have allowed significant correction of the lumbar lordosis (LL) through the lateral approach in adult spinal deformity (ASD). However, there are insufficient studies on the postoperative changes in LL including segmental changes after minimally invasive lateral lumbar interbody fusion (LLIF). Therefore, this study aimed to evaluate the aspect of correction loss through computed tomography (CT) analysis and to find out the impact of correction loss on rod fracture (RF). **Material and Methods:** 89 subjects with ASD (average 71.5 years) with a minimum 2-year follow up were analyzed. The intervertebral disc (IVD) angles of each levels from T12 to S1 were analyzed using CT sagittal images. Comparison analysis was performed by dividing the group into a group showing a decrease of 5° or more in total LL at 2 years after surgery compared to immediately after surgery (correction loss group, n = 23) and a group showing no decrease (non-correction loss group, n = 63). **Results:** Correction loss occurred in all segments over time after surgery, especially in the lower lumbar region. IVD angle decreased at L2-3, 4-5, and L5-S1 within 1 year postoperatively and at L4-5 and L5-S1 between 1-2 years postoperatively, especially at L5-S1. In the non-correction loss group, IVD angles were significantly larger at the L1-2, L3-4, and L5-S1 during the postoperative follow-up period. The overall rate of RF incidence was 25.8% (23/89 cases). LL correction loss more than 5 degrees was associated with RF (p < 0.001, OR = 7.28) and osteoporosis (p < 0.01, OR = 3.85). **Conclusion:** In our study, the LL correction loss showed a distributed pattern with a decrease in each intervertebral disc angles. In particular, LL correction loss of 5 degrees or more was closely associated with RF. Therefore, it can be seen as a danger signal of RF, so additional support should be considered to prevent correction loss and RF.

2471
A057: In patients with a pelvic incidence-lumbar lordosis within 10• who have mechanical complications, does the Roussouly classification explain their failures?

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Introduction: While achieving pelvic incidence-lumbar lordosis (PI-LL) $\leq 10°$ is a standard spinopelvic alignment goal, the Roussouly classification describes four unique spinal shapes with varying lengths and amount of lordosis/kyphosis. In patients undergoing adult spinal deformity (ASD) surgery, we sought to: 1) report the rate of mechanical complications in patients with PI-LL $\leq 10°$, and 2) describe their postoperative Roussouly type and corresponding sagittal parameters. **Materials and Methods:** A single-institution, retrospective cohort study was performed of patients undergoing ASD surgery from 2009-21. Inclusion criteria were: $\geq$ 5-level fusion, sagittal/coronal deformity, fusions to sacrum/pelvis, and 2-year follow-up. The independent variables were postoperative PI-LL $\leq 10°$ and postoperative Roussouly type, lumbar apex, vertebrae in upper/lower lordosis arc, pelvic retroversion, and inflection point. A "False Type 2" was a-priori defined as PI > 50° with a pelvic tilt (PT) > 50% of the PI. Outcomes included overall mechanical complications. Bivariate statistics were performed. **Results:** A total of 181 patients underwent ASD surgery and were instrumented to the sacrum/pelvis with a mean age of 68.7 ± 11.4. Of 65 patients with postoperative PI-LL $\leq$ 10°, 42/65 (64.1%) had a mechanical complication. Among patients with PI-LL $\leq 10°$ and mechanical complications (N = 42), 18/42 (42.9%) patients had False Type 2 alignment. 23/42 (54.8%) patients had mismatch between the theoretical pelvic incidence-based Roussouly type and the practical sacral slope-based Roussouly type. The postoperative lumbar apex moved cranial or was unchanged in 52.4%. The number of vertebrae in the upper lordosis arc decreased or was unchanged in 25 (59.5%) patients, and the number of vertebrae in the lower lordosis arc increased or was unchanged in 20 (47.6%) patients. **Conclusion:** Among patients with a postoperative PI-LL $\leq 10°$, 64% had mechanical complications, most of whom had False Type 2 alignment. Over half had a mismatched theoretical and actual postoperative Roussouly type. PI-LL $\leq 10°$ may not fully explain ASD alignment goals, and the Roussouly classification may help explain how these imperfect alignments lead to mechanical complications.

1521
A058: Impact of pelvic anteversion on spinopelvic alignment in asymptomatic population: a dynamic perspective in standing and sitting position

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Introduction: In asymptomatic population, pelvic anteversion subgroup presented unusual large lumbar lordosis (LL) and highly sloped sacrum with relatively small pelvic incidence (PI). Considering such unique sagittal alignment in anteverted pelvis (AP) subgroup was necessary in spinal surgery. However, there is still lack of a predictive model considering different pelvic version, and dynamic characteristics of AP subgroup was also unclear yet. **Material and Methods:** 565 asymptomatic Chinese participants aged 18-80 were included. All participants accepted the whole spine radiographs in standing position and 235 of them further in sitting position to measure the sagittal parameters. Sagittal parameters including PI, pelvic tilt (PT), sacral slope (SS), LL, thoracic kyphosis (TK), T1 pelvic angle (TPA), sagittal vertical axis (SVA), PI-LL, LL-TK and SS/PI were measured in whole spine radiographs in standing and sitting position. The participants with pelvic anteversion were divided into the AP group. Sagittal parameters were compared between AP and non-AP group, and predictive formulas of LL based on PI were built in both groups. Further, change of sagittal parameters from standing to sitting position were compared in the AP group and a PI-matched control group. **Results:** 171 (30.3%) participants were with pelvic anteversion. Comparing to the non-AP group, the AP group presented larger LL, SS and smaller PT with relatively small PI. The predictive formulas of LL were LL = 0.60×PI+21.60 (R^2 = 0.268, p < 0.001) in the whole cohort, which was LL=0. 83×PI+18.75 (R^2 = 0.427, p < 0.001) in AP group and LL = 0.79×PI+9.66 (R^2 = 0.451, p < 0.001) in non-AP group. From standing to sitting position, the AP group presented larger decrease in SS (-15.1 ± 8.9° vs -8.7 ± 8.7°, p < 0.001) and LL (-24.3 ± 11.4° vs -16.2 ± 11.7°, p < 0.001) comparing to the control group, indicated different patterns of spinopelvic motion. **Conclusion:** 30.3% of Chinese population presented pelvic anteversion. The AP group presented unique characteristics in spinopelvic alignment, and identifying different pelvic version improved the accuracy of the linear models predicting LL. In the process from standing to sitting position, different patterns of spinopelvic motion were discovered in AP group.

1734
A059: High Body Mass Index (BMI) is associated with increased radiation exposure and lower pedicle screw accuracy in robot-assisted minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF)

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Introduction: Robotic navigation is increasingly being utilized in spine surgery as a result of demonstrated safety and accuracy of pedicle screw placement, streamlined workflow, and both decreased radiation exposure and operative times. However, the impact of patient body-mass index (BMI) on these parameters has not been studied. Prior studies have identified obesity as a risk factor for major medical complications, pseudarthrosis, and superficial infection following MI TLIF. This has at least in part been hypothesized due to greater difficulty of surgical exposure and as a consequence, longer operative times. In addition, intra-operative imaging is often calibrated to the patient's body habitus in order to provide adequate visualization. Thus the purpose of this study was to evaluate the effect of BMI on operative time, radiation exposure, and pedicle screw accuracy in patients undergoing minimally invasive transformainal lumbar interbody fusion (MIS-TLIF) using robotic navigation. **Material and Methods:** A retrospective review consecutive patients undergoing robot-assisted single-level minimally invasive transforaminal interbody fusion at a single academic institution (2017-2023) was performed. Demographics including age, sex, BMI, American Society of Anesthesiologists (ASA) score, Charlson Comorbidity Index (CCI), and tobacco use, and surgical parameters such as operative time, blood loss, pedicle screw accuracy, radiation dose, and fluoroscopy time were recorded. Patients were divided into two groups: non-obese (BMI < 30, 170 patients) and obese (BMI > 30, 73 patients). Pedicle screw accuracy was assessed postoperatively by computed tomography; accuracy was defined as good (without tip, endplate, pedicle, or facet breach), acceptable (pedicle breach within < 4 mm superior/lateral or < 2 mm inferior/medial, or tip breach), and poor (facet violation, pedicle breach outside acceptable zone, or endplate breach). **Results:** A total of 243 patients were included (170 in the non-obese group, 73 in the obese group). There were no significant differences in patient demographics, but obese patients had a higher ASA class (p = 0.044) and higher BMI (non-obese: 25.2 ± 0.2 kg/m^2 vs obese 34.3 ± 0.4 kg/m^2, p < 0.001). There were no significant differences in operative time (Mean 158 minutes for obese vs 142 minutes for non-obese, p-0.097), blood loss (median 50 for both groups (p = 0.483), and fluoroscopy time (median 30 seconds for obese vs 25 seconds for non-obese, p = 0.065). Obese patients were exposed to higher doses of radiation than non-obese patients (72.2 mGy versus 47.3 mGy; p = 0.002). After adjusting for age and sex, multivariate regression modeling revealed that higher BMI was not only associated with higher radiation doses (Standardized beta = 0.26, p < 0.001), but also with greater odds of poor screw placement (OR: 1.67, 95% CI: 1.08-2.55; p = 0.018). **Conclusion:** Obese patients undergoing robot-assisted minimally invasive lumbar fusion spine surgery had higher doses of intraoperative radiation exposure and lower accuracy of pedicle screw placement compared to non-obese patients. Optimization of imaging protocols to minimize radiation exposure while allowing adequate visualization may be particularly important in patients with a large body habitus. These findings suggest that future research focusing on perioperative workflow improvements is important in these higher risk patients.

228
A060: Similar radiographic and functional outcomes with either posterior or anterior surgery in patients with moderate sagital imbalance

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Introduction: Over the past decade, some attention has shifted from posterior surgery towards anterior lumbar interbody fusion with anterior column realignment (ALIF-ACR). Thus, there is some uncertainty regarding the use of anterior- versus posterior-based surgery for less severe deformities. This current study tried to clarify this issue and included only patients with a moderate deformity (SRS-Schwab modifier + for PI-LL mismatch, SVA and PT) who

could be treated with either technique. We hypothesized that both functional and radiographic outcomes of ASD patients with moderate deformity who underwent either anterior or posterior approach would be similar at 1-year post-surgery. **Material and Methods:** A retrospective cohort study included 61 ASD patients treated surgically between 2019 and 2020 at a single tertiary orthopaedic specialty hospital. Patients were divided into two groups: Group 1 (ALIF-ACR, 29 patients) and Group 2 (TLIF- Schwab2, 32 patients). Spinopelvic radiographic parameters and functional outcomes were evaluated at 3, 6, and 12 months post-surgery. **Results:** Perioperative outcomes favored the ALIF-ACR group, with significantly smaller blood loss, shorter hospital stay and operative time. Radiographic and functional outcomes were similar for both groups, however the ALIF-ACR group did have a greater degree of correction in lumbar lordosis at 12 months. Complication profiles varied, with the ALIF-ACR group experiencing mostly hardware-related complications, while the TLIF-Schwab2 group faced dural tears, wound dehiscence, and proximal junctional kyphosis. Both groups had similar revision rates. **Conclusion:** Both ALIF-ACR and TLIF-Schwab2 achieved similar radiographic and functional outcomes in ASD patients with moderate sagittal plane deformity at 1-year follow-up. However, the safety profiles of the two techniques differed. Further research is required to optimize patient selection for each surgical approach, aiming to minimize perioperative complications and reoperation rates in this challenging patient population.

2448
A061: One-third of surgical adult spinal deformity (ASD) patients are consuming opioids both pre- and postoperatively with significant international differences: this is partly a cultural issue

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Introduction: Amidst a current opioid epidemic, it is important for providers to understand variables that contribute to sustained opioid use after ASD surgery. Propaganda such as "pain is the 5th vital sign" have pushed a cultural perception that demanding opioids is a responsible solution, which is likely to have some influence on opioid use. Our goal was to evaluate international variation in pre- and postoperative opioid consumption, with the hypothesis that there are substantial regional differences with regards to opioid use before and after ASD surgery. **Material and Methods:** Patients ≥ 60 years of age from 12 international centers undergoing spinal fusion of at least 5 levels for spinal deformity were included. Pain scores were collected using a Numeric Rating Scale (NRS) for both back and leg pain. Opioid use was defined as the consumption of prescribed opioid drugs and from question 11 from the SRS 22r questionnaire. Scores were collected at baseline and 2-yrs. Centers were divided into North America (NA), Europe (E), and Asia (A). **Results:** 219 eligible patients were identified, of which 179 patients had data available at 2 year follow up. 176 (80.4%) were females with a mean age of 67.5 yrs. Overall, a similar number of patients were using preoperative opioids (OP, 75/219 [34%]) as those using them post operatively (55/179 [30%]) at 2-years. Only 5.8% and 7.7% of A pts were taking opioids pre- and postoperatively respectively, whereas 58.3% and 53.2% of E pts were consuming them respectively. Equivalent data for NA patients were 50.5% and 40.2%. There was no difference in NRS-B or NRS-L for E patients at baseline or 2-yrs regardless of opioid use. Patients using opioids at baseline had worse mean NRS-L scores (7.6 vs 4.2, p-0.023), otherwise there was no difference in the baseline NRS-B or 2-yr NRS-B or -L scores. NA patients using opioids had worse baseline NRS-B (6.6 vs 5.5, p-0.003) and NRS-B (3.3 vs 1.4, p-0.001) and NRS-L (2.6 vs 1.0, p-0.007) at 2 years. **Conclusion:** Almost 1/3 of surgical ASD pts are consuming opioids both pre- and postoperatively world-wide. There is a drastic international difference, with Asia having a much lower usage rate suggesting a cultural influence.

2488
A062: The dreaded false negatives - When intraoperative neuromonitoring fails to detect neural deficits associated with complex spinal deformity correction: a prospective international study from the AO spine knowledge forum deformity

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Introduction: Preservation of post-operative neural function is necessary to the success of operations to address spinal deformity. The purpose of this study is to assess and compare rates of new neurological deficits relative to intra-operative neuromonitoring (IONM) alerts in cord-level and non-cord-level complex spinal deformity operations. **Methods:** Twenty international centers prospectively documented the intra-operative neuromonitoring, demographics, radiographic findings, and surgical events of patients undergoing spinal deformity correction based on a standardized created data collection form. Enrolled patients met the following inclusion criteria: age: 10-80 years, neurologically intact, undergoing spinal deformity correction with a major Cobb > 80° or undergoing a posterior column or 3-column osteotomy with EMG, SSEP and MEP monitoring. IONM change was defined as a loss of amplitude of > 50% in SSEP or MEP from baseline or sustained EMG activity that lasts > 10 seconds. Detailed neurological examination was performed at baseline, immediately post-op and prior to discharge from hospital. Rates of new neurological deficits were recorded and compared between cord-level and non-cord-level operations based on IONM alerts. **Results:** 546 patients were recruited into the study, of which 532 had data on new post-operative neurological deficits and were included for analysis. After surgery, a new neurological deficit was present in 11.3% of patients. Of the 60 patients who had a new neurological deficit, 63.3% had no IONM change. For cord-level operations (n = 339), a new neurological deficit occurred in 27 patients (8.0%) of whom 14 (51.9%) had no IONM change. For non-cord-level operations (n = 193), 33 patients (16.8%) experienced a new neurological deficit post-op. Of these patients, 24 (72.7%) had no IONM alert. IONM alerts occurred in 13.5% (72/532) of all cases with similar frequency between cord-level (15.3%) and non-cord-level operations (10.4%). Of the 72 patients who had any IONM alert, 22 (30.6%) had a new post-operative neurological deficit. In the presence of an IONM alert and attempts to address the alerts, a greater percentage of non-cord level patients had a new post-op neural deficit compared non-cord level patients (45.0% v. 25.0%). Of the 460 patients without an IONM alert, 8.3% had a new post-operative deficit (i.e. false negatives). False negative IONM alerts were significantly greater for non-cord-level operations (13.9%) compared to cord-level operations (4.9%). Sensitivity of IONM alerts was significantly lower for non-cord level (27.3%) operations compared to cord level operations (48.2%), while specificity was higher for non-cord level operations (93.1%) compared to

cord-level operations (85.5%). **Conclusions:** In this multi-center, international prospective study of complex spinal deformity operations, new neurological deficits occurred in 8.3% without having associated IONM alerts. That false negative IONM alerts were significantly greater for non-cord-level operations (13.9%) compared to cord-level operations (4.9%) is confirmation that development of new IONM modalities that are more sensitive to root-level neural injuries is critically needed to complement the current multi-modal IONM strategies for spinal deformity operations.

1393
A063: Prospective evaluation of elderly deformity surgery variability

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Introduction: Spinal fusion for adult spinal deformity (ASD) is increasing worldwide. There exists significant variability with of surgical approaches and techniques. The Prospective Evaluation of Elderly Deformity Surgery (PEEDS) Study is an international, multicenter study that was performed to determine the value of ASD surgery in patients over 60 years of age. The objective of this study is to describe the variability in surgical strategy and technique employed worldwide in the treatment of ASD in elderly patient populations. **Material and Methods:** A multicenter, prospective, longitudinal case series was conducted. Patients over 60 years were prospectively included if they were to undergo 5+ level spinal fusion for spinal deformity in the sagittal and/or coronal plane. Data regarding surgical strategy was collected, including single- versus two-stage, choice of approach (anterior, anterior posterior, lateral or combinations thereof) and the presence/absence and type of interbody cage(s). Minimum duration of follow up was two years. **Results:** 219 patients were ultimately enrolled in the study from 12 centers around the world, including 176 females and 43 males. The mean age was 67.5 years (range 60-83 years). The median number of levels fused was 9 (range 5-24). 76% of included patients (166/219) underwent surgery via single-stage posterior-based procedure, involving posterior spinal instrumented fusion, with or without interbody devices. The remaining 24% (53/219) underwent two-stage surgical correction. **Conclusion:** While single-staged posterior spinal fusion with, or without interbodies was the most prevalent approach (73%) in this study, significant variation exists in the

surgical treatment of patients with ASD. Further study is warranted to determine which surgical strategy results in optimal clinical and functional outcomes in order to better guide surgical treatment for ASD patients.

OP08: Patient Related Factor

2090
A064: Uniformity in following spine guidelines recommendations: do spine surgeons follow evidence-based guidelines? A systematic review

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Introduction: Evidence based guidelines and Clinical practice Guidelines are available to ensure that treatment is easily translated into clinical practice and is uniform and equivocal. It is unclear to what extent spine surgeons' treatment choices are based on evidence and recommendations from clinical guidelines. This study is to find out how many spine surgeons in 5 areas of spine surgery – Spine trauma, Cervical degeneration, lumbar degeneration, Deformity and Spine infections are (Guidelines Concordant) versus (Guidelines Discordant). **Material and Methods:** Following PRISMA guidelines, a comprehensive keyword search in Cochrane, Embase, Medline and Scopus were carried out from earliest record to 2022. Inclusion criteria had any study, that reported spine treatment choices through surveys of spine surgeons. Using median and Inter quartile ranges, we categorized the spine surgeons into 3 categories, those who chose treatments 'Following recommendations' from established guidelines, those who 'Do not follow recommendations' and finally those spine surgeons who treat 'without Recommendations' and do not consider evidence-based guidelines for treatments they offer. **Results:** 71 studies were included. Spine surgeons who followed recommendations (n = 15) were 67% for spinal trauma, (n = 3), 11% who did not follow recommendation. For Cervical degeneration, 12% (n1) followed NASS guidelines, 37% (n = 4), did not and 51% (n = 6) did not consider any guidelines for treatment. For Lumbar degeneration, 23% (n = 4), 14% (n = 2) did not follow. For Deformity, out of 7 studies, 3 mentioned spine surgeons who followed recommendation, for infections, SPLIF guideline 42% did not consider any infection guidelines. The 3 categories of surgeons were then subdivided into surgeons who were concordant with guidelines and those who were discordant. Highest amount of discordance was found in Cervical Degeneration group against NASS guidelines at 87%, 77% was 2nd group against NASS guidelines for lumbar degeneration. Surgeon concordance was generally low, 12%

for cervical degeneration group, 23% for lumbar degeneration, Deformity group was 39% and infection at 45%. The highest compliant surgeons following guidelines was seen in Spinal trauma at 67%. **Conclusion:** Many spine surgeons do not follow evidence-based guidelines when they chose treatment in their area of expertise. There is a dire need to educate spine surgeons to improve their ability to treat with use of guidelines and evidence-based medicine. Further studies are needed to establish if this is the case in surgery or specific subspecialty.

815
A065: Spine surgery outcomes in patients with patient-provider language discrepancy

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Introduction: In an effort to provide the best care to our patients, there currently exists a growing focus on understanding which patient groups may be at greater risk for poorer outcomes. In the current body of orthopedic and spine literature, there is very little data regarding outcomes for patients where there is language discordance with the physician-patient. To investigate the impact of language discordant spine care. Specifically, do patients with patient-provider language discrepancies experience 1) increased length of stay? 2) increased rates of complications (i.e., intra/perioperative complications, revision surgery, reoperation)? **Material and Methods:** This is a retrospective cohort study. All patients who underwent spine surgery at a single academic institution by eight spine surgeons in the USA between January 1, 2017, and January 1, 2023, were included. Translator usage was used as a proxy for poor English language proficiency and provider-patient language discordance. Patient demographic and outcome data including age, body mass index, sex, race, insurance type, smoking history, opioid usage, American Society of Anesthesiology class, Charlson Comorbidity Index, primary language, intra/postoperative complications, readmission, reoperation were all collected from the electronic medical record. Patients were 1:2 matched on surgical and demographics factors and analyzed for outcome variables. Multivariable logistic regressions were run to assess variables associated with poor outcomes. **Results:** A total of 220 non-English speakers and 9392 English speakers were originally reviewed. The final matched cohort resulted in 197 non-English speakers and 348 English speakers. Demographic data was no different between the final cohorts.

non-English speakers patients had significantly more preoperative visits (p < 0.001), increased intraoperative complications (p = 0.005), readmission (p = 0.03). On multivariate analysis non-English speakers were predictive of increased length of stay (p < 0.001) and readmission (p = 0.039). **Conclusion:** Patients with low English proficiency experienced significantly longer lengths of stay increased rates of intraoperative complications and readmissions following spine surgery. These patients may benefit from increased and more effective preoperative and postoperative communication.

263
A066: Weight change after smoking cessation on the risk of vertebral fractures: a nationwide population-based cohort study

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Introduction: Smoking cessation reduces the risk of vertebral and hip fractures but increases body weight. The impact of changes in weight subsequent to smoking cessation on the risk of vertebral fractures remains uncertain. The purpose of this study was to assess the risk of vertebral fractures among individuals who reported smoking cessation, with a specific focus on the changes in body weight following the smoking cessation. **Material and Methods:** A nationwide population-based cohort study of adult over 40 years included 913,805 individuals who underwent biennial regular health check-ups between 2007 and 2009. The incidence and rate of vertebral fractures occurring between 2010 and 2018 was assessed based on the smoking status: non-smokers, quitters, and current smokers. Individuals with smoking cessation was categorized according to the weight change between baseline and 2 years prior: weight maintenance (-5%~5% of weight change), weight loss ($\leq$ 5% of weight change) and weight gain (> 5% of weight change). We utilized Cox proportional hazard analyses to determine the hazard ratio (HR) associated with the incidence of vertebral fractures based on smoking status and temporal weight change over a span of two years. **Results:** This study evaluated 913,805 eligible participants, of whom 672,858 were classified as non-smokers, 34,143 as quitters, and 206,804 as current smokers. The overall risk of vertebral fractures was significantly higher in quitter (adjusted HR [aHR] = 1.110, 95% confidential interval [CI] 1.013-1.216) than in non-smokers, but it was lower than in current smokers (aHR = 1.197, CI 1.143-1.253), regardless of weight change after smoking cessation. As compared with current smokers, the aHRs for vertebral fractures were 0.95 (CI 0.972-1.14) among quitters with weight gain, and 0.901(CI 0.807-1.007) among those with weight maintenance. However, even

following the smoking cessation, individuals who experienced weight loss exhibited a notably higher risk of vertebral fractures in comparison to current smokers (aHR = 1.105, CI 0.836-1.461). In female population, weight gain after smoking cessation showed higher the risk of vertebral fractures (aHR 1.34, CI 0.753-2.386) than even in female current smokers. **Conclusion:** Maintaining a weight after smoking cessation may potentially mitigate the risk of vertebral fractures. Furthermore, weight loss after smoking cessation adversely affects the vertebral fracture protective effect of smoking cessation in general population. Different effect of weight change on fracture risk in male and female should be cautious applied to estimate fracture risk after smoking cessation.

293
A067: Words or numbers - A prospective randomized controlled study comparing opioid consumption between two groups of patients receiving two pain evaluation methods following lumbar spinal surgeries

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Introduction: The increasing concern of opioid overuse warrants adequate control of opioid prescriptions in multiple settings including acute pain following spine surgeries. Adequate pain management requires scientific evaluation of pain, however, pain evaluation itself may inadvertently exacerbate pain and increase opioid consumption. The widely used Visual Analogue Scale (VAS), for example, often requires patients to frequently grade their pain on a scale of zero to 10 and, thus, prompts patients to excessively focus on their pain, potentially reinforcing it. This study, therefore, investigated whether replacing the VAS with everyday verbal language in pain evaluation can reduce postoperative opioid consumption in spine patients. **Material and Methods:** This prospective randomized controlled study focused on adult patients with degenerative lumbar spinal disorders undergoing one or two-level posterior lumbar fusion surgeries. Prior to surgery, patients were randomly assigned to either the "Numbers" group or the "Words" group to receive two types of pain evaluation postoperatively. The Numbers group utilized the VAS scale, whereas the Words group replaced the VAS with qualitative verbal questions like "*Is the pain severe?*" and "*Does the pain affect sleep, dining, or sitting at a table*?" The phrasing of these questions can vary, but always emphasizes, as exemplified above, a qualitative inquiry about whether the patient requires pain relief at that moment and a description of the pain's effect on daily activities. Other perioperative protocols were equivalent between groups,

including access to opioid treatment. Primary outcomes include the average dose of opioids (all converted to morphine milligram equivalent) and nonopioids (number of total single doses) consumed within one month postoperatively, as well as the length of analgesics use (days). The sample size was pre-estimated to ensure 80% study power with an α value of 0.05. **Results:** 49 and 55 patients were randomized to the Words group and the Numbers group, respectively. Baseline patient characteristics, such as sex, age, comorbidities, were comparable between groups except that more patients in the Words group received sufentanil, a fentanyl opioid (32.5% vs. 14.7%, p = 0.03). After surgery, the Words group had significantly shorter length of analgesics use (6 [IQR: 4, 9] vs. 7 [IQR: 4, 12], p = 0.02) and lower nonopioid consumption (10 [IQR: 4, 21] vs. 28 [IQR: 12.5, 39], p < 0.001). For the opioid consumption, the use of sufenanil was found to be an effect modifier. When considering all patients regardless of whether they received sufentanil, there was no significant difference in opioid consumption between the two groups (35.3 [IQR: 20.4, 82.5] vs. 51 [IQR: 29.6, 77], p = 0.45). However, when only analyzing patients who did not receive sufentanil (33 patients in the Words group and 47 in the Numbers group); the Words group showed significantly lower opioid consumption (28.5 [IQR: 14.2, 36.8] vs. 41 [IQR: 28, 63.2], p = 0.02). **Conclusion:** Replacing the VAS scale with qualitative verbal language in pain assessment could reduce postoperative nonopioid and opioid consumption for spine patients. This effect may not be observed if the opioid used is a fentanyl such as sufentanil.

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2309
A068: What are the robust clinical criteria in diagnosis of cervicogenic headache?

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Introduction: The diagnosis of cervicogenic headache (CGH) is based on clinical criteria mentioned by the International Headache Society (IHS) and Cervicogenic Headache International Study Group (CHISG). However, its diagnosis is still challenging by the overlap of symptoms and pain location observed in migraine and tension-type headache (TTH), which are high-lightened in the above diagnostic criteria for the differential diagnosis. This study aimed to evaluate the diagnostic accuracy of suggested criteria for CGH. **Methods:** We prospectively evaluated suspected patients having a CGH and treated for the anesthetic blockade from February 2018 to July 2020 and the patients with medical history including cervical operation, tinnitus, dental problems, or ocular disease were excluded. Patients have been referred to a neurologist for differential diagnosis and divided into three groups, CGH, migraine, and TTH groups based on the consensus of the neurologist, and a total of 107 patients were allocated at each group, 58, 21, and 28 patients, respectively. Pain intensity using a numeric rating scale (NRS), unilaterality without side-shift, pain location by the patient-drawing (whether or not to include occipital region), and pain provocation in neck range of motion (ROM), which were the main clinical criteria for diagnosis of CGH in both HIS and CHISG, were evaluated at pre-injection. All patients received anesthetic blockade (3rd occipital nerve or C2-3/C3-4 medial branch block) and the responsiveness was investigated at 2 and 8 weeks after injection. More than 50% reduction of pain intensity at two weeks was considered a responder. The sensitivity, specificity, and diagnostic accuracy of the following four clinical criteria, were evaluated; 1) Response to blockade, 2) Pain location, 3) Unilaterality, and 4) Pain provocation on neck range of motion (ROM). **Results:** The "Response to blockade" and "Pain provocation on neck ROM" demonstrated the higher diagnostic values as a screening tool for differentiating CGH from migraine and TTH with a sensitivity of 96.6% /94.5% and accuracy of 70.1%/79.4%, respectively. In contrast, pain location (whether or not including occiput) and unilaterality were relatively lower diagnostic accuracy, 68.2%/54.2%. Especially, in "Response to blockade", the pain reduction and its sustainability until 8 weeks were statistically significant in CGH compared to migraine and TTH group. **Conclusion:** Among suggested clinical criteria by HIS and CHISG, "Response to blockade" and "Pain provocation on neck ROM" criteria demonstrated the robust diagnostic values, whereas the "Pain location (including occiput)" and "Unilaterality without side-shift" appeared to be insufficient criteria for the diagnosis of CGH. In "Response to blockade", sustainability of pain reduction until 8 weeks could be one of the significant findings to differentiate CGH from migraine and TTH.

2117
A069: A data-driven approach to categorize patients with degenerative cervical myelopathy: a K-prototype clustering analysis of the CSORN DCM database

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Introduction: Outcome prognostication of patients with Degenerative Cervical Myelopathy (DCM) is difficult due to the significant heterogeneity that exists within this patient population. While it is known that surgical treatment of DCM usually leads to improved functional status and results in patient satisfaction, there is limited classification and

stratification of patients with DCM that encompasses demographic, baseline functional and radiographic characteristics to help outcome counselling. **Material and Methods:** We hypothesize that a data-driven approach can identify subgroups of DCM patients with clinical similarities and provide a clinically relevant categorization with distinct outcome patterns. We sought to 1) apply an unsupervised machine learning approach of cluster analysis to identify subgroups of DCM patients using demographics, baseline functional and radiographic characteristics, 2) explore clinical similarity (patterns) within subgroups and create multi-dimensional labels 3) analyze outcome from each subgroup and validate their significance. A national multicentric database of prospectively collected surgically treated DCM patients was used. K-prototype clustering was used to identify patient subgroups based on relevant features influencing outcomes documented in the literature. The following baseline variables collected pre-operatively: Age, time with condition, mJOA, SF12, EQ5D, MRI cord findings, motor and sensory deficits, number of levels involved, number of comorbidities and current work status. After clustering, outcome measures using mJOA, SF12, EQ5D, NDI, work status, residual pain and satisfaction with surgery were computed for each cluster. The identified clusters were qualitatively and systematically described by creating relative multi-dimensional labels. **Results:** Data on 774 patients from the CSORN DCM prospective study was analyzed. Four subgroups were identified using K-prototype clustering, a data-driven unsupervised algorithm. Outcome variables at one-year post-surgery on those subgroups have statistically different values between them (p ≤ 0.05) and supported the notion of clinical and outcomes similarity of the patients within each subgroup. Multi-dimensional labels were created. A classification with 4 clusters was defined as follows: cluster 1: mild disease with significant radiographic findings, cluster 2: youngest patients with moderate disease, cluster 3: oldest patients with most comorbidities with moderate disease and good mental state, and cluster 4: patients with most severe disease of longest duration. It was found that patients from cluster 1 did not improved significantly post-operatively as this group had the best preoperative scores with little room for improvement , from cluster 2 recovered significant function and improved health related quality of life scores, from cluster 3 had low functional improvement and low improvement in health related quality of life scores as well as were the most at risk of decreased mental health scores following surgery and from cluster 4 had best functional improvement as well as mental health scores, but were the least satisfied with their surgery. **Conclusion:** Using K-prototype clustering, we identified four clinically relevant subgroups of DCM patients. Each clusters had distinguishable features that influenced outcome measures in distinct directions. Clustering of DCM patients could help physicians segment that population and help provide more nuanced counselling on outcomes using this new type of data-driven stratification of the DCM population.

329
A070: A clinically applicable predictive score in lumbar disc disease for formulating a surgical plan

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Study Design: Case control study. **Objective:** Micro-lumbar discectomy or Interbody fusion procedure are work-horse surgical procedures in management of lumbar disc disease. Spine surgeon in their early years of practice gets confused in choosing ideal surgical plan when dealing with a complex scenario. A clinical score is needed to guide spine surgeons in choosing an optimal surgical plan. **Materials and Methods:** The Study was done with research grant approval from AO Spine. Before formulating the predictive score based on clinical and radiological parameters, the authors validated the score as pilot study. We had taken eight parameters: Age, type of surgical procedure – primary or revision, disc height, instability in dynamic radiographs, morphology of disc protrusion, modic endplate changes in magnetic resonance imaging, lumbar facet morphology and presence of transitional vertebrae -which were found to be statistically significant parameters in predicting better outcome in lumbar disc disease patients if an appropriate surgical plan was followed. The pilot study helped us to choose the cut-off score of 5 as the discriminating point between the two choices while assessing the score. The patients scoring less than or equal to 5 to undergo Micro lumbar discectomy and patients who score equal or more than 6 to undergo Transforaminal lumbar Interbody Fusion. Two fellowship trained spine surgeons-one using the score (Group A) and other not using score (Group B-control) treated 40 patients included in their respective group. All patients were analysed preoperatively, post-surgery at 12 months follow-up with Visual analog scale score for back pain, leg pain, Oswestry disability index score, SF-36 score. Change in parameters following surgery were analysed statistically. p ≤ 0.05 was considered statistically significant. Success rate of individual surgeon who managed respective group of patients and Difficulty index of surgeon who managed without using score was evaluated at 12 months follow-up. **Results:** Mean age of the patients was 44.5 years in group A and 47.4 years in group B with males being predominant in both groups. Success rate of Group A-surgeon was higher than Group B-surgeon. There was statistically significant improvement in VAS (p = 0.004), ODI (p = 0.009), SF-36 (p = 0.018) score in group A patients when compared to group B patients at 12 months follow-up. Patient's outcome was graded based on their VAS score at 12 months follow-up.

None of the patients in group A had poor outcome, whereas 15% of the patients in group B had poor outcome. Difficulty index of surgeon who didn't use the score was 15%.15% of group B patients would have had different surgical plan, if the model would not have been followed and would have landed up in unnecessary revision surgeries. **Conclusion:** The proposed predictive score comprising all risk factors can be used by spine surgeons when they are confronted with difficult scenario in decision-making. Accuracy, reliability and validity of the score needs to be evaluated in a larger scale.

Level of Evidence: III.

Keywords: clinical score, lumbar spine, discectomy, spinal fusion, spine

1328

A071: What is the environmental impact of adult spinal deformity surgery

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Introduction: While the economic cost of adult spinal deformity (ASD) surgery has been studied extensively, the environmental cost is unknown. The purpose of this study is to (1) determine the carbon footprint associated with anesthesia for ASD surgery and (2) compare this footprint in minimally invasive surgery (MIS) and traditional open surgeries. **Material and Methods:** This study is a single-center retrospective cohort study. ASD patients who underwent > 4 levels of corrective surgery between 2017 and 2021 were included. Our outcome of interest was the amount of carbon dioxide equivalents (CO_2e), which can assess the total greenhouse gas emissions produced during the process by converting non-CO_2 gases and substances to the amount of CO_2 that has equivalent global warming potential. Anesthetic volumes were calculated from intraoperative records and converted to CO_2e with the following algorithm: CO_2e = GWP 100 * Time (min) * Free gas flow (L/min) * end-tidal gas concentration (%) * molar mass (g/mol) / (2412*Density (g/mL)). GWP 100 indicates conversion unit calculated for each agent relative to the CO_2e (e.g. 510 for isoflurane). The open group included a posterior-only, single stage technique, while the MIS group was defined as the use of lateral interbody fusion and percutaneous posterior screw fixation. The MIS and open cohorts were propensity matched based on 8 variables, including age, sex, body mass index, the level of upper instrumented vertebra (UIV), number of instrumented levels, pelvic incidence (PI), PI-LL mismatch, and max coronal Cobb angles. **Results:** Of 175 eligible ASD patients, 15 pairs (65 ± 9y, 46.7% female) were properly matched for all variables and analyzed; mean number of instrumented levels, 4.8 ± 1.3; preoperative PI-LL mismatch, 24.4 ± 12.1°; preoperative max coronal Cobb angle 29.4 ± 15.2°. The estimated total blood loss was significantly lower in the MIS group (318 vs 823g, p = 0.002), and operative time was longer (386 vs 235min, p < 0.001). Intraoperative repositioning was performed in 7 patients and staged surgery was performed in 5 patients, all in the MIS group. The mean CO_2e for the MIS group was significantly higher than the conventional group (28.3 vs 18.0 kg, p = 0.03), which is equivalent to 72.5 miles driven by an average gasoline car. CO_2e derived from the consumption of gas anesthetics, such as isoflurane, sevoflurane, N_2O, accounted for 99.8% of the total CO_2e emissions, which was significantly greater in the MIS group (p = 0.04), while that from non-gas anesthetics (e.g. propofol) accounted for only 0.2%, with no significant difference between groups (p = 0.12). **Conclusion:** The anesthesia necessary for ASD surgery is associated with a significant environmental impact. This impact is significantly associated with higher amount of gas anesthetic use, which is associated with longer operative time due to staged surgery or intraoperative repositioning in MIS surgery group. The carbon footprint must be taken into account in weighing the risk-benefit of surgical techniques that increase anesthetic time and will be a necessary component to factor in when assessing the indirect costs associated with these surgical techniques.

803

A072: Is informed consent just a signature on a paper? An evaluation in patient undergoing spine surgery

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Introduction: To evaluate the information that patients undergoing spine surgery truly receive and assimilate when they sign their informed consent documents. **Material and Methods:** This was a retrospective study on patients who underwent spine arthrodesis or spine discectomy. Patients were given a full explanation of the surgical technique to be employed and its potential risks before they were included on the surgical waiting list. Before surgery, they were asked to sign an informed consent form. The studied variables included whether patients read the informed consent form, whether they recalled the surgical technique used or the spinal segment operated, whether they were aware of the surgical risks involved, and if they had looked for information about their procedure elsewhere. Answers were analyzed by age and educational level. **Results:** Of a total of 458 total patients, only 51.9% answered all the questions. Sixty-three percent of patients said they had read the informed consent document before surgery. Although 91.6% of patients were aware of the

spine segment operated, only 73.5% remembered the surgical technique employed. A total of 63.9% of patients could recall the vertebral levels operated. 39.1% were not aware of the surgical risks involved, and only 16.0% of patients admitted having looked for additional information. A statistically significant correlation was found between the search for additional information and young age (p < 0.001) on the one hand, and high educational level on the other (p = 0.023). **Conclusion:** Even though obtaining informed consent is an important procedure before spinal surgery, almost 40% of the patients in this study underwent surgery without reading the informed consent document or being aware of the risks posed by the procedure.

OP09: Advances in Imaging

1033
A073: Validation of SpineHRNet+ for automated apical vertebral rotation calculation in adolescent idiopathic scoliosis

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Introduction: Background: Adolescent idiopathic scoliosis (AIS) is a prevalent spinal deformity characterized by a three-dimensional deformity of the spine. Accurate calculation of apical vertebral rotation (AVR) is crucial for AIS clinical management and treatment strategies. The advent of artificial intelligence (AI) technology has revolutionized medical image analysis and has the potential to provide automated and accurate AVR calculation. **Material and Methods:** A total of 1686 AIS patients were included in the study. An AI model, SpineHRNet+, was trained and validated using a dataset containing 1924 spinal X-ray images. The model's performance was then tested on an independent testing set of 503 X-ray images. Basic demographic information of patients, such as gender and age, was collected from medical records. Measurements like height, weight, and arm span of the enrolled patients were taken. SpineHRNet+ calculated AVR using the Nash-Moe method, and senior doctors also annotated the X-rays using the same method in a double-blind manner. Multivariate regression analysis was used to clarify the correlation between covariates and AVR in predicting the progression of scoliosis. The model's accuracy in predicting AVR was compared to the annotations made by experienced doctors using Root Mean Square Error (RMSE). In 70 patients with follow-up data, we compared the efficiency of predicting the progression of spinal scoliosis using AVR calculated by different methods. **Results:** SpineHRNet+ demonstrated an accuracy of 87.8% in predicting AVR, closely comparable to the 91.8% accuracy observed in annotations made by surgeons. The overall RMSE difference was found to be comparable to the annotations of the surgeon (3.94 vs 3.45). In predicting the progression of scoliosis, there was no significant difference in predicting the progression of spinal scoliosis using AVR predicted by the SpineHRNet+, AVR calculated by doctors, and AVR obtained from EOS. (AUC=0.656, 0.662, 0.680, respectively, p > 0.05). **Conclusion:** SpineHRNet+ provides a valuable tool for automated detection in formulating AIS clinical treatment decisions and related clinical research. It achieves results close to those of annotations from surgeons and demonstrates consistent performance in predicting scoliosis progression with other measurement methods. This advancement contributes to the field by providing a relatively accurate and automated method for measuring AVR, aiding in the clinical management of AIS.

1723
A074: Clinical and radiological evaluation of BoneMRI for cervical spine fractures

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Introduction: Computed tomography (CT) is considered the gold standard in fracture diagnosis after cervical spine trauma. Concerns about ionizing radiation and limited soft tissue resolution have led to the development of a novel imaging technique termed BoneMRI. This prospective study aims to evaluate the diagnostic accuracy of BoneMRI in comparison with CT. The secondary endpoint aims to assess the accuracy of estimating Hounsfield Unit (HU) values in BoneMRI in relation with its CT reference. **Material and Methods:** Patients diagnosed with cervical spine fractures on CT underwent MRI (including BoneMRI-Sequence) within a 48-hour interval. A dedicated but generally available 4-minute 3D radiofrequency-spoiled T1-weighted multiple gradient echo MRI sequence was added to a 1.5 or 3.0T MRI acquisition protocol. Three spine surgeons independently reviewed the images for diagnostic accuracy and lesion characterization. Clinical relevant radiological features, such as fracture visibility, anterior and posterior wall height, vertebral body angle (VBA), segmental kyphosis (SK), and interobserver (IO) agreement were

calculated for both imaging modalities. In addition, each fracture was classified using the AO-Spine classification system. The presence of soft tissue trauma, which was detected on sagittal T2 and TIRM sequences, was recorded. **Results:** From 2022 to 2023, a total of 18 patients with 25 traumatic cervical spine fractures (mean age 63, SD 13,65) were enrolled. BoneMRI demonstrates equal sensitivity (100%) in detecting cervical spine fractures as CT, with a visibility of fracture gap in all BoneMRI reconstructions. There were no (0%) intra- and IO differences in terms of fracture classification according to the AO Spine Subaxial and Upper Cervical Injury Classification Systems between both imaging modalities. The mean differences of anterior and posterior vertebral body heights between CT and boneMRI were 0.71 (SD ±0.58) and 0,6 mm (SD ±0.94), respectively, while the mean differences of VBA and SK were 1.4° (SD ±1.3) and 1.3° (SD ±0.79), respectively. A mean IO reliability (IOR) of 1.36 mm (SD ±0.93) for anterior body height on BoneMRI and 1.21 mm (SD ±1.37) on CT was observed. The mean IOR for posterior body height was 0.64 mm (SD ±0.75) with BoneMRI and 1.14 mm (SD ±1.35) with CT, respectively. IOR for VBA was 1.86° (SD ±1.39) for BoneMRI and 2.0° (SD ±1.47) for CT, SK showed an IOR of 1,78° (SD 1.3) for BoneMRI and 1.73° (SD ±1.5) for CT. Moreover, MRI offered additional information in 13 of 25 cases, such as ruptured ligaments, traumatic disc herniations and signs of myelopathy. Geometrical analysis of the BoneMRI showed good to excellent agreement with CT. Voxelwise comparisons showed a mean absolute error of 20 (SD ±62) HU and a mean absolute cortical surface distance of 0.45 (SD ±13). **Conclusion:** BoneMRI is a promising, radiation-free alternative to CT for diagnosing cervical spine fractures with comparable radiographic and AO Spine classification accuracy with the added value of providing information related to soft tissue trauma. This novel technology may be of particular importance in younger individuals who are at particular risk for ionizing radiation and in patients in whom a neurologic injury is suspected.

1333

A075: A fully integrated imaging protocol and post-processing pipeline for tract-specific quantitative cervical spinal cord MRI in degenerative cervical myelopathy

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Introduction: Degenerative Cervical Myelopathy (DCM) is the most frequent cause of spinal cord dysfunction in adults. Clinically, DCM presents as a myelopathy accompanied by spinal cord compression on a structural MRI scan. However, structural MRI provides only limited insight into the extent of spinal cord injury, leading to discrepancy between the extent of compression and the severity of the clinical myelopathy. This complicates the prediction of natural progression and postoperative recovery. Recent advancements in DCM research have underscored the need for the development of quantitative MRI sequences that offer a more profound understanding of the spinal cord microstructure. Among the promising biomarkers for assessing white matter damage, Diffusion Weighted Imaging (DWI) and T2*-weighted (T2*) sequences have emerged. However, their practical use is hindered by poor sensitivity, susceptibility to motion artifacts, and the complex and labor-intensive nature of post-processing. The primary objective of this study was to establish a reliable acquisition protocol and a comprehensive post-processing program leading to a clinically usable MRI tool. **Material and Methods:** This study is part of a prospective interventional pilot study aimed at improving diagnostic workup for patients with DCM, in which 5 healthy volunteers and 10 DCM patients were included. The first step was to develop an imaging protocol for T1-weighted (T1), T2-weighted (T2), T2*-weighted (T2*) sequences, and Diffusion Weighted Imaging (DWI) sequences by adapting our hospital's existing protocols and the spine generic acquisition protocol (https://github.com/spine-generic/protocols/releases). The second step involved the development of a post-processing pipeline using 2 open-source software tools: MRtrix (www.mrtrix.org/) and the spinal cord toolbox (www.spinalcordtoolbox.com/). This project was supported by the 2021 AO Spine research Startup Grant. **Results:** Initially, healthy volunteers were scanned, and the protocol was adjusted after every 1 or 2 scans to attain sufficient resolution and an acceptable scan time (+- 30 minutes). Subsequently, we fine-tuned the protocol using a small cohort of study patients to reduce the motion artifact to a minimum. By this process we gradually developed an imaging protocol that met the necessary criteria for both image quality and scan efficiency. The pipeline was further improved to consecutively denoise, motion-correct and segment. Then, by overlaying an atlas, the tracts are localized on the images. Finally, measurements are extracted specifically in the various tracts. Each step was carefully adjusted to make it robust to low image quality, and a quality check is built in. In order to make this pipeline quick and simple to use in a clinical setting, it was finally integrated into a Python program. **Conclusion:** We developed a reliable and robust acquisition protocol and a comprehensive post-processing program that integrates DWI and T2* sequences, facilitating the routine and straightforward utilization of quantitative imaging techniques in our clinic for DCM patients.

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A076: Investigation of cervical spinal cord structure using quantitative anisotropy based on deterministic fiber tractography

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Introduction: Fiber tractography based on voxel-based indices, such as fractional anisotropy (FA), using diffusion tensor imaging (DTI) is highly susceptible to partial volume effects. The use of generalized q-sampling imaging (GQI) has been proposed as a solution to obtain diffusion orientation distribution functions (ODF). Quantitative anisotropy (QA), an ODF-based index, has been shown to be superior to FA in various in vitro modeling and in vivo studies. Fiber tractography using QA has been used in the study of white matter tracts in the brain with notable success, but similar application in the spinal cord has not been reported previously. This study is the first report of deterministic fiber tractography of the cervical spinal cord using QA in asymptomatic volunteers. **Material and Methods:** This is a prospective IRB-approved study of five normal subjects. All MRI sequences were acquired in a clinical 3T Prisma Scanner with a 64-channel head/neck RF coil. Fast T1-weighted three-dimensional images and high-resolution T2-weighted images were obtained. RESOLVE DTI imaging parameters were TR/TE 3000/106ms, voxel resolution $0.6´0.6´2.0$ mm^3, and TA 2:26. The diffusion data was reconstructed on DSI-studio software using GQI with a diffusion sampling length ratio of 1.25. A seeding region was placed at scanned regions to obtain all the white matter tracts in the cervical spinal cord. **Results:** After processing and further reconstruction using the GQI protocol we were able to successfully reconstruct the white matter tracts traveling through the cervical spinal cord in all the subjects. The mean QA on the entire cervical spinal cord was 0.061 (0.041-0.088). Additionally, we divided the cervical spinal cord into 13 segments from occiput down to T1 and obtained QA values on each segment: Occiput-C1 mean 0.066 (0.045-0.098), C2 vertebral body mean 0.067 (0.045-0.104), C2-C3 mean 0.063 (0.044-0.089), C3 vertebral body mean 0.065 (0.047-0.092), C3-C4 mean 0.062 (0.043-0.091), C4 vertebral body mean 0.064 (0.041-0.093), C4-C5 mean 0.059 (0.037-0.086), C5 vertebral body mean 0.055 (0.034-0.086), C5-C6 mean 0.051 (0.028-0.081), C6 vertebral body mean 0.046 (0.027-0.068), C6-C7 mean 0.044 (0.031-0.066), C7 vertebral body mean 0.043 (0.029-0.061) and, C7-T1 mean 0.041 (0.028-0.055). There was an overall trend of lower QA at lower cervical spinal cord segments. **Conclusion:** Quantitative-anisotropy aided tractography is able to reliably reconstruct the white matter tracts in the human cervical spinal cord. QA-aided tractography provides high-resolution anatomical imaging. Further studies are necessary to further delineate individual tracts in the spinal cord and their correlation to different disease processes.

1782

A077: Microdose EOS: just as good, and safer

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Purpose: Children with scoliosis are exposed to significant radiation doses throughout their lifetime as a result of multiple imaging studies as part of their investigation and treatment. EOS scanning has been shown to significantly reduce overall radiation and cancer risk. In an effort to reduce radiation further, a microdose setting can be used on the EOS scan. We aimed to quantify the reduction in radiation dose and assess image quality, compared to the standard EOS study. **Material and Methods:** We reviewed all paediatric patients who had received both a standard dose EOS scan and a Microdose EOS scan for investigating their scoliosis within a 6-month period. We compared the total radiation doses, and estimated cancer risk using a validated risk tool. In addition to this, we asked five surgeons to compare image quality, using a five-point visual analogue scale between blinded standard and microdose studies. **Results:** We identified a group of 25 children, mean age 12.15 (range 7 - 16) who met the criteria and calculated their total radiation exposure for both scans (PA and Lateral). Converted total doses in the standard EOS group were 133.46 mSv (PA 62.62 + 70.83 Lat) with a lifetime cancer risk per study of 1.97% (Male 1.15%, Female 2.22%), compared to 16.69 mSv (PA 10.1 + 6.59 Lat) with a lifetime cancer risk per study of 0.37% (Male 0.21%, Female 0.41%) in the Microdose EOS group (p < .0001). Image quality VAS in standard EOS averaged 4.1 (range = 2-5) and 3.8 in Microdose EOS (range = 2-5) (p = .0415). **Conclusion:** Standard EOS requires eight times more radiation than Microdose EOS, resulting in a 532% reduction in lifetime cancer risk per study. Image quality of Microdose EOS was comparable to Standard EOS, both being graded as "very good" on average. We therefore recommend using the Microdose setting as standard in EOS studies of Paediatric spinal deformity.

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A078: Comparison of the effective dose of mobile and stationary intraoperative 3D imaging with computed tomography for the evaluation of lumbar pedicle screws

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Introduction: Intraoperative 3D imaging with mobile or stationary C-arms has established itself as a valuable tool for intraoperative positioning control of, among others, pedicle screws in the lumbar spine over the past 20 years. Often, this can already obviate the need for postoperative computed tomography (CT). Despite the widespread use of this modality, there have been no studies to compare the radiation exposure to the patient during 3D C-arm imaging with that of CT examinations. The aim of this experimental study was to make the effective dose generated during intraoperative imaging with mobile and stationary 3D C-arms comparable to CT examination, based on measurements on a phantom. **Material and Methods:** An anthropometric phantom was used for effective dose measurements (CIRS Inc., ATOM® Dosimetry Phantoms, Norfolk, VA, USA), equipped with dosimeters at 91 positions (Best Medical Canada Ltd., Ottawa, ON, Canada). Imaging was performed using a mobile 3D C-arm (Cios Spin, Siemens, Forchheim), a stationary C-arm (ARTIS pheno, Siemens, Forchheim), and a CT scanner (Somatom x.cite, Siemens, Forchheim). In accordance with clinical application scenarios, scans on the mobile C-arm were conducted at "Low", "Standard" and "High" dose settings, while the stationary C-arm scans were done at "Standard" and "reduced dose" settings. The CT scan was performed with automatic dose optimization. Three scans were conducted for each condition and the average was determined and used for further analysis. **Results:** For measurements on the mobile C-arm, the determined dose at the "Low" setting was 0.51 mSv, at the "Standard" setting was 1.0 mSv, and at the "High" setting was 3.1 mSv. On the stationary C-arm, the dose at the "Standard" setting was 1.6 mSv, and at the "reduced dose" setting was 0.52 mSv. The CT dose was 2.0 mSv. **Conclusion:** Two essential conclusions can be drawn from the results. Firstly, it was demonstrated for the first time that the effective dose of intraoperative 3D imaging is in the same order of magnitude as CT imaging. It's important to note that aspects of image quality were not explicitly investigated. Secondly, it was observed that the effective dose varies by a factor of 6 depending on the dose presetting used. This underlines the need for careful indication and adherence to the ALARA (As Low As Reasonably Achievable) principle in imaging practices.

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A079: Investigation into the use of T2*Weighted Imaging for identifying potential tissue variations in lumbar herniated discs as classified in the Michigan State University (MSU) Classification system

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Introduction: Herniated discs (HD) have been known to spontaneously resorb in approximately 70% of patients within 6 weeks. Investigations into HD resorption has involved attempts at morphologically classifying HD using the Michigan State University (MSU) HD Classification which accounts for location and size and assesses HD histology. However, morphological associations to HD resorption remains inconsistent in the literature and histological investigation can only be performed post-surgery, after HD tissue extraction, removing the ability to assess HD resorption. Further developments in Magnetic Resonance Imaging (MRI) techniques including T2 Star Weighted Imaging (T2*WI), have shown promising results in detecting macroscopic and microscopic level changes. This study aims to assess the feasibility of T2*WI to detect variations HD in tissue composition, relative to HD morphology as classified in the MSU Classification, in order to provide a non-invasive and systematic means of predicting HD resorption. **Methods:** Approximately 100 patients undergo discectomy or micro-discectomy procedures for the treatment of herniated discs at NeuroSpine Institute every 6 months, indicating ample participant accessibility for this study. Participants, included in this study will be selected if they are 18 years or older, have single level, posterior, lumbar herniated discs and if they are eligible to receive non-contrast MRI imaging, as per surgeon recommendations, prior to consultation. Radiographic imaging will be prospectively collected from 25 participants, scheduled to undergo routine T1, T2 and STIR MRI. These participants will have additional T2*WI included in their routine imaging. Experienced radiologist and orthopedic spinal surgeons will assess T1, T2 and STIR MRI as per routine radiology reporting and will morphologically classify herniations using the MSU Classification for HD. The T2*WI will be processed in post processing software by the recruited radiologists. Mapping of axial planes will be performed, and T2*Values derived for regions of interest. Appropriate statistical analysis will be performed to determine associations

between MSU HD types and T2*WI values. **Results:** We anticipate fluctuations in T2*Values derived from T2*WI maps of the HDs, to be relative to morphological HD type. We anticipate that those HD that are larger and have migrated further into the spinal canal, will demonstrate greater fluctuations in T2*Values, indicative of greater histological molecular activity, compared to smaller HD. Alternatively, if no associations between morphology and variation in T2*Values is depicted, morphology may not be an indicator for resorption and molecular mechanisms may provide greater prediction of resorption. Future wet lab validation of T2*Values in correlation with histological molecular markers may provide better indications of resorption. **Conclusion:** Application of T2*WI has not been applied to HD. Successful application of T2*WI to indicate histological variations in relation to morphological classification, may provide a non-invasive means of predicting for HD resorption prior to surgical intervention, to further inform surgeon decision making between conservative or surgical treatment, for HD patients.

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## A080: Superiority of MRI for evaluation of sacral insufficiency fracture

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Introduction: Sacral insufficiency fractures (SIF) are relatively rare fractures and difficult to diagnose on plain radiographs. The primary objective of the present study was to evaluate the role of lumbar magnetic resonance imaging (MRI) for the diagnosis of SIF. The secondary objective was to identify the classification of SIF by computed tomography (CT). **Material and Methods:** A total of 77 (Male 11, female 66, mean 80.3 years) people were included in this study. Inclusion criteria for this study were: age ≥ 60 years and no history of high energy trauma. Exclusion criteria were high energy trauma and a current history of malignancy. Differences in the fracture detection and description in the various radiologic procedures were evaluated. Fracture patterns were evaluated with CT. The detection rates of additional pathologies in the MRI of the pelvis and lumbar spine were also recorded.

Results: The sensitivities for SIF were 28.5% in radiographs and 94.2% in CT, and all fractures were detected in MRI. MRI showed a more complex fracture pattern compared with CT in 65% of the cases. We observed 71.4% of single SIFs, 9.1% with other spinal fractures, 13.0% with other pelvic fractures, and 7.8% with other fractures. According to the SIF fracture pattern, the H/U type was 40.2%, transverse type was 33.7%, λ/T type was 24.7%, unilateral vertical type was 1.3%, and bilateral vertical type was 0%.
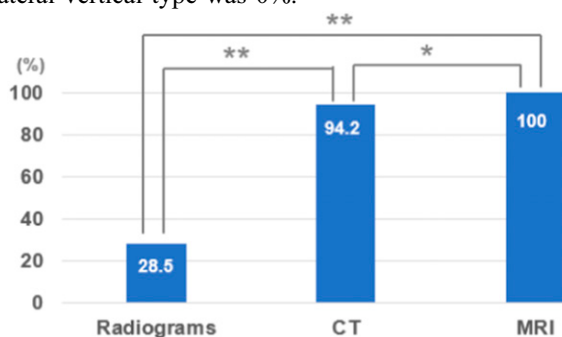
Conclusion: An MRI of the lumbar spine including the sacrum with a coronal fat-suppressed T2-weighted image is useful for elderly patients with suddenly increasing low back pain at an early stage. This procedure improves an early SIF detection, recognition of concomitant pathologies, and adequate treatment for the patients.
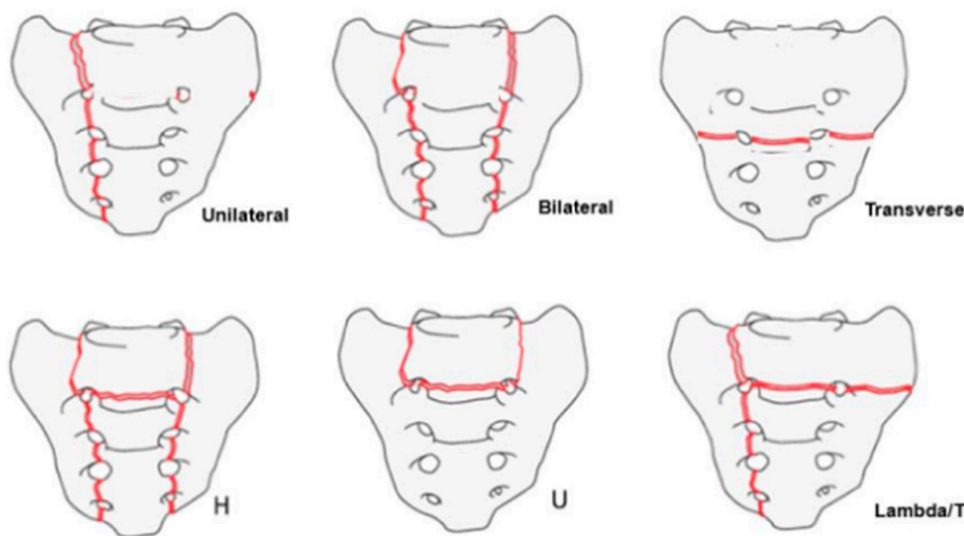
1851
A081: Detection of vertebral body fractures-comparison between conventional radiography (CR) and EOS imaging

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Introduction: Diagnostic Imaging procedures performed to answer a specific clinical question frequently result in additional questions and hence in further imaging, mostly by use of other modalities as the preceding study. At the same time, each additional radiological study performed entails additional radiation exposure for the patient. With CR, a vertebral body fracture (VBF) is seen and a regional CT scan is performed to better understand the specific characteristics of that VBF. With the VBF being classified as stable, a full-spine film is ordered to properly assess spinopelvic balance which can be critical in further therapeutic decision-making. At that point, the question arises, whether the initial CR could have been avoided. This question is of even greater interest, when a low-dose imaging option such as an EOS 2D/3D® system (EOS) is available for full spine imaging. **Material and Methods:** A database search of the PACS / RIS system of a University Radiology Department was performed in order to identify patients as of July 2015 who had undergone EOS® imaging of the spine or the whole body and Conventional radiography of the spine within a time window of 3 months. The search yielded 213 eligible patients. Postoperative examinations as well as incomplete conventional imaging (thoracic spine or 1 plane only) were eliminated and 79 patients finally included. The identified images were pseudonymized and independently evaluated by 2 experienced orthopedic spine surgeons in consensus. A total of 1100 vertebrae per imaging modality were subjected to a categorical visual assessment as well as semiquantitative and quantitative evaluation according to the Genant classification plus a combination of the above. Whenever multiple fractures were detected, the most severely fractured vertebra was determined by semi-quantitative and quantitative measurement in each modality. **Results:** Surprisingly, CR remarkably underperformed as compared to EOS in sufficiently visualizing vertebrae at and above the Th10 level, with 25,6 % of vertebrae being considered unreadable. Overall at least one vertebral body fracture was detected in 51/79 patients (65%) by means of CR and in 57 patients using EOS. Concordant identification between the 2 modalities was observed in 50 patients (88%), whereas in 12% of VBF, these were only identified in one of the 2 modalities. 6

VBF were detected with EOS only, whereas only 1 VBF was detected with CR but not with EOS. Having a closer look on the per- vertebrae distribution high specificity was found throughout the lumbar spine to detect a fracture $\geq$ grade 1 whereas sensitivity was low. Given multiple fractures, the majority of the identified most severe fractured vertebrae occurred in the thoraco-lumbar junction (TH 11-L1) with 33/51 (70%) in CR and 31/57 (57%) in EOS followed by the lumbar spine. **Conclusion:** Fracture detection as well as quantitative fracture assessment was reliable with both, CR and EOS and showed high concordance between the techniques. However, EOS appears to be more sensitive than CR, especially in the thoracic spine, which might be partly due to its orthogonal fan beams moving perpendicular to the imaging target reducing image distortion and its greater greyscale dynamics.

OP10: Lumbar Degenerative: Factors to Optimize Outcomes

960
A082: Risk factors for extended length of stay following elective surgery for lumbar degenerative pathology: a multivariate analysis

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Introduction: The purpose of this study is to identify independent risk factors associated with length of stay $\geq$ 5 days following elective operations of $\leq$ 3 segments for diagnosis of lumbar degenerative pathology. **Material and Methods:** Adults who underwent short-segment fusions for lumbar degenerative pathology at a single institution (2016-2021) were identified and reviewed. Excluded were patients who underwent non-elective operations, revisions, and/or operations for trauma, malignancy, and infections. The primary outcome was extended length of stay(eLOS), defined as $\geq$ 5 days. Predictor variables included demographics, co-morbidities, operative information, and social support. Fisher's exact test was used for univariate analysis, and significant variables were implemented in multivariate binary logistic regression, with generation of 95% percent confidence intervals (CI), odds ratios (OR), and p-values. **Results:** Three-hundred sixty-five patients met inclusion criteria. Post-operatively, 21.6% (n = 79) had a length of stay $\geq$ 5 days(eLOS). Significant risk factors for eLOS included higher

ASA scores, alcohol use, chronic obstructive pulmonary disease, inflammatory disease, and higher SII scores. **Conclusion:** Extended length of stay(eLOS) is an important contributor to cost in elective spine surgery. Preoperative identification of patient risk factors for eLOS is important to identify cost outliers. Significant risk factor variables may be preoperatively modified in preoperative optimization programs, and surgical strategies may be altered. Clinicians may also use the identified risk factors to inform management of patient expectations and enable cost savings for healthcare systems.

971
A083: Risk factor for failure to be considered in decompression only procedure for lumbar degenerative spondylolisthesis - A systematic review of literature

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Introduction: The current literature suggests that decompression-only procedure may be an adequate treatment option for low-grade degenerative spondylolisthesis. It is necessary to understand the causes of the failure to adequately select patients to achieve acceptable results. The aim of this study is to identify the key factors associated with failure of decompression-only procedures for degenerative lumbar spondylolisthesis. **Material and Methods:** An independent systematic review of four scientific databases (PubMed, Scopus, clinicaltrials.gov, Web of Science) was performed to identify relevant articles as per the preferred reporting in systematic reviews and meta-analysis (PRISMA) guidelines. Studies analysing the risk factors for failure following decompression-only procedure for degenerative lumbar spondylolisthesis were included for analysis. Pooled analysis was performed using Stata software. **Results:** We included six studies with the baseline characteristics of the successful group and the failed group following a decompression-only procedure for degenerative spondylolisthesis. Individual study analysis has found factors such as motion at index level, and multi-level decompression to be responsible for failure. However, upon pooled analysis patient-related factors such as age, sex, body-mass index; disease-related factors such as Pfirrmann grade, slip distance, disc height, facet angulation, translation, movement at index level, sacral slope, and outcome parameters such as visual analog score, Oswestry disability index and Japanese orthopaedic association score between the two groups did not demonstrate any significant difference. **Conclusion:** High-quality evidence that analyses risk factors for failure of decompression-only procedure for degenerative spondylolisthesis is limited. Although factors such as motion at index level, multi-level decompression were found to a potential risk factors in individual studies, pooled analysis did not find any of them to significantly predict failure of decompression-only procedure for degenerative spondylolisthesis.

1585
A084: Impact of weekday timing on short-term outcomes after lumbar fusion surgery

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Objectives: Reducing inpatient complications is crucial for improving short- and long-term patient outcomes after spinal fusion surgery. Timing of surgery has recently been

implicated as a potentially significant factor that may impact spine surgery outcomes. In what has been termed the "weekend effect", investigators suggest that patients who undergo spine surgery on the weekend are subject to inferior conditions resulting in poor outcomes. There has not yet been a study evaluating whether a similar difference in outcomes exists between weekdays. Thus, the purpose of this study is to investigate whether weekday of elective lumbar spine fusion surgery has an impact on surgical outcomes, including inpatient physical therapy (PT) outcomes. **Materials and Methods:** All patients > 18 years who underwent primary lumbar spinal fusion from 2014-2020 at a single academic institution were retrospectively identified. Patients were subdivided into an early surgery subgroup (surgery between Monday-Wednesday) and a late surgery subgroup (surgery between Thursday-Friday). Outcome variables included inpatient complications, physical therapy outcomes, 90-day readmissions and one-year revisions. Physical therapy data gathered from the first inpatient PT session included hours to PT session, AM-PAC Daily Activity or Basic Mobility scores, and total gait trial distance achieved. Pearson's chi-square tests were used to compare inpatient complications, inpatient PT outcomes, readmissions and revisions between the two patient groups. Multivariable logistic regression models were used to further analyze factors impacting the primary outcomes. **Results:** Of the 1239 patients identified, 839 (53.3% female) had surgery between Monday-Wednesday and 400 (51.5% female) had surgery between Thursday-Friday. Bivariate analyses showed no significant difference between groups regarding demographic information. Patients in the late surgery subgroup had more levels fused (1.51 + 0.70 vs. 1.33 + 0.55, p < 0.001), longer surgeries (3.98 + 1.60 vs. 3.37 + 1.38, p < 0.001), and longer length of stays (3.54 + 1.74 vs. 3.92 + 1.65, p < 0.001). Patients in the later surgery subgroup were more likely to experience a neurologic complication (3.08% vs. 0.86%, p = 0.008), however there was no difference in total complications. Patients in the early surgery subgroup had their first inpatient PT session earlier than patients in the late subgroup (15.7 + 10.5 hrs vs. 18.9 + 11.8 hrs, p < 0.001). However, patients in the late subgroup achieved a farther total gait distance (98.2 + 146.0 vs. 75.4 + 108.0, p = 0.011). A multivariate logistic regression demonstrated that late surgery was a significant predictor of more hours to PT (est. = 0.256, p = 0.016) and longer length of stay (est. = 2.277, p = 0.001). There were no significant differences in readmission rates and revision rates between groups. **Conclusion:** Patients who undergo surgery later in the week (Thursday-Friday) may experience more neurologic complications, wait longer for their first inpatient PT appointment, and experience longer length of stays. While there is substantial research regarding the "weekend effect", our analysis shows that a similar effect is not observed in later weekday surgery as it relates to total complications, readmissions, and reoperations.

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A085: Role of ESPB in ERAS following lumbar fusion surgery - A prospective randomised control study

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Introduction: Postoperative pain management following major spinal surgeries remains a challenge. In the era of ERAS spinal surgeries, successful management of immediate post-surgical back pain with minimal side effects is mandatory to obtain acceptable surgical outcomes, early mobilization, and decrease the length of hospital stay. We aimed to investigate the efficacy of intraoperative freehand erector spinae plane block (ESBP) after single-level lumbar fusion spinal surgeries as simple and reliable way. **Material and Methods:** We randomly divided sixty consecutive adult patients who underwent transforaminal lumbar interbody fusion for single-level degenerative spondylolisthesis into two groups. The study (ESPB) group (n = 30) received intraoperative freehand bilateral ESPB with a 20 ml mixture solution of 0.25% bupivacaine and 1.0% lidocaine equally divided in the operating level. In the control group (n = 30), 20 ml of physiological saline was injected. Postoperatively, we ordered 1 gram of Paracetamol thrice/day, besides patient-controlled analgesia pumps with fentanyl. We evaluated post operative visual Analog Scale (VAS), opioids and NSAIDS consumption, initial mobilization time after surgery, ESPB-related adverse effects, and length of hospital stay (LOS) in both the groups and compared. **Results:** Postoperative 24th-hour VAS and postoperative VAS scores recorded at all time points were significantly higher in the controls (p < 0.05). Fentanyl consumption was significantly higher in the controls within the first postoperative 24-hour in the ESPB participants (p < 0.001). Post-operative mobilization time was significantly earlier in the ESPB group 4 ± 2.2 hours versus 14 ± 4.4 hours in the control group. In control individuals, the first analgesic demand time was shorter, and PLOS was longer (p < 0.001). Immediate post-operative patient satisfaction was significantly higher in the ESPB group. We observed no significant difference regarding postoperative complications. **Conclusion:** Intraoperative free hand ESPB, as a part of multi-modal analgesia has a significant role in Enhanced Recovery after single level Lumbar Fusion Surgery In terms of postoperative back pain, opioid consumption, initial mobilization after surgery and length of hospital stay.

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A086: Efficacy, safety, & reliability of surgery on the lumbar spine under general versus spinal anesthesia - An analysis of 64 cases

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Quasi-experimental design purpose: Compare intra and postoperative parameters, surgeons' satisfaction, and cost-effectiveness between general anesthesia (GA) and spinal anesthesia (SA) on patients undergoing surgery in the lumbar spine surgery. **Overview of literature:** Surgery on the lumbar spine is the commonest surgical procedure among all spinal surgical practices. Both the GA and SA are shown to be suitable techniques for performing the surgery safely. GA is used most frequently. But, SA became increasingly more popular because it allows the patient to self-position thereby reducing various complications associated with GA in a prone position. **Methods:** A total of 64 patients from June 2016 to July 2019 who underwent either discectomy, laminectomy, or lamino-foraminotomy for herniated lumbar disc or canal stenosis in 1 or 2 levels were included. During the study period, 32 patients were non-randomly selected for each of the GA and SA groups. The heart rate (HR), mean arterial pressure (MAP), blood loss, total anesthetic time, surgeons' satisfaction, analgesic requirements, cost of the procedure, and hospital stay were recorded and compared. **Results:** In the context of demographic characteristics, baseline HR, or MAP, no significant differences were noted between SA and GA groups. Mean anesthetic time, mean PACU time, mean doses of analgesic requirement, cost of anesthesia, and the surgeon's satisfaction was significantly lower in the SA Group (P < 0.05). The blood loss, duration of operation, and hospital stay were not significant too. No major Intra and postoperative complications were reported nor were significant differences found in either series. **Conclusion:** Safety and efficacy of SA in comparison to GA were similar for the patients undergoing surgery on the lumbar spine. Notable advantages of SA include shorter anesthesia duration, fewer drug requirements, relative cost-effectiveness, and fewer complications rate. Successful surgery can be performed using either anesthesia type. **Keywords:** General anesthesia; Lumbar spine surgery; Spinal anesthesia.

1164
A087: Implementation of an enhanced recovery after surgery protocol (ERAS) after elective lumbar spine surgery

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Introduction: The Enhanced Recovery After Surgery (ERAS) protocol is a multidisciplinary, evidence-based set of measures aimed at reducing post-operative hospital length of stay to improve patient care and outcomes. The ERAS pathway at our hospital consists of four stages of interventions: pre-admission, pre-operative, trans-operative, and postoperative, each of which includes a series of recommendations validated by the ERAS Society. Since its implementation in 1997, the ERAS protocol has shown promise in various surgical areas, including spine surgery. The aim of this study was to compare the effectiveness (length of stay) and safety (re-admission and reoperation) of ERAS protocol vs. conventional treatment in patients undergoing elective lumbar spine surgery (decompression and fusion) with spondylolisthesis and lumbar stenosis. **Material and Methods:** A retrospective case-control analysis of data collected from patients who underwent elective lumbar spine fusion were realized at our hospital. The data was collected from two groups: the conventional group (2014-2015) who received conventional treatment and the ERAS group (March 2022 to January 2023) who received treatment under the ERAS protocol. Patients with surgical indication for lumbar spinal stenosis and lumbar spondylolisthesis that did not respond to conservative treatment were included. Exclusion criteria were patients with cancer, infection, trauma, double surgical approach, and deformity in spine. Demographic and surgical variables, hospital length of stay, complications, re-admission, and reoperation rates at 90 days between the two groups were analyzed. The variable length of stay determined effectiveness and, the variables readmission and reoperation defined safety. **Results:** A total of 160 patients were registered. Group 1 included 90 patients in the conventional pre-ERAS and Group 2, 70 patients in the ERAS group. Both groups were homogeneous in terms of age, sex, BMI, American Society of Anesthesiologists (ASA) grade, number of levels, or comorbidities. The analysis of surgical time, bleeding, or immediate postoperative complications between the two groups showed no differences. The ERAS group showed a significantly shorter length of stay (M ± SD) of 2 ± 0.8 days compared to the conventional group 5.3 ± 3.0 days (p < 0.001), confirming the effectiveness of the protocol. In terms of safety, the 90-day complications and reoperation rates of both groups were similar. Moreover, 84% of patients in the ERAS group were "very satisfied" with the postoperative medical care provided. **Conclusion:** The ERAS protocol reduces postoperative hospital length of stay, without increasing the 90-day readmission or reoperation rate in elective lumbar spine surgery patients, therefore is a safe and effective protocol applicable in patients undergoing elective lumbar decompression and fusion.

1713

A088: Efficacy of ultrasound guided bilateral erector spinae (ESP) block with conventional anaesthesia care vs general anaesthesia in patients undergoing single level transforaminal lumbar interbody fusion surgery (TLIF): double blindprospective randomised control study single centre experience

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Introduction: Postoperative pain management in spinal fusion surgery is challenging and usually includes administration of extensive amounts of opioid which has adverse effects, such as respiratory depression, sedation, nausea, vomiting, and constipation leading to a longer hospital stay and a worse patient experience. Even with opioids, pain is not always sufficiently managed. Inadequate pain control increases cardiac and respiratory complications, delays mobilization, increases the length of hospital stay and may increase the risk of developing a chronic pain syndrome. Novel interfacial plane blocks such as the erector spinae plane (ESP) block, can provide regional analgesia without producing much interference in spinal cord function and are therefore suitable for spinal surgery pain management. ESP block was first described in 2016. Using ultrasound, local anesthetic is injected below the erector spinae muscle group (m. spinalis, m. longissimus thoracis and m. iliocostalis). This causes a sensory blockade over the Antero and dorsolateral side by blocking ventral and dorsal rami of the spinal nerves. ESP block has an easily recognizable sono-anatomy and hence carries a lower risk of complications. This is further aided by the anatomical barrier action of the transverse process which prevents needle insertion into pleura or vessels, thus reducing chances of pneumothorax or hematoma. Spinal cord injuries are relatively rare as the needle positioning is far from vertebral canal. **Material and Methods:** 500 patients over a period of two years were enrolled for the study, out of patients were randomized in to two groups control and test based on simple randomized method from 2021 June to 2022 June. All the patients in the study underwent single level TLIF surgery. **Results:** Pertinent demographic and operated data of 500 patients were analyzed, compared to the control group ESPB patients showed significant reduction in intra op bleeding, maintain low heart rate and normal blood pressures, saturation of opioid consumption significantly 6 hours after the surgery with significant mean value, p < 0.0001, and lowered the pain

score (0-10) at various points at rest or during mobilization for 24-48 hours after the surgery. ESPB reduced the intra-op bleeding. ESPB decreased the post operative complications relating to opioids like nausea and vomiting; p < 0.001 also reducing the length of hospital mean of 1 ± 0.5 days; p < 0.001. **Conclusion:** ESP Block in our study in a single center proved to be very effective in reducing intra-op bleeding and reducing the postop opioids consumption, early pain free mobilization and pod 0 discharge in patients undergoing TLIF surgery compared to the control group.

2543

A089: The potential under-diagnosis and impact of depression in patients undergoing lumbar spine surgery

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Background: Spine surgery patients have greater rates of preoperative depression and anxiety than the public, with about 1 in 3 patients experiencing these mental health conditions. PROMIS Depression survey measures the cognitive and affective manifestations of depression. This survey has been found to correlate well with formal depression screening tools, such as the Patient Health Questionnaire-9 (PHQ-9). The purpose of this study is to assess the effects of depression on patient-reported outcomes and its potential underdiagnosis in our patient population. **Methods:** Patients who underwent lumbar decompression $\pm \leq 2$ level fusion at a single institution between March 2019 and January 2021 were identified from a prospectively maintained database. PROMIS Anxiety, Depression, Fatigue, Pain Interference (PI), Physical Function (PF), Sleep disturbance (SD), and Social Roles (SR) surveys were recorded at preoperative intake with subsequent follow-up at 6 and 12 months postoperatively. Patients were categorized based on clinical diagnosis of depression by a psychiatrist prior to surgery. Between cohort comparisons of the mean for each PROMIS measure were performed using a simple t-test. Subsequent analysis was conducted on patients with a diagnosis of depression based on PROMIS Depression score cutoff of ≥ 53[1]. We controlled for variables that may be independent predictors of self-reported health status including age, gender, co-morbidities, length of stay, duration of surgery, and surgical invasiveness index. **Results:** One hundred and fifteen patients met our inclusion criteria of completed PROMIS surveys at the designated time points. A total of 37 (32.2%) patients were diagnosed with depression prior to surgery. Analysis of patient-reported health outcomes shows that depression correlated with worse ODI (47.1 ± 18.0 vs. 36.6 ± 18.2, p = 0.005) and Depression (59.0 ± 9.21 vs. 52.4 ±

7.71, p < 0.001), Fatigue (57.1 ± 8.07 vs. 49.5 ± 7.36, p < 0.001), and PI (59.6 ± 8.68 vs. 51.5 ± 10.8, p < 0.001) scores at baseline. At 1-year follow-up, patients with depression continued to have worse PROMIS Depression (55.1 ± 7.90 vs. 48.5 ± 9.59, p < 0.001), Fatigue (53.4 ± 8.55 vs. 47.0 ± 8.14, p < 0.001), and PI (51.9 ± 10.2 vs. 47.1 ± 10.5, p = 0.021). Based on PROMIS Depression cutoff score of ≥ 53, twenty-eight out of seventy-eight patients without a clinical diagnosis of depression (35.9%) met the criteria for depression. Patients with suspected depression had significantly worse preoperative scores across all survey domains with the exception of PROMIS SR and SD compared to patients without clinical diagnosis of depression. Subsquent comparison between patients with a clinical diagnosis of depression and patients with suspected depression based on PROMIS Depression scores, revealed no difference in patient-reported outcome scores across all survey domains and measured timepoints with the exception of PROMIS depression at 6month follow-up (54.33 ± 8.68 vs. 49.28 ± 8.49, p = 0.022). **Conclusion:** Our findings suggest that depression is associated with worse patient-reported outcome metrics and that depression is potentially underdiagnosed in spine patients. Consideration of utilizing PROMIS Depression scores as a screening tool for depression could aid in detecting this risk factor in our spine patients. Future work is needed to understand the role of treating depression and psychiatry intervention in preoperative optimization for lumbar surgery.

Reference: [1]Cheng AL et al. JBJS 2023

1227
A090: Does erector spinae plane block help decrease intraoperative blood pressure variance and yield safer outcome postoperatively in transforaminal lumbar inter body fusion: a case control study

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Introduction: Erector spinae plane block (ESPB) has been shown to provide better recovery and less opioid usage; meanwhile, intraoperative blood pressure variability (IBPV) has been shown to negatively impact postoperative outcome. Given high heterogeneity in literature, our study aims to evaluate the efficacy of ESPB in IBPV and postoperative outcomes. **Material and Methods:** We retrospectively reviewed patients received transforaminal lumbar interbody fusion (TLIF) with and without ESPB from January 2021 to June 2023. ESPB was performed by specialized anesthesiologist or the two operators under ultrasonography guidance. Intra-operative arterial blood pressure was analyzed using DigitizeIt. Mean arterial pressure (MAP) was calculated. Individual coefficient of variation (CV) and difference between highest and lowest MAP (MAPD) were analyzed as outcome of IBPV. Postoperative pain score, morphine consumption, days to removal of lines and discharge were also recorded and analyzed. **Results:** 60 patients were included in the study (30 with and 30 without ESPB). The mean age was 61.8 and 67.4, respectively. Significant lower MAPD (41.9 vs 49.9, p = 0.02), CV (12.8 vs 15.0, p = 0.01), pain at postoperative recovery room (4.7 vs 6.7, p < 0.01) and postoperative day 1 (2.3 vs 2.8, p < 0.01), And faster recovery to adequate nutrition (1.7 vs 3.0, p < 0.01) were noted in the ESPB cohort. Only one complication was noted in the non-ESPB cohort (decreased muscle power secondary to hematoma). **Conclusion:** In our practice, ESPB provides decreased postoperative pain, less IBPV, and no complication after operation. It also features a trend of lower morphine consumption and faster mobility recovery, though not significant.

OP11: Spinal Deformity

221
A091: Lower instrumented vertebra (LIV) selection in early onset scoliosis at index growth rods insertion-can we predict distal add-on at index surgery?

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Introduction: There are still no consensus criteria on how to select the lower instrumented vertebra (LIV) for growing rods (GRs) at index surgery. The aim was to evaluate whether the criteria used for adolescent idiopathic scoliosis fusion adapts to early onset scoliosis (EOS). **Material and Methods:** Retrospective analysis of prospectively collected data in a consecutive cohort of patients with EOS treated with GR, expanding from index surgery to 2 years after graduation. The LIV was analysed regarding its relation to the stable vertebra (SV), substantially touched vertebra (STV), and not STV (NSTV). Failure of LIV selection was considered when revision surgery with distal add-on was needed during follow up. **Results:** A total of 13 patients met inclusion criteria. Mean chronological age was 9.16 years (at index surgery), 12.9 years (at graduation), and 14.9 years (at final follow up). The most frequent LIV at index surgery was L4 in 4 cases, closely followed by L2 and L3 with 3 cases each at the index surgery. The designation of Stable vertebra (SV) substantially touched

vertebra (STV) and Non-substantially touched vertebra (NSTV) was based on standard antero-posterior radiographs. There were 6 cases where the LIV at growth rod insertion was the stable vertebra. Three of these did not require revision of the LIV at graduation. The remaining three which required revision required addition of one level. There were six cases in which the LIV was higher than the SV. Four of these were one level higher i.e STV and two of these NSTV. Those which were at STV did not require revision of the LIV at graduation. Of the two where the initial LIV was NSTV, one required revision down to 4 levels below while the other required extension by one level. **Conclusion:** For Idiopathic EOS, whenever an SV or STV was chosen, the incidence of revision of LIV was about 30 percent. The revision required was distal add-on by one level. If the LIV was any higher than STV, the revision required distal add-on to more than 1 level. Choosing a STV or SV as the distal foundation for construct of EOS correction possibly leads to lesser rates of add-on phenomenon.

1124
A092: Spine Alignment Assessment Via Generation of 3D Spine Curve

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Introduction: Adolescent Idiopathic Scoliosis (AIS) is the most prevalent spinal deformity affecting children. The screening, diagnosis, and monitoring of AIS generally involves radiographic examination which exposes patients to harmful radiation. In this study, we proposed and validated a novel technique that enables radiation-free and accurate examinations with depth sensing techniques and deep learning methods to analyze AIS by generating the 3-dimentional (3D) spine curve. **Methods:** This study enrolled consecutive AIS patients between October 9, 2019, and May 21, 2022. Individuals with psychological and/or systemic neurological disorders that might affect study adherence and/or patient mobility were excluded. For each participant, both optical and depth images (i.e., RGBD images) of the unclothed back were obtained. The spine curve obtained from biplanar X-rays served as the ground truth (GT). We used images from the training and internal validation cohort (n = 1936) to develop a deep learning model which generated the spine curve from the input RGB images. Then, the generated spine curve was mapped onto the patient's back in terms of the depth information to obtain 3D spine curve. The proposed deep learning model was prospectively validated on an independent cohort (n = 302). The proportion of training and validation datasets used in this study was 8:2. The performance of our model in severity grading was assessed. **Results:** The spine curve generation results of 302 patients were analyzed to assess the severity of their condition. The prediction accuracy was found to be 83.5% for the 85 normal-mild patients, 93.5% for the 184 moderate patients, and 90.9% for the 33 severe patients. The overall average sensitivity across the three categories was 89.3%, with a specificity of 93.4%, a negative predictive value of 94.0%, and a positive predictive value of 90.8%. **Conclusion:** Our non-radiative medical devices, employing depth sensing and deep learning technologies, provide immediate and accurate spinal alignment analysis. This method presents the possibility of incorporation into routine adolescent screenings, potentially facilitating early detection and diagnosis of AIS, and subsequently leading to more prompt and effective treatment plans. Furthermore, the non-invasive nature of the system diminishes risks associated with recurrent radiation exposure, thereby enhancing patient safety. The portable design also enables widespread utilization in diverse clinical settings, improving access to screening services and ultimately contributing to improved overall outcomes for AIS patients.

787
A093: Correction and fusion of pelvic obliquity in neuromuscular thoracolumbar scoliosis: comparison of two original techniques in a continuous monocentric population of 124 patients

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Introduction: Neuromuscular scoliosis often requires a long fusion from the upper thoracic spine to the sacrum or pelvis in order to achieve and maintain correction of the curve and pelvic obliquity. Pelvic fixation remains a challenging and controversial area in spine surgery. To date, S2 alar iliac screw fixation permits the minimization of implant prominence and tissue dissection but remains technically challenging. We present the results of a prospective continuous series of 124 patients treated for neuromuscular spinal deformities by two consecutive original spinopelvic fixation using ilio-sacral screws and sacral-bi-iliac fixation. **Material and Methods:** From 2010 to 2015, all the patients undergoing a spinopelvic fixation for a neuromuscular spinal deformity were prospectively included in a computerized database. Age, neuromuscular disorder and clinical and radiographical data were noted. Pelvic obliquity was measured with the pelvic obliquity

angle. The spinal and spinopelvic fusion was assessed at final follow-up by the absence of back pain with no loss of correction. The minimal follow-up was five years to assess spinal fusion and late complications. **Results:** 124 patients were operated on during the study period. In the 62 first patients, pelvic anchorage was done using ilio-sacral screws. In the next 62 patients, pelvic anchorage was done using an original sacral-bi-iliac spinopelvic construct using two sacral screws and two iliac screws. Spinal deformity correction was done using all-screw constructs. Pelvic obliquity correction was done linking the spine and the pelvic constructs with dual-rods dominos. Preoperative pelvic obliquity ranged from 4° to 49° (mean 23.4°). Postoperative pelvic obliquity ranged from 0° to 14° (mean 4.4°). No significant loss of correction was noted at last follow-up. One patient died 3 months after the initial procedure due to respiratory compromise. 24 patients had early postoperative infections of the posterior approach with no statistical differences according to the type of fixation. Outcome was favorable in 23 cases after local wound debridement and antibiotics. In one case, hardware removal was done after one year with no loss of correction following hardware removal. No statistical differences were noted between the two techniques according the rate of correction, intra-operative time, bleeding or length of hospital stay. In five cases, early unilateral mobilization of ilio-sacral screw was diagnosed. In these cases, the screw was changed for a longer one by a percutaneous technique. No iterative mobilization or losses of correction were noted at final follow-up. No mechanical complications were diagnosed in patients with sacral-bi-iliac fixations. **Conclusion:** Despite the high rate of infectious complications, the two techniques of pelvic anchorage were effective to treat frontal and sagittal spinal deformity in neuromuscular patients. Segmental correction of both thoracolumbar curve by all-screw constructs and pelvic obliquity by a strong pelvic fixation achieved a satisfactory sitting position in all the patients. The rate of mechanical complications was lower in patients with the sacral-bi-iliac fixation. The sacral-bi-iliac fixation is also made using conventional pedicle screws and connectors that makes this option easier to implement. This technique is currently used at our institution for spinal deformities corrections in neuromuscular patients.

1244
A094: Risk factors for thoracic pedicle screw misplacement using t-EMG in scoliosis surgery

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Introduction: Misplaced thoracic pedicle screws (TPS) in scoliosis surgery can reach a percentage of 40%. Proper placement of TPS has been reported with better results using navigation systems however, malpositioning rates remain around 10%. The objective of this study was to evaluate the accuracy and the risk factors for correct position of TPS using t-EMG. **Material and Methods:** A retrospective cohort study of 55 patients (44 women- 11 men) who underwent scoliosis correction with 825 free-handed TPS evaluated with single pulse t-EMG (SP t-EMG). The Cobb ranged from 41 to 120 degrees. Once all TPS have been placed a maximum investigative stimulus intensity of 12 mA was chosen. The results of 825 SP t-EMG tests were stratified into three different groups: 1 - (≤6 mA), for very significant violations; 2- (6.1 - 11.9 mA), to alert the surgeon to medial violation; and 3 - (12 mA), screws well placed. Pre-operative radiological evaluation with CT images of pedicle morphology were analyzed through Watanabe classification (A, B, C and D). 813 images of the postoperative positioning of TPS were re-evaluated by Abul-Kasim classification (AK), and M1 and M2 were considered misdirected. The TPS were also grouped into groups: T1-T6 and T7-T12, concavity and convexity and through different diameters (4.0 to 6.5 mm). Regression analyzes were performed with univariate logistic models to identify relationships between potential risk factors and poor positioning of the TPS, presenting the chance of occurrence of each category and the OR. **Results:** Post-operative CT evaluation of significant medial pedicle ruptures (M1 and M2) was classified as positive (dependent variable) and had a general prevalence of 8.4%. The Watanabe classification, concavity / convexity, diameter of the screws and SP t-EMG readings were considered independent variables. The chance of screw malposition in pedicles "A" and "B" is 8% and in dysplastic pedicles it is 13%. The chance of incorrect positioning in dysplastic pedicles is 65.7% greater than in non-dysplastic pedicles. The prevalence of malpositioning in concave pedicles is 10.8% and in convex is 6.1%. The chances of screw malposition in concave pedicles are 85% higher than in convex. In opposition to the initial hypothesis, 55 % of positive results occurred between screws 4 to 4.75 mm in diameter. The chance of a positive result is 8% when the SP t-EMG is > than 6 mA and 50% when ≤ 6 mA. The chance of TPS in a relevant medial position is 6.2 times greater when the SP t- EMG is ≤ 6mA compared to SP t-EMG > 6 mA. Epidemiological results showed drawback of low sensitivity and positive predictive value of 14 % and 33 %, respectively, on the other way specificity had 97 % and negative predictive value of 93%. **Conclusion:** Misplaced thoracic pedicle screws during scoliosis correction occurs with a higher incidence and relative risk in patients with dysplastic, concave pedicles and with SP t-EMG tests ≤ 6mA. Despite low sensitivity values and

positive predictive value, neuromonitoring with SP t-EMG has high specificity and negative predictive value, remaining an important tool to minimizing neurological risk.

764

A095: Predicting curve progression risks in adolescent idiopathic scoliosis with the proximal femur maturity index

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Introduction: The proximal femur maturity index (PFMI) can be used to assess skeletal maturity on whole spine radiographs without additional radiation. However, the relationship between PFMI and curve progression in bracing patients with adolescent idiopathic scoliosis (AIS) remains unknown. This study aims to investigate the relationship of PFMI and curve progression, and its predictability of curve progression risk to adulthood deterioration and surgical thresholds based on PFMI grades at brace initiation. **Material and Methods:** This was a prospective study of 202 patients with AIS who were prescribed with bracing according to the Scoliosis Research Society criteria with good brace-wear compliance. These patients were followed from brace initiation until complete skeletal maturity. Longitudinal data of coronal Cobb angles, and skeletal maturity assessment using Risser staging, Sanders staging, distal radius and ulna classification and PFMI were collected. Each patient was assessed on whether major curve progressed to adulthood deterioration (≥ 40 deg) and surgical (≥ 50 deg) thresholds. Logistic regression models were used to predict probabilities for curve progression to the two thresholds, adjusted for significant factors identified in univariate analyses. **Results:** PFMI correlated with other skeletal maturity indices (rs = 0.65 to 0.72, p < 0.001). Prebrace PFMI gradings correlated with brace outcomes of progression to $\geq$ 40 deg (rrb = -0.30, p < 0.001) and to ≥ 50 deg (rrb = -0.20, p = 0.005). Based on regression models adjusted for pre-brace major Cobb angles, menarchal status and curve type, brace initiation at PFMI grade 2 and grade 3 with curves ≥ 30 deg have respective predicted risk of 30% (95% CI: 4% to 55%) and 12% (95% CI: 7% to 17%) for progression to surgical threshold. Brace initiation at PFMI grade 5 has 0% progression risk. **Conclusion:** PFMI can be used for predicting curve progression for patients with AIS undergoing bracing, and in prognosticating brace outcomes. Skeletally immature patients initiating brace treatment at PFMI grade ≤ 3 with major curves ≥ 30 deg have higher progression risk to adulthood deterioration and surgical thresholds despite compliant bracing. In comparison, brace initiation at PFMI grade 4 for < 30 deg curves, or at PFMI grade 5 is unlikely to deteriorate to both thresholds.

1877

A096: Return to sport after posterior spinal fusion for adolescent idiopathic scoliosis: what variables actually have an influence? A retrospective study

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Introduction: Adolescent idiopathic scoliosis (AIS) affects 2–3% of the population and less than 10% of these patients require surgery. Since it is an asymptomatic disorder, adolescents with AIS are frequently athletically active as age-matched controls and postoperative reduction in sports participation can have detrimental effects on their quality of life; therefore, return to sport (RTS) is an important perioperative concern for the patients and their families. Nevertheless, current guidelines for postoperative physical activities resumption are mostly derived from expert opinion and a few evidence-based recommendations exist regarding timing of RTS after spinal fusion for AIS. As ability to return to specific sports has not been studied, it is difficult to guide both surgeon and patient with appropriate expectations regarding postoperative RTS. Aim of this study is to retrospectively evaluate a cohort of athletically active patients who underwent posterior spinal fusion for AIS, and to determine which clinical, surgical and anthropometric variables influenced their return to physical activity. **Material and Methods:** 112 adolescents who underwent high-density posterior fusion for AIS by a single surgeon were analyzed for clinical, surgical and demographic predictors of return to presurgical physical activity levels. Data were retrospectively collected by charts and X-rays analysis and patients interviews. **Results:** Preoperative main curve Cobb was 64.4 ± 14.12° and obtained correction was 70.0 ± 12.5%. Included patients played many different sports, most of all ballet (44/112, 39.2%), swimming (40/112, 35.7%) and gymnastics (32/112, 28.6%). At an average of 50.3 months follow-up, 76 (67.8%) patients returned to sports (RTS) at an equal or higher level than preoperatively. Younger age, lower Lenke curve type and lower main curve Cobb were significantly associated with RTS. As for RTS timing, patients who returned within the frst 6 months were younger, with a higher Lenke and a less severe main curve, a more distal UIV and a more proximal LIV. No complications related to RTS were registered. **Conclusion:** In conclusion, patients with adolescent idiopathic scoliosis safely returned to physical activity after surgery. Younger age, higher Lenke type and lower main curve severity predicted a quicker return to sport. However, prospective studies are needed to confirm these findings.

881
A097: Shoulder and neck balance in adolescent idiopathic scoliosis: which radiographic indices are reliable and practical?

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Introduction: Deformities of the spine and thorax in adolescent idiopathic scoliosis affect appearance. They are a cause of inferiority, affecting psychological well-being and the social life of the patients. To contribute to curve evaluation, planning in curve correction, and improving the postoperative aesthetics, many studies on the correlation between appearance and radiography in the assessment of shoulder and neck balance have been reported recently. In general, these studies did not clarify which indices are required to evaluate shoulder and neck balance. This study aimed to learn about indices to assess shoulder and neck balance in adolescent idiopathic scoliosis in correlation between clinical appearance and radiography. **Materials and Methods:** This observational study recruited 50 patients with adolescent idiopathic scoliosis who were 12 to 18 years of age with Cobb angle > 10°. Based on Pearson correlation coefficient, radiographic parameters such as coracoid height difference (CHD), clavicle rib intersection distance (CRID), clavicle angle (CA), clavicle chest cage angle difference (CCAD), and T1 tilt angle were evaluated in correlation with clinical shoulder and neck balance by difference of inner shoulder height (SHi), difference of outer shoulder height (SHo), and neck tilt angle. **Results:** SHi was moderately correlated with T1 tilt angle (r [hereafter] = 0.45), CA (0.47), and CHD (0.57), high-moderately correlated with CRID (0.64), very-highly correlated with CCAD (0.84). SHo was moderately correlated with T1 tilt angle (0.43), highly correlated with CHD (0.60), CA (0.63), and CRID (0.72), and very-highly correlated with CCAD (0.89). T1 tilt angle was high-moderately correlated with neck tilt angle (0.76). The correlation coefficients between clinical and radiographic shoulder and neck balance according to sex, BMI, type of main curve, severity of main curve did not change significantly. **Conclusion:** There was a very high correlation between SHo (shoulder tilt) and CCAD (0.89); the correlation between SHo and CRID was high-moderate (0.72), but CRID is easier than CCAD to evaluate on radiographs. On the other hand, T1 tilt angle, which is the easiest radiographic parameter to evaluate, had a high-moderate correlation with neck tilt angle (0.76) but a moderate correlation with SHo (0.43).

579
A098: The efficacy and safety of apical wiring technique combined with pedicle screw fixation in the treatment of severe dystrophic scoliosis in neurofibromatosis type 1

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Objective: The purpose of this study is to evaluate the clinical efficacy and safety of apical wiring technique combined with pedicle screw fixation in the treatment of severe dystrophic scoliosis in neurofibromatosis type 1 (NF-1). **Methods:** From June 2015 to June 2021, patients with severe dystrophic scoliosis (main curve Cobb angle > 80°) in NF-1 who underwent posterior pedicel screw fixation were retrospectively included. According to whether apical wiring technique was applied, patients were divided into the apical wiring group (AW group) and the control group. Preoperative, postoperative, and the last follow-up (FU) radiographic parameters that measured in digital radiography, including the main curve Cobb angle, distance between the C7 plumb line and the central sacral vertical line (C7PL-CSVL), apical vertebral rotation (AVR), apical vertebral translation (AVT), maximal kyphosis (MK), and sagittal vertical axis (SVA) were compared between the groups. Also, the complications were recorded to evaluate the safety of apical wiring technique. **Results:** A total of 37 patients (male 17, female 20) were included in this study. The mean age was 14.8 ± 2.4 years (11-18 years), and the mean follow-up duration was 33.4 ± 5.1 months (24-48 months). Of the patients, 16 were in the AW group (male 9, female 7) and 21 were in the control group (male 8, female 13). The baseline characteristics were matched between the groups. In the AW group, the main curve Cobb angle was corrected from $96.7° \pm 15.5°$ (preoperative) to $38.7° \pm 10.1°$ (postoperative) and $40.3° \pm 10.9°$ (the last FU); MK was corrected from $73.2° \pm 18.9°$ (preoperative) to $37.7° \pm 15.8°$ (postoperative) and $39.2° \pm 11.6°$ (the last FU). In the control group, the main curve Cobb angle was corrected from $93.8° \pm 12.2°$ (preoperative) to $42.7° \pm 14.1°$ (postoperative) and $45.8° \pm 12.9°$ (the last FU); MK was corrected from $70.6° \pm 17.7°$ (preoperative) to $40.2° \pm 17.3°$ (postoperative) and $44.2° \pm 14.3°$ (the last FU). Complications were recorded in four cases in the AW group (incidence 25.0%; 3 for dural tear and 1 for proximal junctional kyphosis) and six cases in the control group (incidence 28.6%; 3 for instrumentation failure, 1 for PJK, 1 for dural tear, and 1 for surgical site infection). All the patients with instrumentation failure and PJK in the control group underwent additional revision surgery. **Conclusion:** For patients with severe dystrophic scoliosis in NF-1, apical

wiring technique combined with pedicle screw fixation could obtain and maintain the satisfactory correction effect, and decrease the risk of implant-related complications.

966
A099: Should pelvic fixation be included in neuromuscular scoliosis surgery?

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Introduction: The utilization of pelvic fixation in patients with neuromuscular scoliosis remains a subject of controversy, primarily limited to non-ambulatory patients presenting with both scoliosis and pelvic obliquity. The aim of the current study was to compare the activity levels and radiological outcomes of patients who underwent neuromuscular scoliosis (NMS) surgery with and without pelvic fixation. **Material and Methods:** Thirty-three NMS patients aged 10-20 years with a pelvic obliquity (PO) of 15° or more and a follow-up of at least 24 months who underwent posterior surgery for NMS at two different centres were included in the study. Out of the 33 patients, 16 without PF (WoPF) and 17 with PF (WPF) underwent posterior spinal surgery. Radiological results (Figure 1 and 2) and independent movement levels according to the Gross Motor Function Classification System (GMFCS) were compared in the two groups. **Results:** The follow-up period of the patients was 46.69 ± 21.95 months in WoPF and 43.88 ± 20.05 months in WPF, and there was no significant difference between the two groups in postoperative radiological values ($p = 0.763$). In the pelvic obliquity values, postoperative improvement was more pronounced in the WPF group (WoPF: 14.31° ± 8.292; WPF: 9.35° ± 5.338), but there was no statistically significant difference between the two groups ($p = 0.087$). Patients' GMFCS levels were higher in the WPF group than in the WoPF group (WoPF: 2.75 ± 1.29; WPF: 3.76 ± 1.03). GMFCS levels of patients in both groups did not change and were similar to preoperative levels. (Table). **Conclusion:** The study demonstrated that NMS surgery with PF was not

TABLE

Demographic Characteristics And Basic Information Of The Patients			
	WoPF group	WPF group	p value
Patients (n)	16	17	
M±SD (age)	16.81±7.305	15.76±5.019	0.845
Follow-up M±SD (month)	46.69±21.951	43.88±20.056	0.709
Results Of Preoperative And Postoperative Radiological Evaluation Of The Patients			
	WoPF group (°) (M±SD)	WPF group (°) (M±SD)	p value
Cobb Angle			
Preoperative	78.00±15.752	57.59±19.413	0.006
Early control	19.25±8.614	20.41±12.089	0.709
Final follow-up	22.00±8.914	20.53±12.053	0.763
Pelvic Obliquity Angle			
Preoperative	24.50±10.532	20.41±7.500	0.260
Early control	12.69±7.726	9.41±5.444	0.217
Final follow-up	14.31±8.292	9.35±5.338	0.087
Thoracic Kyphosis Angle			
Preoperative	45.25±24.349	28.35±19.493	0.041
Early control	34.69±9.958	30.29±9.399	0.363
Final follow-up	36.69±10.682	30.88±9.158	0.179
Lumbar Lordosis Angle			
Preoperative	47.19±16.204	28.24±23.012	0.011
Early control	40.50±8.075	33.18±15.989	0.245
Final follw-up	42.13±8.107	32.47±15.529	0.068
Results Of The GMFCS Evaluation			
GMFCS levels	WoPF group (M±SD)	WPF group (M±SD)	p value
Preoperative I/II/III/IV/V	4/3/2/7/0 (2.75±1.291)	1/2/4/8/2 (3.76±1.033)	0.028
Final follw-up I/II/III/IV/V	4/3/2/7/0 (2.75±1.291)	1/2/4/8/2 (3.76±1.033)	0.028

WoPF- without pelvic fixation; WPF- with pelvic fixation; M: means, SD: standard deviations. GMFCS- gross motor function classification system.
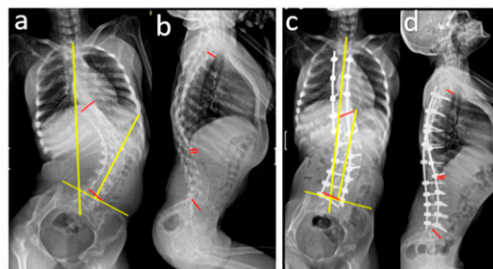

Figure 1. Preoperative and postoperative plain radiographs of a patient undergoing posterior spinal surgery without pelvic fixation. (a and b: Preoperative anterior posterior and lateral radiographs; c and d: postoperative anterior posterior and lateral radiographs)

Figure 2. Preoperative and postoperative plain radiographs of a patient undergoing posterior spinal surgery with pelvic fixation. (a and b: Preoperative anterior posterior and lateral radiographs; c and d: postoperative anterior posterior and lateral radiographs)
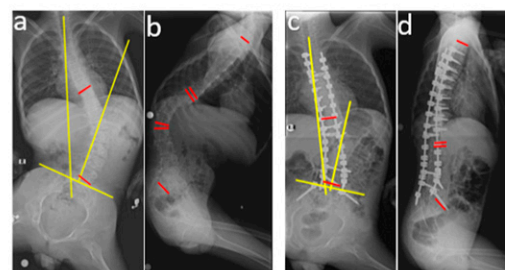
significantly different clinically and radiologically from surgery without PF. Considering PF-related complications in NMS surgery, surgery without PF may be an option in NMS patients with PO.

OP12: Diagnostics

2187

A100: What events are associated with intraoperative neuromonitoring alerts in spinal deformity surgeries? Results from the multi-centre prospective spinal deformity intraoperative monitoring (SDIM) study

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Purpose: To describe the events prior to intraoperative neuromonitoring (IONM) alerts during deformity surgeries. **Methods:** Patients between aged 10 and 80 with a minimum Cobb angle of 80° and/or requiring a posterior column or 3 column osteotomy using multimodal neuromonitoring with EMG, SSEP and MEP were analysed. Patient demographics, radiographic parameters, IONM alert types and triggering events were recorded. An alert was defined as SSEP amplitude loss > 50%; MEP amplitude loss > 50% in two of three muscle groups and/or EMG sustained activity for > 10 seconds. Patients were divided into cord level surgery if the curve correction was at or above the conus medullaris, and non-cord level if the correction was below the conus. **Results:** 555 patients were included in primary analyses, of which 349 were classified as

cord level, and 197 as non-cord level. Overall, IONM alerts were recorded in 79 patients (14.5%), of which 81 alerts occurred in 57 patients (16.3%) at cord level, and 26 alerts occurred in 22 patients (11.2%) at non-cord level. For cord level surgeries, 78 out of the 81 alerts had MEP changes, of which 44 were unilateral and 34 were bilateral MEP changes. The most common surgical event prior to an unilateral MEP change was an osteotomy/release (57.9%) whereas for a bilateral MEP change it was correction/rod placement (64%). Unilateral changes were associated mostly with a type 2 osteotomy (68.2%) whereas bilateral changes were associated more with a type 5 or 6 osteotomy (66.7%). MEP alert occurred more frequently during decompression on the concave side (76.5%) in unilateral MEP changes. For non-cord level surgeries, 21 out of the 26 alerts had MEP changes, of which 16 were unilateral and 5 were bilateral MEP changes. The most frequent event was an osteotomy/release prior to both unilateral (50%) and bilateral (66.7%) MEP changes, and types 2, and 3,4 osteotomies had similar rate of IOMN alerts. For non-surgical events that preceded any alert in cord level surgeries, technical was most frequent (9.1%) in unilateral changes, whereas anaesthesia (26.5%) and technical (23.5%) were most frequent in bilateral MEP changes. For non-cord level surgeries, technical (25%) was most frequent in unilateral changes, whereas systemic events such as low blood pressure or anaemia (20%) and technical (20%) were found in bilateral MEP changes. **Discussion and Conclusion:** Osteotomy/release most frequently occurred prior to an unilateral MEP change whereas correction/rod placement was more frequently observed in bilateral MEP changes in cord level deformity surgeries. For non-cord level surgeries, osteotomy/release was the most frequent surgical maneuver that triggered an IONM alert. These are the critical steps that require meticulous handling and attention to prevent neurologic injuries.

1291

A101: Diagnosis of osteoporosis using CT based Houndsfield units

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Introduction: Since the incidence of osteoporotic fractures increases with advancing age, measures to diagnose and prevent osteoporosis, as well as its complications assume great importance for public health. Gold standard is the dual-energy X-ray absorptiometry (DEXA) and the resulting T-score. Some studies have already shown that the reliability of DEXA is defeated to other methods of bone densitometry in terms of diagnosis and predictive power for subsequent fractures. The aim of this study is to compare the correlation between

measured DEXA values compared to "Houndsfield units" (HU) in patients with severe manifest osteoporosis with osteoporotic vertebral fractures. **Material and Methods:** From 2021 to 2023 we examined 215 patients with osteoporotic fractures of the spine (mean age 77 ± 6.5 years). All patients received CT imaging to evaluate the "OF classification." 68 patients were evaluted by Dexa measurement. The study included 68 patients who received both examinations. The HU were evaluated axially in each of three non-fractured vertebral bodies of the lumbar spine. A ROI was measured for each vertebral body below the cover plate, in the central plate and above the base plate in the spongy bone. The HU cut off value was determined for an osteoporotic fracture on the basis of previous postulations of < 110 and compared with the T-score of the DEXA. **Results:** According to DEXA, only 46% of patients showed an osteoporosis (T- $\leq$ -2.5). However, according to the HU, 97% of the examined patients presented an osteoporosis. While HU demonstrated a high sensitivity of 94% and specificity of 96% (positive predictive value (PPV): 95.6%, negative predictive value (NPV): 94.1%), comparatively DEXA showed a low sensitivity of 51% and specificity of 50% with a PPV of 46,5% and an NPV of 49.5%.In patients who did not show any osteoporotic fracture (> -1) in the T-score, the mean HU value showed: 73.53; in patients with a low suspicion (-1 to -2.5): 87,16 and with manifest osteoporosis (< -2.5): 78.53. After classification of the osteoporotic fracture via OF classification, a successive decrease in HU according to the severity of the osteoporotic fracture could be evaluated (OF2: 98.28; OF3: 91.83; OF4: 75.48; OF5: 68.297), currently without any significant correlation. **Conclusion:** Although currently still the gold standard for bone densitometry and diagnosis of osteoporosis, DEXA does not seem to be suitable for reliably detecting manifest osteoporosis in the spine in contrast to HU. Based on our data, HU seem to be much more suitable to verify manifest osteoporosis.

1920
A102: Analysis of ChatGPT in the triage of common spinal vignettes

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Introduction: Chat-GPT is a natural language processing chatbot with a significant prevalence in modern media. Its applicability to the medical workflow is being increasingly investigated as healthcare organizations attempt to incorporate AI into their triage systems. Chat-GPT has been shown capable of passing the ABNS board exam and adequately simplifying and interpreting most radiology reports, and with the release of GPT 4 in Q1 of 2023, Chat-GPT experienced a large expansion in its processing capabilities. There has never been an evaluation of the chatbot in triaging and diagnosing common spinal vignettes. In this study we assess Chat-GPTs capability to assess, diagnose, and provide recommendations for some of the most common spinal issues seen in urgent and primary care offices. **Materials and Methods:** Ten clinical scenarios were created to mimic the common spinal complaints. These included non-operative disc herniations, lumbar stenosis, failed back syndrome, spinal fracture, and pathological fractures. GPT4 was instructed to assess the situation as if it was in a primary care office, and either recommend conservative measures, further imaging, or neurosurgical or ER referral if necessary. **Results:** GPT4 provided a differential diagnosis for each scenario, indicating the correct diagnosis as most likely each time. Additionally, it recommended reasonable clinical management of each scenario which would fall within standard practice guidelines. In each case Chat-GPT provided an explanation for its management choices and diagnostic reasoning. Chat-GPT tended towards recommending all relevant tests at once, as opposed to utilizing a more conventional diagnostic ladder. **Conclusion:** Chat-GPT is a powerful tool for primary triage of spinal issues. It is able to rapidly and accurately evaluate clinical scenarios and provide diagnostic and management reasoning. GPT4 is not primarily designed for medical use and will provide a disclaimer as such. It did tend towards ordering all imaging/diagnostic tests at once, though each of these tests were reasonable. With specific training, it is likely that AI and NLP chatbots will become widely used in primary triage of spinal issues.

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A103: Level specific hounsfield unit thresholds as a predictor of subsidence following transforaminal and posterior lumbar interbody fusion

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Introduction: Subsidence after lumbar interbody fusion can lead to adverse surgical outcomes. Recent literature has shown that there is a correlation between bone mineral density (BMD) and risk of subsidence. Hounsfield Units (HU) derived from computed tomography (CT) scans have

been proposed as a complementary method for assessing BMD outside dual-energy X-Ray absorptiometry. The purpose of this study was to (1) determine if HU values are associated with radiographic settling following transforaminal and posterior lumbar interbody fusion (TLIF/PLIF), (2) determine clinically sensitive level-specific HU thresholds for subsidence, (3) evaluate which vertebral level is most predictive for radiographic settling, and (4) identify if there is a difference in radiographic settling between expandable and non-expandable cages. **Material and Methods:** A retrospective analysis was performed identifying patients who underwent single-level TLIF or PLIF from 2007-2022. Exclusion criteria included a non-degenerative diagnosis, inadequate radiographs, multilevel and revision surgery, and postoperative follow-up less than one month. HUs from L1-S1 were measured on either preoperative or postoperative CT scans taken within one year of the index surgery. Measurements at the same level as instrumentation were excluded. Changes in segmental lordosis (SL) were measured on intraoperative and postoperative lateral spinal radiographs. Cage subsidence was defined as >5 degrees difference of SL from the intraoperative to the latest postoperative period. Descriptive and inferential statistics were utilized. **Results:** A total of 50 patients met inclusion criteria. Average follow-up time was 22.7 months. Eighteen (36%) patients had evidence of radiographic cage subsidence. A univariate logistic regression analysis revealed that HU measured at L1-L5 were significantly associated with cage subsidence [L1 < 145 HU (OR 3.958, p = 0.039), L2 < 145 HU (OR 3.740, p = 0.049), L3 < 110 (OR 14.4, p = 0.02), L4 < 150 (OR 5.333, p = 0.047), and L5 < 155 (7.071, p = 0.033)]. Multivariate analysis using L1-S1 HU and fusion level as covariates, HU measured at L1-L3 remained significantly associated with subsidence. ROC curve analysis revealed that a cutoff of 106.9 HU at L1 correlated to 92.6% sensitivity/31.2% specificity for cage subsidence [area under curve (AUC) = 0.692], 94.1 HU at L2 with 92.6%/18.7% (AUC = 0.613), 120.4 HU at L3 with 92%/50% (AUC = 0.750), 118.5 HU at L4 with 100%/45.5% (AUC = 0.747), 109.6 HU at L5 with 93.3%/44.4% (AUC = 0.726), and 140.6 HU at S1 with 90.5%/25% (AUC = 0.675). Both univariate and multivariate logistic regression analyses showed no difference in subsidence between static and expandable cages. **Conclusion:** A significant association was found between HU and radiographic subsidence following TLIF/PLIF. Highly sensitive HU thresholds for subsidence were found to be 107 HU at L1, 94 HU at L2, 120 HU at L3, 119 HU at L4, 110 HU at L5, and 141 HU at S1. Measurements taken at the L3 and L4 vertebral levels were overall most predictive and accurate of radiographic settling at the above cut-offs. No difference was found in radiographic settling between expandable and non-expandable cages. These findings suggest the use of HU derived from CT scans shows promise as a tool to predict risk of cage subsidence and guide clinical decision making.

1230
A104: Anteroposterior X-ray Cobb angle auto measurement by artificial intelligence model

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Introduction: Cobb angle (CA) is a critical diagnostic metric for assessing spinal deformities, especially in scoliosis cases. The manual measurement of CA requires end vertebrae and endplate landmark identification, which is time-consuming and subject to inter- and intra-observer variability. To address this issue, we propose an artificial intelligence model called Cobb Angle Transformer Net (CATNet) to measure the CA automatically and provides accurate and consistent results. **Materials and Methods:** A total of 1934 anteroposterior X-ray images containing the whole spine were obtained from two scoliosis clinics. The endplate vertices on the X-ray, ranging from the seventh cervical vertebra to the fifth lumbar vertebra, were labelled as endplate landmark ground truth (GT), encompassing 72 points. Furthermore, the end vertebrae centers were designated as end vertebrae GT. Senior surgeons with a clinical experience exceeding 20 years conducted this labelling process. The images were partitioned into training and test sets using an 8:2 ratio for training and testing CATNet. The CATNet employs an HRNet for multi-scale feature extraction, a transformer encoder for local and global feature extraction, and a convolution layer to output the end vertebrae and endplate landmark heatmaps. With the heatmaps, the coordinates of endplate landmarks and end vertebrae are obtained, enabling CA calculation. **Results:** CAs are classified into thoracic CA (TCA) and lumbar CA (LCA) based on the spinal curvature position. The major curve CA (MCA) is defined as the maximum in TCA and LCA and used to categorize scoliosis severity as normal-mild CA ≤ 20°), moderate (20° < CA ≤ 40°), and severe CA > 40°). To assess the performance of CATNet, we conducted linear regression of the CA prediction and the CA GT. The Pearson correlation coefficient (r-value) and p-value were calculated between the CA prediction and the CA GT for MCA (r = 0.86, p < 0.01), TCA (r = 0.84, p < 0.01), and LCA (r = 0.74, p < 0.01). We also determined the scoliosis severity, with sensitivity values of 0.93 for normal-mild, 0.74 for moderate, and 0.74 for severe cases. **Conclusion:** Our proposed CATNet offers considerable potential for improving the efficiency and reliability of CA measurements in clinical settings, providing a robust, precise, and real-time tool for evaluating spinal deformities. It eliminates potential human error, provides consistent and reliable CA measurements efficiently, alleviates the burdensome nature of clinical work, and enhances treatment planning.

1154
A105: Magnetic resonance imaging and dynamic X-ray's correlation with dynamic electrophysiological findings in cervical spondylotic myelopathy : a retrospective cohort study

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Background: Dynamic somatosensory evoked potentials (DSSEP) can be used to disclose abnormalities of ascending sensory pathways at dynamic positions and diagnose cervical spondylotic myelopathy (CSM). However, radiographic tests including magnetic resonance imaging (MRI) and dynamic X-ray are used much more widely in the management of CSM. Our study aims to clarify the correlations between several radiographic parameters and the DSSEP results, and further determine their reliability with clinical data. **Methods:** We retrospectively enrolled 38 CSM patients with surgical intervention. DSSEP tests were performed before surgery. Amplitude ratios of DSSEP N13 and N20 waves at extension and flexion were calculated and recorded as N13_E, N20_E, N13_F, N20_F, respectively. Baseline severity was evaluated with the modified Japanese Orthopedic Association (mJOA) score and the Nurick grades. Prognosis was evaluated based on the 2-year recovery rate. Sagittal diameter and transverse areas of the cord and canal were measured and the the compressive ratios at the compressed site (Compression_Ratio), central (Central_Ratio), and 1/4-lateral points (1/4-Lateral_Compression_Ratio), and spinal cord/Canal Area Ratio were calculated. The intramedullary T2 hyperintensity patterns (Ax-CCM types) were also collected from MRI axial images. Dynamic X-rays were used to test for segmental instability of the cervical spine. The correlations between radiologic findings, DSSEP data, and clinical assessments were investigated. **Results:** We found that DSSEP N13_E and N13_F correlated with the Compression_Ratio, Central_Ratio, 1/4-Lateral_Compression_Ratio (Pearson, $p < 0.05$) and Ax-CCM types (ANOVA, $p < 0.05$) in MRI axial images and cervical segmental instability in dynamic X-ray (t-test, $p < 0.05$). Apart from the 1/4-Lateral_Compression_Ratio, these radiographic parameters above also correlated with the baseline clinical assessments (Spearman or ANOVA or t-test, $p < 0.05$) and postoperative recovery rate (Pearson or ANOVA or t-test, $p < 0.05$). **Conclusions:** We found that the preoperative Compression_Ratio, Central_Ratio and 1/4-Lateral_Compression_Ratio in MRI and cervical segmental instability in dynamic X-ray could reflect the dynamic neural dysfunction of the spinal cord. Different Ax-CCM types corresponded to different DSSEP results at extension and flexion, suggesting divergent pathophysiology. These radiographic parameters could help evaluate disease severity and predict postoperative prognosis.
Keywords: cervical segmental instability; cervical spondylotic myelopathy; dynamic X-ray; dynamic-somatosensory-evoked potentials; magnetic resonance imaging

551
A106: Analyzing the utility of electrodiagnostic studies in patients with double crush syndrome

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Introduction: Double crush syndrome (DCS) represents a condition that involves peripheral nerve compression in combination with cervical nerve root impingement. Electrodiagnostic studies (EDS) may help in differentiating between the compression of the median nerve at the carpal tunnel and cervical radiculopathy but interpreting these studies can be challenging when both pathologies occur simultaneously. **Material and Methods:** Patients receiving an isolated carpal tunnel release (CTR) were compared to those undergoing CTR and anterior cervical discectomy and fusion (ACDF) within two years of their carpal tunnel procedure. The latter group was defined as our DCS cohort. A propensity match was performed between groups to control for patient age, sex, body mass index (BMI), and diabetes status. The electronic medical record was reviewed to collect EDS results which included sensory and motor nerve conduction data as well as electromyogram (EMG) findings. All EDS were performed prior to CTR in both sets of patients. Descriptive statistics were reported for patient demographics and laterality of symptoms, which were then compared using Chi Square tests. Time between EDS and CTR, sensory nerve conduction, motor nerve conduction, and EMG study data were evaluated using Mann-Whitney U tests. **Results:** There were 54 patients in the DCS group and 137 CTR-only patients. The DCS cohort was found to have decreased sensory onset latency (3.51 vs 4.01 ms) and peak latency (4.25 vs 5.17 ms) compared to the CTR-only patients. The DCS group had slower motor velocity across the wrist (30.5 vs 47.7 m/s), decreased elbow motor latency (9.62 vs 10.6 ms), and faster motor velocity across the elbow (56.0 vs 49.4 m/s). EMG results showed that the DCS group

was more likely to have positive findings in the biceps (31.9% vs 1.96%) and triceps (24.4% vs 2.97%), but not in the abductor pollicis brevis (APB) (45.7% vs 37.9%). **Conclusion:** This study identified several changes on EDS between patients with and without DCS. In patients with DCS, sensory nerve studies showed the peak and onset latency of electrical impulse to be shorter than in CTR only patients. Interestingly, DCS and CTR-only patients had different patterns of motor nerve conduction findings at the wrist and elbow. Providers observing positive EMG findings proximal to the APB should raise their suspicion for possible cervical radiculopathy and when present with carpal tunnel syndrome-like symptoms, should also consider DCS in their diagnostic differential.

1710

A107: Evaluation of Global Alignment Proportion (GAP) Score in a diverse, asymptomatic cohort: multi-ethnic alignment normative study

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Introduction: The GAP score has been used to categorize spinal morphology and prognosticate adult spinal deformity (ASD) surgical outcomes and mechanical complications. However, literature is lacking on applying the GAP score to asymptomatic, normative subjects. We analyzed a large, multiethnic, asymptomatic cohort to assess the distribution of GAP scores. **Methods:** 467 healthy volunteers without spinal disorders were recruited from spine centers in 5 countries as part of the Multi-Ethnic Alignment Normative Study (MEANS). Sagittal radiographic parameters were measured via the EOS imaging system. The GAP total and subcategory scores were calculated for each patient, who was then assigned a group based on the calculated scores. One-way analysis of variance (ANOVA) was performed to compare subject characteristics across groups, followed by post hoc Bonferroni correction. Fisher's exact test was used to compare categorical variables. The significance level was set to p < 0.05. **Results:** In the MEANS cohort, 13.7% (64/467) of volunteers were ≥ 60 years old, and 86.3% (403/467) were < 60 years old. In the Relative Pelvic Version (RPV) subcategory, 1.3% (6/467) had severe retroversion, 8.6% (40/467) had moderate retroversion, 72.2% (337/467) was aligned, 18.0% (84/467) had anteversion. In the Relative Lumbar Lordosis (RLL) subcategory, 2.6% (12/467) had severe hypolordosis, 10.7% (50/467) moderate hypolordosis, 81.6% (381/467) aligned, and 5.1% (24/467) hyperlordosis. In the Lordosis Distribution Index (LDI) subcategory, 1.9% (9/467) had severe hypolordotic maldistribution, 4.5% (21/467) had moderate hypolordotic maldistribution, 83.9% (392/467) was aligned, and 9.6% (45/467) had hyperlordotic maldistribution. In the Relative Spinopelvic Alignment (RSA) subcategory, 1.7% (8/467) had severe positive malalignment, 6.6% (31/467) moderate positive malalignment, 77.5% (362/467) was aligned, and 14.1% (66/467) had negative malalignment. Considering the GAP total score, 76.9% (359/467) was proportioned, 19.5% (91/467) was moderately disproportioned, and 3.6% (17/467) was severely disproportioned. There was no significant difference in the frequency of proportioned, moderately, or severely disproportioned spinal alignment between subjects from different countries (p = 0.060). In the GAP subcategories, only RLL differed between countries (p < 0.001). Volunteers from France had the largest proportion of aligned RLL (89.8%; 88/98), from U.S. the largest proportion of hyperlordosis (15.4%; 14/91), from Singapore the largest proportion of moderate hypolordosis (19.0%; 15/79), and severe hypolordosis (5.1%; 4/79). Discounting the age factor, 77.5% (362/467) was proportioned, 19.1% (89/467) moderately disproportioned, and 3.4% (16/467) severely disproportioned. Compared to subjects with proportioned alignment, those with severely disproportioned GAP alignment were on average 14.4 years older (p < 0.001), had 23.1° lower magnitude lumbar lordosis (LL) (p < 0.001), 14.2° higher pelvic tilt (p < 0.001), 13.3° lower sacral slope (p < 0.001), 24.1° higher pelvic-incidence (PI)-LL mismatch (p < 0.001), 18.2° higher global tilt (p < 0.001); thoracic kyphosis and PI were not significantly different (p > 0.05). **Discussion and Conclusion:** The GAP system applies to a large, multi-ethnic, asymptomatic cohort. 76.9% of patients had a proportionate GAP score, whereas only 3.6% were severely disproportioned. Spinal alignment should be considered on a spectrum, as 19.5% of the asymptomatic volunteers were classified as moderately disproportioned. Radiographic malalignment does not always indicate symptoms or pathology.

184
A108: The association between inflammatory biomarkers and low back disorder: a systematic review and meta-analysis

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Background: Low back disorder (LBD) is one of the greatest contributors to disability adjusted life years (DALYs) in the world. Inflammation results in proliferation of cytokines or consequent degradation products (collectively known as Inflammatory Biomarkers) that activate pain pathways which can result in non-specific LBD. **Purpose:** Evaluate the relationship between inflammatory biomarkers, clinical presentation, disability and outcome of treatment in patients with LBD. **Methods:** Three online databases were searched of randomized controlled trials (RCTs) and observational studies. The association between low back pain (LBP) and/or leg pain and/or back-specific disability scores and the expression of inflammatory biomarkers in patients with LBD were considered as primary outcomes. Standardized mean difference (SMD) and their 95% confidence intervals (CI) were evaluated. The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach was used to summarize the strength of evidence. **Results:** Four RCTs and sixteen observational studies were included in the analysis of 1142 patients with LBD. There was a statistically significant reduction in back pain score (SMD = 1.38 (95%CI = 1.00 to 1.76)) and IL-1 beta (SMD = 1.05 (95%CI = 0.56 to 1.54)) and increase in the expression of CTX-1 (SMD = -0.54 (95%CI = -0.99 to -0.10)) and IL-10 (SMD = -0.91 (95%CI = -1.28 to -0.53)) levels post treatment. There was a significant relationship between increase in the expression of MCP-1 (r = 4.46, (95%CI = 2.72, 6.20), p = 0.004) and reduction in the expression of hsCRP (r = -3.44, (95%CI = -5.16, -1.69), p = 0.003) with increase in back pain. Significant relationship was also observed between increase in the expression of MCP-1 (r = 4.34, (95%CI = 1.30, 7.38), p = 0.025) and reduction in the expression of IL-6 (r = -1.20, (95%CI = -1.20, -0.41), p = 0.023) with increase in leg pain. Increase in the expression of IL-8 (r = 3.36, (95%CI = 2.71, 4.01), p < 0.001) and reduction in the expression of hsCRP (r = -4.04, (95%CI = -4.54, -3.55), p < 0.001) was also associated with increased disability score. **Conclusions:** Inflammatory biomarkers play a significant role in the pathogenesis of LBD. CTX-1, IL-10 and IL-1 beta may be responsible for the decrease in back pain scores post treatment. There is a relationship between MCP-1, IL-6, IL-8 and hsCRP with clinical and functional assessments for LBD. Further studies will improve understanding of the pathogenesis of LBD and aid in targeted management strategies. **Keywords:** Low back disorder, inflammatory biomarkers, pain score, meta-analysis, meta-regression

OP13: MIS Endoscopy

1603
A109: Influence of BMI on disability outcomes in spinal endoscopic surgery: a cohort study

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Introduction: Amid the global obesity epidemic, its impact on spinal pathologies and surgeries has gained attention. While obesity is recognized as a risk factor for spinal issues, its specific influence on endoscopic spinal surgery outcomes remains understudied. This study aimed to (1) assess the relationship between pre-operative BMI and post-operative outcomes in endoscopic spinal surgery, and (2) Equip clinicians with data to gauge the procedure's efficacy across different BMI classifications. **Methods:** This retrospective analysis of 98 patients with spinal conditions who had undergone endoscopic surgery between August 2021 and January 2022 were included. Comprehensive patient data, including demographic information, preoperative clinical status, intraoperative details, clinical complications, and postoperative outcomes, were collected from electronic medical records. Surgical outcomes, include, Visual Analogue Scale (VAS) leg pain scores, VAS back pain scores, Oswestry Disability Index (ODI), Roland-Morris Disability Questionnaire (RMDQ) scores, and the Quality-of-life EuroQol-5 Dimensions Questionnaire (EQ5D) scores, were assessed. Descriptive statistics, Estimation-Stats package, and Spearman's rank correlations were used for statistical analysis, considering a P-value < 0.05 as statistically significant. **Results:** The mean BMI of the patients was 29.72 ± 6.46, with 38.8% categorized as overweight. The analysis revealed significant negative correlations between BMI and both Delta-ODI (r = -.395, p = 0.01) and Delta-RMDQ (r = -432, p = 0.01). Furthermore, when assessed based on BMI categories, there was a significant negative correlation with BMI category and Delta-ODI (r = -.445, p = 0.003) and Delta-RMDQ (r =

-501, p = 0.00). Higher BMI categories were significantly associated with less improvement in ODI-scores compared to a shared control. Improvement in ODI-scores was observed for all BMI categories postoperatively. No significant correlation between BMI and VAS back pain, VAS leg pain or quality of life were found. **Conclusion:** This study demonstrates that higher BMI is strongly negatively associated with postoperative improvement in disability for patients undergoing endoscopic surgical treatments. These findings emphasize the importance of addressing obesity as a modifiable risk factor to enhance patient outcomes after surgery. Surgeons should set realistic expectations for functional improvement when discussing endoscopic procedures with obese patients.

2342

A110: Exploring physical lumbar microvascular geometry through endoscopy and illustrations: implications for clinical interpretation

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Introduction: Minimally invasive endoscopic spinal surgery is gaining popularity, but our understanding of the lumbar spine's microvascular geometry relies heavily on cadaver studies and textbook illustrations. Additionally, inconsistent nomenclature of vessels in the literature hampers effective communication among surgeons. This study aims to improve the clarity and comprehensibility of the lumbar spinal microvascular geometry under endoscopic view. **Material and Methods:** The study included 400 patients who underwent endoscopic spinal surgery for lumbar spinal canal stenosis and foraminal stenosis. The surgeries were performed by an experienced surgeon using either the interlaminar or transforaminal approach. Endoscopic video recordings were further analyzed to map the microvascular geometry and common bleeding foci. The observed results were cross-referenced with existing literature to reconstruct a comprehensive view of the vascular anatomy. **Results:** The transforaminal approach commonly encounters bleeding foci originating from the major branches of the segmental lumbar artery and the emissary veins within the foramen. The interlaminar approach primarily encounters bleeding foci from the muscle vessels in the dorsal lamina, which are believed to be located near the ends of the three main branches. In the intracanal region, epidural vessels form a rotary loop above the disc, which can contribute to most of the bleeding during discectomy.

Conclusion: This study provides a comprehensive understanding of the microvascular anatomy in the lumbar spine during endoscopic spinal surgery. Recognizing the geometry will help surgeons anticipate and control bleeding, reducing the risk of complications. The findings contribute to the improvement of surgical techniques and patient safety in endoscopic spinal surgery.

2572

A111: Cost-effectiveness analysis of transforaminal endoscopic thoracic discectomy and microscopic discectomy for thoracic disc herniation

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Introduction: This study aimed to evaluate the clinical outcomes and cost-effectiveness of transforaminal endoscopic thoracic discectomy (TETD) compared to microscopic discectomy (MD) for the treatment of symptomatic thoracic disc herniation (TDH). **Material and Methods:** Healthcare costs were broken down into direct and indirect costs. Direct costs encompassed expenses from the operation to a 1-year follow-up, while indirect costs considered work loss. A cohort of 77 patients with symptomatic TDH were retrospectively reviewed (39 TETD and 38 MD). Clinical outcomes were appraised using the Visual Analogue Scale (VAS), Oswestry Disability Index (ODI), and the American Spinal Injury Association impairment scale. Patient satisfaction was assessed via the modified MacNab criteria. **Results:** The estimated direct costs for TETD were $3,650 ± $1,100, while MD stood at $4,250 ± $950. When considering indirect costs, TETD averaged at $600 ± $480 in comparison to MD's $770 ± $470. Patient recovery time was notably shorter for the TETD group, leading to fewer days of work loss. The projected one-year quality-adjusted life year (QALY) gains showed an edge for TETD at 0.21 versus MD's 0.19. The Incremental Cost-Effectiveness Ratio (ICER) for MD was approximated at $35,000 ± $24,500. When assessing overall patient satisfaction, TETD patients reported fewer post-operative complications and a quicker return to daily activities. In economic terms, TETD showcased potential savings of around $7,500 per QALY compared to MD, emphasizing its cost-effectiveness. **Conclusion:** TETD for symptomatic TDH not only offers promising clinical outcomes but also emerges as a more cost-effective solution when compared to MD. While achieving similar primary clinical outcomes as MD, TETD differentiates itself in terms of reduced post-operative recovery times, higher patient satisfaction, and overall cost-effectiveness, largely attributed to its minimal invasiveness.

1515
A112: Comparison of demography, effectiveness and safety of MISS microscopic, endoscopic, and open discectomy for lumbar disc herniation

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Background: In the young population, lumbar disc herniation is a common spine pathology that often needs surgical interventions. Patients present with neurological impairment, lower limb radiation neuralgia, and back pain. If the condition is severe, paralysis might result. **Objective:** To compare the demography, effectiveness and safety of MISS microscopic discectomy, endoscopic, and open discectomy for lumbar disc herniation. **Methods:** A retrospective study was performed at the Department of Orthopaedics & Spine Centre, Ghurki Trust Teaching Hospital, Lahore from the duration of 2016-2023 including all those patients who were diagnosed with lumbar disc herniation. All patients above 18 years of age with symptomatic disc herniation and who have failed non-surgical management were selected. Patients were randomly divided into three groups; Group A = MISS microscopic discectomy, Group B = MISS endoscopic, and Group C = open discectomy. Safety and efficacy were assessed among these patients. **Results:** A total of 1716 patients were included in our study among these 236 patients underwent MISS microscopic discectomy, MISS endoscopic was done in 71 cases while in the majority of cases (1409) open discectomy was done. Of 236 cases of MISS microscopic discectomy, more than half 161(68.2%) were males while fewer 75 (31.8%) were females with a mean age of 31.2 ± 2.59, as compared to MISS endoscopic, of 71 cases, the majority 49 (69%) were males and 22 (30.9%) were females with a mean age of 30.6 ± 3.20. On the other hand, of 1409 cases of open discectomy 911 (64.7%) were males and 498 (35.3%) were females with a mean age of 32.1 ± 4.50. Out of 1716 patients, 849 (49.5%) cases were found with a level of disc L4-L5 While an L5-S1 level of disc was seen in 706 (41.1%). L3-L4 level was seen in 23 cases. Two level disc (L4-L5-S1) was observed in 138 (8.04%) cases. We also assessed the complications (dural injury, recurrent disc, wound infection) among patients. Re-exploration and dura repair were performed in 5 (2.12%), 1 (1.41%), and 70 (4.97%) MISS microscopic discectomy, MISS endoscopic and open discectomy cases respectively. Recurrent disc cases were (MISS microscopic discectomy = 2 (0.84%), MISS endoscopic = 1 (1.41%) and open discectomy = 9 (0.64%)). We observed wound infection in 2 (0.85%) and 25 (1.77%) cases of MISS microscopic discectomy and open discectomy cases respectively. There is no case of wound infection found in MISS endoscopic discectomy. **Conclusion:** It is concluded that MISS microscopic and endoscopic techniques had relatively similar lower rates of complications in terms of wound infections and dural injury compared to open discectomy. So these techniques are safe and effective in spine surgery practice. Cost-effective Open discectomy is also an effective traditional technique to reduce the rate of recurrent disc for lumbar disc herniation patients.

Keywords: endoscopic discectomy; symptomatic lumbar disc herniation; open discectomy; MISS (minimal invasive spine surgery) microscopic

2392
A113: Comparison of clinical outcomes and muscle invasiveness between unilateral biportal endoscopic discectomy and percutaneous endoscopic interlaminar discectomy for lumbar disc herniation at L5/S1 level

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Objective: Both unilateral biportal endoscopic discectomy (UBED) and percutaneous endoscopic interlaminar discectomy (PEID) could achieve favorable outcomes for lumbar disc herniation (LDH). There are limited studies comparing the two different methods of endoscopic discectomy. The objective was to comprehensively compare the clinical outcome and muscle invasiveness of UBED and PEID for the treatment of LDH at L5/S1 level with at least 1-year follow-up. **Methods:** The retrospective cohort study enrolled 106 LDH patients of L5/S1 level from January 2018 to December 2020. There were 51 patients underwent UBED (22 males and 29 females, 43.8 ± 14.2 years old) and 55 patients underwent PEID (28 males and 27 females, 42.3 ± 13.8 years old). Clinical outcomes and surgical invasiveness were compared between the two groups for at least 1 year follow-up. Clinical outcomes included visual analogue scale (VAS) scores, Oswestry Disability Index (ODI), complications, recurrence of LDH, intraoperative anesthesia time, operative time, number of intraoperative fluoroscopies, and postoperative length of stay. Surgical invasiveness was evaluated with serum CPK level and change rate of lean multifidus cross-sectional area (LMCSA). Independent-sample t test and paired sample t test were used to compare continuous data. Chi-square test and Fisher's precision probability tests were used to analyze the categorical data. **Results:** Both groups achieved favorable clinical outcomes at the last follow-up, including VAS and ODI (all Ps < 0.05). The intraoperative anesthesia time for UBED was longer, but with no difference of operative time. As for intraoperative fluoroscopy times (2.5 vs. 2.4),

postoperative length of stay (2.1 vs. 2.0 days), postoperative complications (5.9% vs. 3.6%), there were also no significant difference. The serum CPK level and change rate of LMCSA for UBED was higher than PEID at postoperative 1st day. At the last follow-up, there was no significant difference in the change rate of LMCSA between the two groups (p = 0.096). **Conclusions:** Both UBED and PEID could achieve favorable clinical outcomes for the treatment of L5/S1 LDH. Despite UBED is more invasive, the radiological manifestation of paraspinal muscle invasiveness was equal at last follow-up with at least 1 year. UBED is a safe and innovative alternative choice for treatment of LDH at L5/S1 level.

1561
A114: Monoportal endoscopic treatment of symptomatic thoracic disk herniation: how I do it with video content

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Introduction: Symptomatic thoracic disc herniations is a surgical challenge, demanding specific expertise to determine the optimal approach, either through a posterolateral or mini-thoracotomy route, depending on the disk herniation's location and the presence of calcifications within the target hernia. The use of endoscopy opens up a new route with a transforaminal retropleural approach. Herein, we report a case of a patient with a symptomatic T8-T9 thoracic disc herniation who underwent a single-port endoscopic transforaminal approach. **Material and Methods:** A 45-year-old male presented with a slowly progressing spinal cord compression syndrome, characterized by T8 radicular pain, occasional lower limb weakness episodes, and occasional urinary incontinence. MRI revealed a left paramedian T8-T9 disc herniation compressing the spinal cord, with central centromedullary FLAIR hyperintensity. The procedure was performed under general anesthesia and neuromonitoring (NIM eclipse), using JOIMAX Tessys instruments, with fluoroscopic control. **Results:** The surgery lasted 1 hour and 45 minutes and proceeded without complications. Adequate decompression was achieved, and the postoperative course was uneventful without neurological deterioration. The patient was mobilized with the assistance of a physiotherapist on the day of surgery (Day 0) and was discharged home on Day 2 postoperatively. **Conclusion:** This endoscopic approach, compared to our current standard (anterior-lateral approach guided by mini-thoracotomy), reduced operative morbidity. The endoscopic approach decreased postoperative pain by avoiding rib resection and thoracic drain placement while ensuring satisfactory decompression. During the presentation, we will compare both techniques and provide a video of the endoscopic case.

1401
A115: Modified full-endoscopic foraminotomy in low-grade degenerative and isthtmic spondylolisthesis: patient-specific tailored approach

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Introduction: Lumbar spondylolisthesis (SL) is a prevalent and often debilitating spinal condition. Over the years, various surgical techniques have been developed to treat SL, ranging from spinal fusion to laminectomy. However, these methods often involve extensive surgical intervention, which may lead to prolonged recovery periods and potential complications. While endoscopic foraminotomy has been employed in various spinal conditions, its application in the context of low-grade degenerative and isthmic spondylolisthesis has not been extensively studied. The primary aim of this study is to introduce and rigorously evaluate a patient-specific tailored approach for endoscopic foraminotomy in patients diagnosed with low-grade degenerative and isthmic spondylolisthesis. This innovative approach is conceptualized to provide a customized treatment plan that takes into account the unique anatomical and pathological characteristics of each patient. By doing so, the study aims to offer a surgical option that is not only effective in alleviating symptoms but also minimizes potential complications and enhances postoperative recovery. **Material and Methods:** The study comprised a total of 30 patients, who were diagnosed with either degenerative or isthmic spondylolisthesis and were experiencing radicular symptoms. These patients were treated over a period spanning from March 2019 to September 2022. Utilizing a "patient-specific" tailored approach, the endoscopic foraminotomy was customized based on the individual combination of clinical (mono or dual radiculopathy), and imaging characteristics regarding compressing structure (endplate osteophyte, disc herniation, inferior articular process slippage) and listhesis anatomy (craniocaudal stenosis, Meyerding grade). Outcome variables were meticulously measured, including the Visual Analog Scale (VAS) for leg and back pain, and the Oswestry Disability Index (ODI). These were assessed preoperatively, and at 3, 6, and 12 months postoperatively. **Results:** Out of the cohort of 30 patients, 19 were diagnosed with isthmic spondylolisthesis and 11 had degenerative spondylolisthesis. A significant majority of the cases, precisely 75.86%, were classified under Meyerding Grade 1 listhesis. Surgical

intervention was primarily performed using a transforaminal approach, accounting for 86.21% of the total cases. The remaining 13.79% were treated using an Interlaminar Contralateral approach, which was chosen based on specific anatomical considerations. In terms of clinical outcomes, the study observed a statistically significant reduction in the VAS scores for both leg and back pain. The average preoperative VAS score for leg pain was 7.3, which decreased to 1.7 at the 12-month follow-up. Similarly, the VAS score for back pain showed a reduction from an average of 6.9 preoperatively to 2.1 at the 12-month follow-ups. The ODI also showed a significant improvement. The average preoperative ODI was 48.6%, which improved and stabilized at 18.7% at the 12-month follow-up. These improvements in VAS and ODI scores were not only statistically significant but also clinically relevant. **Conclusion:** The study conclusively demonstrates that a patient-specific tailored approach for endoscopic foraminotomy can be highly effective in treating patients with low-grade degenerative and isthmic spondylolisthesis. This approach not only provides satisfactory clinical outcomes but also does so without compromising the segmental stability of the lumbar spine.

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A116: A review of the first 108 cases of endoscopic biportal spine surgeries: a single-surgeon experience

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Introduction: Endoscopic spinal surgery has emerged as a compelling minimally invasive alternative to conventional open surgery for addressing degenerative disc disease and prolapsed discs. Its distinct advantages include markedly reduced tissue disruption, muscular trauma, negligible intraoperative blood losses, a diminished tendency for postoperative fibrosis and scarring, expedited recovery as well as comparable clinical outcomes. The application of uniportal endoscopic techniques may however be challenging in cases involving obese patients, patients with prior surgeries, multilevel disc disease or those with listhesis. The biportal approach hence features dual channels for enhanced visualization and instrumentation to address some of these complexities. In this study, we present the outcomes of a comprehensive investigation drawing from the experiences of a single proficient surgeon. **Material and Methods:** A retrospective review of biportal endoscopic surgery cases by a single surgeon were examined. Comprehensive data including patient epidemiological data, chief complaints, diagnostic

imaging results, and subjective patient reported outcome measures such as the 36-item Short Form Survey (SF-36), Visual Analogue Scale for Pain (VAS) and Oswestry Disability Index (ODI) were scrutinized. Details pertaining to the operations were analyzed alongside postoperative clinical follow ups and physiotherapist reviews for up to three months. **Results:** A total of 108 patients were operated on with a mean age of 57.8. 50% of the patients were females (n = 54), and most of our patients were overweight to obese by Asian standards (mean BMI $27 \pm 5.0 \text{ kg/m}^2$). The primary presenting complaint was leg pain (91.7%), with lower back pain (73.1%) and claudication (45.4%) following behind. 3 patients (2.8%) received prior open spinal surgery in the same region before. Most cases required bilateral decompression (44.4%), and 7 patients received two-level surgery whilst 1 patient received three-level surgery. The L4/L5 (50.4%) and L5/S1 levels (28.2%) were most operated on. Intraoperatively, 3 patients suffered from dural tears (2.8%), 1 patient had significant bleeding (0.9%), and 2 patients had postoperative acute retention of urine (1.9%). The average length of stay was 1.90 days, with majority of our patients receiving partial (46.3%) to complete relief (53.7%) of all symptoms. Operative times were 117.73 minutes on average for single level surgeries and were significantly longer in patients with higher BMI (r = 0.2122, p < 0.05), and shorter with increased surgical experience (r = -0.235, p < 0.05), especially in cases involving the L4/L5 and L5/S1 regions. VAS for back pain decreased significantly at the one- and three-month follow-ups when compared against pre-operative levels (5.37 > 2.68 > 2.15, p < 0.05). Similarly, VAS for leg pain also saw improvements (6.60 > 2.59 > 1.90, p < 0.05). ODI scores also saw significant improvement (51.70 > 34.98 > 23.29, p < 0.05). The SF-36 also saw significant improvements in multiple domains, including physical function, physical roles, and a reduction in bodily pain. In total, 3 patients required revision surgery. **Conclusion:** Our single surgeon single center experience on 108 patients was fruitful, with a significant reduction in surgical time with respect to number of previous cases done, as well as marked improvement in patient reported outcomes measures. Biportal endoscopic spine surgery in experienced hands often grants patients good resolution of symptoms whilst avoiding complications.

2350

A117: Open posterior approach versus endoscopic approach for thoracic ligamentum flavum ossification: a systemic review and meta-analysis

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Introduction: Thoracic Ossification of the Ligamentum Flavum (TOLF), a rare condition more prevalent in East Asia, is managed through open and endoscopic surgical approaches. Determining the superior surgical option remains unclear. This study assesses the safety and clinical outcomes associated with these approaches in TOLF patients. **Material and Methods:** Following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, we conducted a systematic literature search up to August 5, 2023, across PubMed, Scopus, EMBASE, Web of Science, Cochrane, and ClinicalTrials.gov. We included randomized controlled trials and cohort studies reporting complication rates, mJOA (modified Japanese Orthopedic Association) scores, JOA scores, VAS (Visual Analog Scale) scores, or hospitalization duration for both open and endoscopic surgeries in TOLF patients. **Results:** We analyzed 37 studies encompassing 1,646 TOLF patients using a random-effects model. Our findings revealed a significant difference in complication rates (overall complication rates: 0.12; 95% CI: 0.07, 0.19; p < 0.01; I2: 69%; quality of evidence: moderate), with lower complication rates in the endoscopy group. However, no significant differences were observed in JOA scores (overall JOA: 8.35; 95% CI: 7.16, 9.54; p = 0.12; I2: 99%; quality of evidence: very low), VAS scores (overall VAS: 1.31; 95% CI: 1.03, 1.59; p = 0.35; I2: 91%; quality of evidence: very low), or hospitalization duration (hospital stay: 10.83 days; 95% CI: 6.86, 14.80; p = 0.35; I2: 91%; quality of evidence: very low) between the open and endoscopic groups. **Conclusion:** This meta-analysis reports lower complication rates and improved postoperative mJOA scores for endoscopic surgery in TOLF patients compared to open surgery. It represents the first comprehensive evaluation of clinical outcomes and safety of different surgical approaches for TOLF patients. Further randomized controlled trials are essential to validate these findings.

OP14: Lumbar Degenerative: Understanding Outcomes

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A118: Outcomes of risk prediction for secondary lumbar instability after decompression surgery: validation of a new scoring system in 107 patients

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Introduction: Surgical management of lumbar spinal stenosis (LSS) remains controversial, as factors qualifying patients for fusion procedures may not be met and decompression alone may carry the risk for the development of secondary lumbar instability (SLI). The aim of this study was to validate a novel scoring system for SLI risk prediction including a 14-point scale, created using the most relevant risk factors selected by the authors' spine surgery research group with the help of a peer-review process. **Material and Methods:** Patients treated with lumbar "over-the-top" decompression due to LSS at the author's department between January and December 2018 were included. BMI, gender, smoking history, age, previous lumbar surgery, presence of lumbar back pain, presence of spondylolisthesis (> 5 mm), dynamic listhesis (> 3 mm), segmental kyphosis (> 10°), disc height > 6.5 mm, facet joint angle (> 50°) and fluid-filled facet joints were retrospectively assessed. Clinical deterioration, presented as SLI with requirement for spondylodesis of the pre-operated segment during a postoperative two year follow up was defined as the primary outcome value. **Results:** 107 patients with a median age of 69 years were included in this study. Twenty-eight patients (26.2%) had mechanical low back pain with VAS > 4, and 24 patients (22.4%) already received previous surgery at the segment to be operated on. The median SLI score was 6/14 (IQR 5, 8), patients who subsequently required spondylodesis (9/107, 8,4%) showed a significantly higher SLI score compared to patients who did not subsequently develop SLI (9 vs. 6, p = 0.013). The most relevant risk factors for development of SLI were disc height > 6.5 mm, a high BMI as well as the presence of a lumbar listhesis with a relative risk (RR) of 2.8, 2.3 and 2.8, respectively. **Conclusion:** Using the novel SLI score, we were able to show a clear difference regarding pre-defined risk factors for patient with and without subsequent fusion surgery after lumbar decompression. Further studies are needed in order to define clear cut-off values for a more efficient distinction and easer decision making during the preoperative evaluation of patient scheduled for decompression or fusion surgery.

1575

A119: 10-year trajectories on thresholds of improvement and treatment satisfaction following lumbar fusions

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Introduction: Patient-reported outcome measures (PROMs) have become key determinants in spine surgery outcomes studies. Minimal important change (MIC) and patient acceptable symptom state (PASS) are concepts established to aid PROM interpretations. **Material and Methods:** 613 consecutive patients undergoing lumbar fusion (mean age 61 years;

69% women) were recruited into a prospective 10-year follow-up. Surgical indications comprised spinal stenosis with (327, 53%) or without (96, 16%) spondylolisthesis, spondylolysis (93, 15%), degenerative disc disease (51, 8%), and adult spinal deformities (46, 8%). At pre-defined time-points, patients completed PROMs including Oswestry Disability Index (ODI) and Visual analogue scale (VAS) for back and leg pain and specific anchor questions. Improvement was screened with a question: "Are your back and/or leg symptoms after fusion in total 1) worse, 2) the same, 3) better, or 4) much better". Patients were thereafter categorized as "Improved" or "Not improved". Receiver operating characteristics (ROC) curve analysis was used to estimate MICs (95% confidence intervals, CIs) as ODI and VAS change scores that best predicted improvement at distinct time-points. The anchor question for treatment satisfaction was: "Now that you have undergone spinal fusion and know the outcome, would you still undergo surgery in a similar situation you had – providing that the surgery was not performed? No / Yes". ROC curve analysis was used to estimate PASS (95% CIs) as the lowest ODI and VAS levels at which patients were still satisfied with treatment received. **Results:** 80% of patients perceived themselves improved at 1-year, and 70% at 10-years. MIC for ODI represented instability across 10-years, ranging from 21 (16 to 24) at 2-years to 8 (4 to 7) at 5-years, $p < .001$. Areas under the ROC curves (AUCs) (0.79 to 0.85) indicated acceptable to excellent discrimination. Heterogeneity was not significant in the MIC trajectory for back pain, VAS ranging from 17 (6 to 36) at 5-years to 34 (21 to 45) at 2-years, $p = .28$, and leg pain, VAS ranging from 11 (4 to 34) at 10-years to 26 (8 to 44) at 1-year, $p = .64$. AUCs (0.73 to 0.78) indicated acceptable discrimination. 94% of patients would have undergone surgery again at 1-years, that rate remaining over 90% throughout follow-up. No significant heterogeneity was observed in 10-year PASS trajectories for any PROM. PASS for ODI ranged from 22 (15 to 29) at 1-year to 38 (26 to 48) at 5-years, $p = .059$. AUCs ranged from 0.79 to 0.85. PASS for back pain, VAS ranged from 38 (20 to 56) at 1-year to 47 (25 to 70) at 5-years, $p = .91$, and leg pain, VAS ranged from 37 (11 to 63) to 49 (26 to 72), $p = .92$. AUCs ranged from 0.69 to 0.81. **Conclusion:** Using MIC and PASS scores has limitations in long term. MIC for ODI represented instability over time. Caution is needed when interpreting long-term treatment effects and using MICs in power calculations.

2455

A120: Patients undergoing primary L4-S1 decompression and fusion surgery: are we giving them enough lordosis or setting them up for future surgery?

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Introduction: Adequate L4-S1 lordosis is critical to maintain a harmonious spinal shape. In a pilot study of patients undergoing primary, degenerative L4-S1 decompression/fusion, we sought to: 1) describe changes in L4-S1 andL1-S1 lordosis, 2) report the change in lordosis apex with respect to Roussouly type, and 3) determine the impact of lordosis and apex changes on reoperation. **Materials and Methods:** A single-institution, retrospective cohort study from a prospective registry was conducted for patients undergoing primary, degenerative L4-S1 decompression/fusion from 2016-21. Exposure variables included preoperative L4-S1 and L1-S1 lordosis, lordosis apex, and Roussouly type. A "False Type 2" was a-priori defined as a pelvic incidence $(PI) > 50°$ with a pelvic tilt $(PT) > 50\%$ of the PI. A change in lordosis of 5° was deemed significant. The primary outcomes were postoperative L4-S1 and L1-S1 lordosis. Secondary outcomes were postoperative lordosis apex and reoperation. Bivariate statistics were performed. **Results:** A total of 51 patients were included with a mean follow-up of 4.2 ± 1.6 years. Mean age was 59.8 ± 12.7 and 22 (43.1%) were males. Spondylolisthesis was present in 44 (86.3%) patients, and 22 (43.1%) had an interbody, placed posteriorly in 21/22 patients. L4-S1: Mean preoperative/postoperative L4-S1 lordosis was $30.1 \pm 13.0°$ vs. $27.0 \pm 11.5°$ $(p = 0.054)$. A total of 35.3% maintained the same L4-S1 lordosis, 47.1% decreased, and 17.6% increased. L1-S1: Mean preoperative/postoperative L1-S1 lordosis was $51.2 \pm 11.4°$ vs. $45.0 \pm 14.1°$ $(p = 0.002)$. A total of 27.5% maintained the same L1-S1 lordosis, 54.9% decreased, and 17.6% increased. The number of False Type II patients increased from 27.5% to 37.3% $(p = 0.023)$. Reoperation: 8/51 (15.7%) patients underwent reoperation at a mean f/u of 13.3 ± 8.7 months for pseudarthrosis (4/8), adjacent segment disease (3/8), and osteodiscitis (1/8). Patients with worsened L1-S1 lordosis had a higher but non-significant reoperation rate compared to those with the same/improved L1-S1 lordosis (21.4% vs. 8.6%, $p = 0.269$). In patients with a misplaced apex postoperatively, 4/18 (22.2%) underwent reoperation compared to 4/33 (12.1%) $(p = 0.430)$. **Conclusions:** In patients undergoing primary, elective L4-S1 decompression/fusion, approximately half experienced worsening in L4-S1 (47%) and L1-S1 lordosis (55%). The number of False Type II patients significantly increased from preoperative to postoperative. A higher but non-significant rate of reoperation was seen in patients with worsened L1-S1 lordosis and a misplaced lordosis apex. Despite a small sample size, the results of this pilot study suggest that attention to lordosis maintenance/correction in primary, degenerative L4-S1 decompression/fusion may improve long-term outcomes.

1116

A121: Minimum clinically important difference in patient-reported outcome measures in de novo degenerative lumbar scoliosis: is it appropriate to apply the values of adult spine deformity?

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Introduction: Minimum clinically important difference thresholds for back pain, leg pain, and the Oswestry Disability Index (ODI) and SRS-22R have not been widely described in patients with adult spine deformity (ASD). The objective of this study was to calculate the range of minimum clinically important difference threshold values using anchor-based and distribution-based methods for back pain, leg pain, the ODI, and the Scoliosis Research Society 22R instrument (SRS-22R) in patients with de novo degenerative lumbar scoliosis (DNDLS) who underwent long-segment fusion surgery. Then, we sought to determine a statistically sound meaningful, minimum clinically important difference in patient-reported outcome measures (PROMs) and compare our results with previously reported values for other ASD populations. **Material and Methods:** PROMs were obtained preoperatively and two years postoperatively in 128 patients with DNDLS. We applied different minimum clinically important difference calculation methods to the data, and the results were compared. **Results:** There was a statistically significant improvement in the two-year postoperative PROM scores compared with the preoperative scores. Different preoperative calculation methods yielded an ~10-fold range of values. Minimum clinically important difference values were established as 1.9 for back pain, 1.5 for leg pain, 18.9 for the ODI, 0.8 for SRS-22R pain, 0.5 for SRS-22R activity, 1.6 for SRS-22R appearance, 0.8 for SRS-22R mental, and 0.98 for the SRS-22R subtotal. Compared with the previously reported minimum clinically important differences in ASD, the values for back pain, ODI, and SRS-22R appearance were higher in patients with DNDLS. **Conclusion:** Sensitivity-based and specificity-based methods provide statistically sound minimum clinically important difference thresholds for the DNDLS population. The minimum clinically important difference thresholds for PROMs in patients with DNDLS were different from the threshold values previously reported for adult patients with spinal deformities.

2313

A122: Hospital length of stay: a swift drop following lumbar spine surgery in tertiary-care hospitals vs. ambulatory surgery center

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Introduction: Amid escalating costs and declining reimbursements, the emergence of surgical centers and specialty hospitals offering same-day discharges for eligible patients represents a cost-mitigating strategy without compromising patient care. However, in the sphere of spine surgery, there is limited information regarding patient outcomes between ambulatory surgery centers and tertiary-care hospitals. The objective of this study is to compare outcomes and complication rates based on the surgical setting in patients following elective lumbar spine surgery. **Material and Methods:** Patients who underwent elective lumbar fusion surgery at a single tertiary care hospital (TCH) and a single ambulatory surgery center (ASC) from 2017 to 2022 were identified retrospectively. Patient demographics, surgical characteristics, and surgical outcomes were collected from an electronic medical record. Patients were identified and separated into two cohorts based on where their surgery was performed. Patients were excluded if they were less than 18 years of age or if surgery was performed due to trauma, infection, or tumor. Propensity score matching was performed in a matched 1:1 comparison based on (Age, CCI, Procedure type, and Total levels fused). All statistical analyses were performed using R Studio Version 4.0.2 (Boston, MA), with P values < 0.05 considered statistically significant. **Results:** Of the 368 patients identified, 184 were surgically treated at a TCH, and 184 were surgically treated at an ASC. Patients treated at the TCH had a significantly longer length of stay compared to their counterparts at the ASC (3.03 vs. 1.65 days, p < 0.001). Both hospitals exhibited no significant difference regarding operating time (p = 0.068), procedure type (p = 0.913), or the total number of levels fused (p = 0.938); however, a notable divergence emerged in the extent of decompression, with the TCH cohort having significantly more levels decompressed than the ASC cohort (1.70 vs. 1.51, p = 0.021). There was no noticeable significant difference regarding revision rates (p = 0.195) and complication rates (p = 1.000). Conversely, the 90-day readmission rate at the ambulatory surgery center was zero, compared to the 6.52% readmission rate observed at the tertiary-care hospital (p = 0.001). Not surprisingly, the patients at the ASC had a 100% home discharge rate, whereas 7 TCH patients (3.8%) were discharged to an inpatient rehab (IPR), and 4 (2.2%, p = 0.001) were admitted to a skilled nursing facility (SNF). **Conclusion:** Our study revealed that patients treated at the ambulatory surgery center experienced a significantly shorter hospital length of stay, zero 90-day readmissions, and a 100% home discharge rate following lumbar

spine surgery compared to those at the tertiary care hospital. No differences were noted in revisions and complication rates between the two hospitals, indicating that the expedited recovery at an ambulatory surgery center did not compromise surgical quality or postoperative outcomes. These findings suggest that for certain patient populations, ambulatory surgery centers may offer a more efficient, cost-effective model for lumbar spine surgery without sacrificing the quality of patient care compared to tertiary-care hospitals.

1417

A123: Larger and lordotic discs are associated with better lumbar muscle health: a retrospective review of disc geometry and posterior muscle characteristics

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Introduction: There have been several studies examining paralumbar muscle health and patient-reported outcomes. However, there is currently limited data on the association between lumbar disc morphology and paralumbar muscle health. Therefore, this study aimed to provide a comprehensive retrospective analysis of the associations between lumbar disc morphology and paralumbar muscle health at every lumbar level between L1-S1. **Material and Methods:** This was a single surgeon, retrospective, Institutional Review Board-exempt review of 615 lumbar degenerative patients. Associations between x-ray analysis of disc shape (focal lordosis, posterior disc height, listhesis) and MRI measurements of muscle health (Cross-Sectional-Area/Body-Mass-Index, Lumbar indentation value, Goutallier classification) at each individual lumbar levels L1-S1 were evaluated using a partial correlation controlling for significant demographic variables. Patients were further stratified for listhesis at L4-S1 as retrolisthesis (R) if < -5mm, spondylolisthesis (S) if > 5mm, or neutral (N). Demographic data were compared between listhesis groups and an ANCOVA analysis controlling for significant demographics parameters was conducted to evaluate for differences in muscle characteristics. **Results:** 435 patients were included (age: 55.6 ± 15, BMI: 29.5 ± 6, 60.9% Female). Muscle health median characteristics were CSA/BMI = 140 (IQR 112-170), LIV = 13 (IQR 9-17), and Goutallier Classification of 1 (IQR 1-2). Mean lordosis for the cohort was 54.6 ± 14° between L1-S1, 20.9 ± 7 (38.4% LL) at L5-S1, and 21.3 ± 8 (39.3% LL) at L4-L5. Partial correlations between focal disc parameters and muscle health

while controlling for age and sex showed significant positive associations between focal lordosis and lumbar indentation value (LIV) at every level (Mean r = 0.264 between L1-L5, p < 0.001), weak positive association between focal lordosis and CSA/BMI (Mean r = 0.113 at L2-L5, p < 0.03) and weak negative associations between disc height and Goutallier Classification (Mean r = 0.158 at L1-L5, p < 0.03). Stratification by listhesis at L4-S1 revealed that 6.9% (N = 30) patients presented with spondylolisthesis (mean: 9 ± 3mm), 6% (N = 26) with retrolisthesis (mean: 6 ± 1mm), and 87.1% (N = 377) as neutral (mean: 1.3 ± 1.5mm). ANCOVA controlling for sex and age demonstrated no significant association between S and R groups and CSA/BMI, LIV, or Goutallier classification (p > 0.1). **Conclusion:** Posterior muscle health was significantly associated with disc shape, especially disc height and disc lordosis, with larger and more lordotic discs being associated with better muscle health. Disc listhesis was not significantly associated with muscle quality when controlling for demographic characteristics, and no differences in muscle health parameters were observed in patients with spondylolisthesis versus retrolisthesis. Overall, results highlight key associations between lumbar compensation, disc geometry, and posterior muscle health, which may have implications in identifying spinal parameters that predict better lumbar muscle health.

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A124: Does indirect decompression by OLIF produce similar short term clinical and radiological outcome as by direct decompression Open TLIF in single level lumbar interbody fusion

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Background: Open transforaminal lumbar interbody fusion (O-TLIF) remains the most popular and widely practiced method of lumbar fusion even today which provides direct decompression. Oblique lateral interbody fusion (OLIF) has is a novel retroperitoneal approach that allows placement of a large interbody cage which provides an indirect neural decompression and screws can be placed minimal invasively or via Wiltse approach (W-OLIF). We aim to find out the short-term efficacy of W-OLIF to O-TLIF in terms of radiological and clinical outcomes in patients of LDDs. **Methods:** 52 patients divided equally in both groups (group O-TLIF and group W-OLIF). Several parameters were measured like the SC-CSA, foraminal Cross Sectional Area (F-CSA), Disc Height (DH), Foraminal Height (FH), Schizas Grade for stenosis and Meyerding's grading for listhesis. Functional scores were measured using the visual analogue scale (VAS)for low back pain, and lower limbs, Oswestry Disability Index (ODI) All parameters were repeat

measured at 3 months follow up. Statistical analysis was done using SPSS software. **Results:** Both groups were similar in composition preoperatively. There was significant improvement in all clinical and radiological parameters post-surgery in either group. However, at 3 months, The DH, FH, FSA and the Vas (LBP) was better in the W-OLIF group in comparison to O-TLIF. Procedure related complication sere seen in both groups (15% in O-TLIF group and 19% in W-TLIF group) but only one patient in O-TLIF required revision due to cage migration. **Conclusion:** There occurs similar improvement in most of the clinical and radiological parameters in W-OLIF group when compared to the O-TLIF group. Few radiological parameters like the DH, FH and F-CSA and the correction of the VAS (LBP) are superior in the W-OLIF group in the short-term follow-up. We conclude that indirect decompression by W-OLIF provides equivalent if not better results than the traditional O-TLIF lumbar fusion.

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A125: Patient-reported review of symptoms is not predictive of postoperative outcomes after lumbar spine surgery

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Introduction: A review of symptoms (ROS) is a component of the preoperative clinical assessment, and often consists of a patient-reported list of symptoms from the clinic intake questionnaire. Previous literature has suggested that there may be an association between number of allergies reported on the ROS and outcomes of lumbar spine surgery in the early postoperative period. The study goal was to determine whether patients who self-report more symptoms on their pre-clinic questionnaire have worse outcomes after lumbar spine surgery. **Methods:** A retrospective review was conducted of 179 adult patients who underwent elective lumbar surgery from 2019-2022 at a single academic institution. The primary outcome measure was minimal clinically important different (MCID) change in the postoperative visual analog scale (VAS), Oswestry disability index (ODI), or patient-reported outcome measure (PROMIS). Demographics, preoperative and postoperative outcomes measures were recorded for patients as well as number of reported symptoms on a written ROS form filled out by patients. Multivariable logistic and linear regressions were used to determine the relationship between each primary outcome and the natural log of the total number of ROS reported. **Results:** A total of 179 lumbar surgery patients were included. Mean VAS results decreased from 6.20 to 3.25 and mean ODI results decreased from 47.82 to 32.75 at 3 months post-op. Mean PROMIS pain results decreased from 65.70 to 59.48, mean PROMIS function

results increased from 34.33 to 36.66 and mean PROMIS health results increased from 35.84 to 41.04 all at 3 months post-op (all p-values < 0.05). Following multivariate logistic regression, the natural log transformation of number of positive ROS was not predictive of achieving the minimal clinically important difference (MCID) for VAS (odds ratio [OR] = 0.98, 95% confidence interval [CI] 0.85-1.13, p = 0.746), ODI (OR = 0.90, 95% CI = 0.75-1.08, p = 0.289), PROMIS function (OR = 0.66, 95% CI = 0.28-1.03, p = 0.171), or PROMIS pain interference (OR = 0.94, 95% CI = 0.70-1.23, p = 0.644). At 3 months follow-up, pre-operative VAS and ODI scores were predictive of achieving the MCID using a multivariate logistic regression model (OR = 0.52 95% CI = 0.43-0.82 p = 0.0036, OR = 0.94 95% CI = 0.89-0.98 p = 0.0115, respectively). **Conclusion:** Patient-reported positives on review of symptoms did not correlate with pain or functional improvement after lumbar spine surgery. This contradicts evidence reported in previous literature (Xiong et al.). Although previous studies have suggested that patient-reported allergy burden may correlate with poor postoperative outcomes, patient-reported positives on review of symptoms should not be considered as a predictor when patients are considered for lumbar surgery. This evidence may help limit bias when discussing surgical options with patients that have multiple positives on ROS intake forms. These results also reflect the similar trend in patients with preoperative depression whose surgical outcome is also not adversely affected by the presence of depression. Our results also supported that appropriately indicated lumbar surgery can improve patient reported outcomes and overall quality of life.

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A126: Single centre cohort study comparing minimally invasive surgery (MIS) vs open techniques in lumbar fusion surgery

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Background: Transforaminal interbody fusion in Lumbar spine (TLIF) is a common spinal fusion technique for spinal instability, spondylolisthesis, and spinal stenosis. Spinal fusion surgery is constantly evolving and can be performed by both open or Minimally Invasive Surgery (MIS) techniques. Both open and MIS techniques have been shown to provide good outcomes with minimal complications. This is a retrospective study directly comparing both techniques for their surgical time, complications and outcomes in a single centre. **Methods:** A retrospective observational cohort study was conducted in Stepping Hill Hospital, Stockport, UK. Patients who had spinal lumbar fusion surgeries between 2019-2020 were included. All patients had ongoing symptoms for at least 2-years before proceeding to surgical intervention. Data was

collected from hospital records including pre and post-operative follow-up notes, in addition to pain scores as per the visual analogue score (VAS). **Results:** A total of 60 patients (26 MIS Vs 34 open) were included. Better outcomes were reported by patients in the MIS group when compared to open surgery in terms of post-operative complications (7.6% vs 8.8%), improvement of symptoms (73.7% vs 58.8%) and average hospital stay (1.82 vs 2.76 days). However, the open group demonstrated a lower rate of metal work failure (8.8% vs 11.5%). **Conclusion:** Our study demonstrated that the MIS technique has overall better outcomes related to symptoms alleviation, post-operative complications and less hospital stay despite having a slightly higher rate of metal work failure.

OP15: Adulty Deformity: Surgery

1863
A127: Utilization trends of pedicle subtraction osteotomy in adult spinal deformity: an analysis of a large insurance claims database from 2010-2021

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Introduction: Despite the prevalence and disabling nature of adult spinal deformity (ASD), there is limited research into the updated utilization trends of its commonly used treatment, pedicle subtraction osteotomy (PSO). The present study aims to characterize PSO use over the 2010-2021 time period in a retrospective trends analysis using a national insurance claims database. **Material and Methods:** Patient data from 2010 to 2021 was accessed through the querying of the national insurance database PearlDiver. After first identifying ASD ICD-9 and ICD-10 codes, patients in this larger cohort who underwent PSO were isolated using codes CPT-22207, CPT-22208, and CPT-22206. Temporal distribution by year and demographic data including gender, age, region, payor type, and service location were extracted. Subsequent analysis included utilization trends of PSO for isolated ASD categories including scoliosis, kyphosis and lordosis. **Results:** 4218818 patients with spinal deformity were identified from 2010-2021. Of this cohort, 4749 underwent PSO for treatment. Trend analysis demonstrated an initial rise in utilization, peaking in 2016 and steadily decreasing until the end of the study period. Comparing 2010 to 2013 demonstrated an increase from 295 to 455 patients (+54.24%), subsequently falling to 425 in 2015 (-8.79%) before returning to a peak case volume of 522 in 2016 (+22.82%). Post-2016 demonstrated a decrease in PSO procedures, ultimately ending with 305

patients in 2021 (-41.57% from 2016). This decrease from 2016 to 2021 is also visible across individual deformity diagnoses including scoliosis (-34.38%), kyphosis (-43.90%), and lordosis (-22.22%). **Conclusion:** The present study demonstrates a decreasing national trend of PSO treatment of adult spinal deformity after 2016. Such findings may reflect a growing surgeon preference for posterior column osteotomy (PCO) over PSO, possibly due to the former's lower labor demands and decreased blood loss, as reported in literature.

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A128: Modified pedicle subtraction osteotomy for osteoporotic vertebral compression fractures: a retrospective study of 104 patients

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Introduction: Osteoporotic vertebral compression fracture, referred to as OVCF, is an important public health problem in the world's aging society. According to statistics, OVCF occurs every 22 seconds in the world, and the prevalence rate of the elderly over 80 years old is as high as 40 %. Posterior osteotomy and internal fixation of vertebral fusion is the standard treatment for patients with kyphosis, persistent low back pain and neurological impairment. Because patients are often complicated with severe osteoporosis, higher postoperative mechanical complications increase the difficulty and challenge for the treatment of patients. At present, there is a lack of comparative study of large samples to choose which osteotomy method can be more effective and safe. **Material and Methods:** 104 patients who underwent posterior osteotomy (Modified PSO, SPO, PSO, VCR) and kyphosis correction surgery at our hospital between April 2006 and August 2021 with a minimum follow-up period of 24 months were included. All cases were injuries induced by a fall incurred while standing or lifting heavy objects without high-energy trauma. The mean CT value was 71 HU, which was below 110 HU, indicating severe osteoporosis. The indications for surgery included gait disturbance due to severe pain with pseudarthrosis, increased kyphotic angle, and progressive neurological symptoms. Pre- and postoperative CL, TLK, TK, PrTK, TKmax, GK, LL, PI, SS, PT, SVA, TPA, were

investigated radiologically. Additionally, we evaluated estimated blood loss, surgical time and perioperative symptom. **Results:** The results show, after operation, TLK ($39.42 \pm 14.26°$ vs $9.02 \pm 8.30°$, p < 0.001), TK ($34.05 \pm 17.71°$ vs $21.83 \pm 11.90°$, p = 0.003), TK max ($51.78 \pm 11.96°$ vs $18.35 \pm 9.93°$, p < 0.001), PT ($26.31 \pm 13.60°$ vs $14.4 \pm 17.84°$, p = 0.009), SVA (38.44 ± 27.52 vs 21.44 ± 13.02, p = 0.010), CL ($16.12 \pm 15.92°$ vs $8.15 \pm 7.58°$, p = 0.038) and TPA ($24.9 \pm 13.18°$ vs $16.18 \pm 10.28°$, p = 0.045) were improved significantly in modified Pedicle subtraction osteotomy (mPSO). During follow-up, TLK ($39.42 \pm 14.26°$ vs $11.68 \pm 8.48°$, p < 0.001) and TK max ($51.78 \pm 11.96°$ vs $23.53 \pm 9.8°$, p < 0.001) were improved significantly in Modified PSO group,- compared with control group. In addition, estimated blood loss (790 ml vs 1198 ml, p = 0.035), surgical time (244 min vs 301 min, p = 0.010) were favorable in Modified PSO group.What's more, modified PSO can significantly reduce the incidence of postoperative follow-up mechanical complications (6.98% vs 26.92%, p = 0.054). **Conclusion:** To conclude, mPSO could acquire a favorable degree of kyphosis correction as well as early and less postoperative complications. Compared with other surgical methods, it also has the advantages of less surgical trauma and shorter operation time. It can be an effective solution for the treatment of OVCF.

2332
A129: A prospective, observational, multicenter study assessing functional improvements after multi-level fusions for adult spinal deformity: 5 year follow-up results

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Introduction: The main indications for surgery in patients with adult spinal deformity are pain, disability and loss of function. Multiple patient reported Health Related Quality of Life (HRQOL) measures are utilized to assess functional status and disability before and after the surgery. Some components of these questionnaires may be more pertinent in the elderly population. Primary aim was to assess which key functional outcomes were most impacted by multilevel fusion surgery for ASD. Secondary aim was to assess if these functional improvements were maintained over the follow up period. **Material and Methods:** Patients ≥ 60 years of age from 12 international centres undergoing spinal fusion of at least 5 levels were included. Follow up visits were performed at 10 weeks, 12 months, 24 months and 60 months. Function was assessed using the Scoliosis Research Society 22r (SRS22r) function domain, and with the personal care, walking, sitting and standing sections from the Oswestry Disability Index (ODI) and EQ-5D-3L scores. Results were assessed based on the percentage of patients at each level of function, as well as assessing results based on pre-operative baseline function. **Results:** A total of 219 patients (80.4% females) were included with a mean age of 67.5 years. The mean SRS-22r function scores preoperative were 2.7 (0.7) which improved to 3.5 (0.8) by 2 years post-surgery and were sustained at 5 years (3.4). 44.9% patients were either bedbound or had primarily no activity before the surgery which reduced to 18.3 % at 2 years and 17.1% at 5 years follow up. Similarly, percentage of patients that could stand > 30 minutes improved from 24.4% to 68.6% at 2 years and 60% at 5 years. 26% of the patients could walk for a mile or more before surgery which improved to 63.1% at 2 years and sustained in 57.3% patients at 5 years. 42.6 % had unlimited sitting pre-operatively, that improved to 65.0% at 2 years and 64.2% at 5 years. Normal social life was seen in 18.8% of patients at baseline compared to 56.0% at 2 years and 50.4% at 5 years. Patients with the lowest pre-operative baseline showed the greatest improvement, however, had the lowest rate (38%) of reaching the highest level of function. Patients with the highest baseline function were able to maintain the highest level of function in 85% of cases. **Conclusion:** Patients undergoing multilevel spinal fusions for ASD experienced significant functional improvements in sitting, standing, walking and their social life. This improvement is sustained at 5 years postoperatively and can be utilized during patient counselling pre-operatively. Patients with the lowest pre-operative baseline showed the greatest improvement, however, had the lowest rate (38%) of reaching the highest level of function.

1205
A130: Immediate postoperative decrease in Hounsfield unit values at adjacent vertebral levels after long thoracolumbar fusion with pelvic fixation for lumbar degenerative disorder

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Introduction: PJK/F is a common complication in adult spinal deformity (ASD) surgery, and osteoporosis is considered as a risk factor for PJK/F. Hounsfield units (HU) are obtained using computed tomography (CT) scans, and it has been demonstrated that HU could be used as an alternative bone strength assessment method for dual-energy X-ray absorptiometry (DXA). Several studies have demonstrated that surgery itself could be a factor for bone loss after surgery. However, in those studies, the patient population was mostly patients undergoing decompression alone and/or short-segment fusion surgery. The effect of long-instrumented fusion on regional bone quantity in the adjacent vertebrae and the association between postoperative bone loss and the occurrence of PJK/F remains unclear. **Material and Methods:** The records of patients who had undergone long thoracolumbar fusion defined as fusion including pelvis to T10 or above, between 2016 and 2022 for ASD were retrospectively reviewed. Moreover, we retrospectively reviewed patients who underwent single-level posterior lumbar interbody fusion surgery between 2018 and 2022 as a control group. According to the institutional protocol, all patients underwent routine CT scans preoperatively and typically within 1-2 weeks postoperatively. Postoperative changes in HUs in the vertebrae at one or two levels above the upper instrumented vertebra (UIV+1, UIV+2) were measured. HU measurements were performed using an elliptical region of interest in the trabecular bone on the axial plane. Three axial slices were chosen per vertebra (upper 1/4, middle, lower 1/4), and the mean values of all three measurements were utilized. The pre- and postoperative HU values were compared. Furthermore, the presence of PJK/F within two years was investigated, and HU changes were compared between the PJK/F and control groups. For statistical analysis, the paired t-test was used to compare pre- and postoperative measurements. Fisher's exact test for categorical variables and Student's t-test or Mann-Whitney U test for continuous variables were used. Statistical significance was set at $p < 0.05$. **Results:** A total of 127 patients were included in the final analysis (45 long fusion; 73.9 ± 5.6 years, 82 PLIF; 72.5 ± 9.29 years). Postoperative CT scan was performed at a median of 3.0 [1-7] and 4.0 [1-7] days postoperatively. In both group, HU in UIV+2 demonstrated a significant decrease postoperatively. Regarding the comparison between long fusion and PLIF group, there is no significant background difference between two groups. UIV+1 and UIV+2 decreased to a larger extent in the long fusion group, although not significantly so. In the PJK/F group, HU values in UIV+1 and UIV+2 decreased significantly compared with those in the non-PJK/F group. There were no osteoporosis-related complications, including PJK/F, in the PLIF group. **Conclusion:** Lumbar spinal fixation negatively affected the regional HU values at adjacent levels immediately after surgery in long thoracolumbar fusion with pelvic and PLIF patients. Among the long fusion group patients, PJK/F patients showed greater bone loss at UIV+1 and UIV+2. Nevertheless, this phenomenon was not observed in the short-fusion patients. Further research is required to prevent postoperative bone loss and subsequent PJK/F.

1035

A131: Ideal length of accessory rod for the prevention of rod fracture after pedicle subtraction osteotomy in adult spinal deformity; short or long?

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Introduction: Pedicle subtraction osteotomy (PSO) is a potent surgical procedure in adult spinal deformity (ASD). Yet, the complexity of the procedure and its associated complications including rod fracture (RF) remain challenging issues. Among several RF reduction methods, accessory rod (AR) technique is an important surgical technique to reduce RF in ASD patients undergoing PSO. However, there is limited knowledge about the ideal length and rod-configuration of AR. **Material and Methods:** We retrospectively selected 57 consecutive (mean age 70.6 years) who underwent deformity correction including PSO and AR technique with a minimum 2-year follow up. Patients were classified into the non-RF group (n = 49) and the RF group (n = 8). Along with the two groups analysis of patient factors including age, bone mineral density, and body mass index, and radiologic factors including spinopelvic parameters, comparative studies were performed including rod-configuration of AR (D shape vs. linear shape) and the connection levels of AR (long AR, the lower end below S1-2 vs. short AR, above L5-S1). **Results:** The overall rate of RF incidence was 14% (8/57 cases) at an average of 42.5 months in our study (6 with bilateral RF and 2 with unilateral RF). RF occurred most commonly at L4-5, below the lower end of AR; 6 below the lower end of AR and 2 at the PSO site. There were no significant differences in patient and radiologic factors between groups. Comparisons between two groups confirmed that more RF occurred when the configuration of AR was the linear shape (p = 0.016) and the distal end of AR was above L5-S1 (p = 0.025). **Conclusion:** In this study, we found that the D shape configuration of AR and the lower end of AR below S1-2, long AR can be preventive methods for reducing RF after deformity correction using PSO and AR technique in ASD. Here, we provided the first comprehensive outline for AR technique, and these can be an effective guideline for spine surgeons.

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A132: Halo-pelvic traction combined with posterior correction improves pulmonary function and reconstructed 3D lung volume in severe rigid spinal scoliosis

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Introduction: Severe rigid spinal scoliosis (SRSS) leads to severe restrictive ventilation dysfunction. So far, the reports about the influence of preoperative halo-pelvic traction (HPT) combined with the following correction surgery on pulmonary function in SRSS patients were relatively few. This study is to investigate (1) the influence of preoperative HPT on lung volume and pulmonary function, (2) the further influence of the following correction surgery on lung volume and pulmonary function, (3) the relationship among deformity correction, pulmonary function test (PFT) outcomes and CT-based lung volume. **Material and Methods:** One hundred and thirty-five adult patients with SRSS who underwent preoperative HPT and correction surgery were reviewed. Spinal parameters including proximal thoracic curve (PTC), main thoracic curve (MTC), lumbar curve (LC), thoracic kyphosis (TK), lumbar lordosis (LL), coronal balance (CB), sagittal vertical axis (SVA). PFT outcomes (FVC, FVC%, FEV1, TLC) and CT-based 3D lung volume (Vin) were recorded and analyzed before HPT, after HPT, and at final follow-up respectively. The correlations among the deformity correction, PFT outcomes, and lung volume was evaluated. **Results:** The mean FVC, FVC%, FEV1, TLC increased from 1.67 L, 51.13%, 1.47 L and 2.37 L to 1.95 L, 64.35%, 1.75 L and 2.78 L, respectively after HPT and further improved to 2.22 L, 72.14%, 1.95 L and 3.15 L, respectively at final follow-up. The mean Vin increased from 1.98 L to 2.42 L after traction and further increased to 2.76 L at the final follow-up. The mean MTC and TK also decreased from 103.2°and 67.5°to 61.2°and 42.4°, respectively after HPT and maintained at 48.1°and 34.7°, respectively at final follow-up. The variation of MTC was correlated with the improvement of FVC (r = 0.429, p = .026), FVC% (r = 0.401, p = .038), FEV1 (r = 0.340, p = .043), and TLC (r = 0.421, p = .029) after surgery. The variation of MTC also was correlated with the variation of Vin (r = 0.425, p = .015) after surgery. **Conclusion:** Preoperative HPT can increase the preoperative lung volume and improve preoperative pulmonary function. There were significant correlations among the variations of main thoracic curve, pulmonary function indexes, and lung volume after surgery in SRSS patients. Preoperative HPT combined with posterior multi-level low-grade osteotomy is a safe and effective treatment strategy in not only correcting SRSS but also improving pulmonary function of SRSS patients.

1626

A133: Scoliosis Research Society-Schwab Grade 6 osteotomy for severe Pott's kyphoscoliosis: efficacy and complications

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Introduction: For patients with severe Pott's kyphosis (SPK), 1-level vertebral column resection is insufficient and the Scoliosis Research Society (SRS)-Schwab Grade 6 osteotomy is often recommended. However, a comprehensive investigation into the indications and clinical outcomes of SRS-Schwab Grade 6 osteotomy for SPK patients remains lacking. The aim of this research is to investigate the radiographic and clinical outcomes of SRS-Schwab Grade 6 osteotomy in SPK patients, and to evaluate the postoperative neurological complications associated with this demanding surgical technique in this cohort. **Material and Methods:** Patients with SPK undergoing SRS-Schwab Grade 6 osteotomy from 2006 to 2021 followed up at least 2 years were retrospectively reviewed. The segmental kyphosis (SK), sagittal vertical axis (SVA), thoracic kyphosis (TK), lumbar lordosis (LL), pelvic tilt (PT), pelvic incidence (PI) and sacral slope (SS) were measured at preoperation, postoperation, and final follow-up. The intraoperative and postoperative complications were recorded and the Scoliosis Research Society-22 (SRS-22) score were employed to evaluate patient's quality of life. The neurologic function was assessed based on American Spinal Injury Association (ASIA) grading at pre-operation and each follow-up. **Results:** This study included 23 SPK patients (14 males and 9 females) with an average follow-up duration of 31.5 ± 14.8 months. The average intraoperative blood loss was 3050.6 ± 1416.5 ml, and the mean duration of operation was 415.9 ± 62.7 minutes. The average number of osteotomy segments was 2.5 ± 0.7 with a mean 11.4 ± 1.6 fused segments. Compared to preoperative values, the postoperative measurements showed significant improvements in SK, SVA, LL, and TK (p < 0.05 for all). Specifically, the mean values of GK and SVA were 106.8° ± 8.6° and 23.1 ± 17.7 mm preoperatively. And the GK was significantly corrected to 39.3° ± 10.0° (t = 22.33, p < 0.001) at immediate post-operation, with a correction rate of 63.1% ± 9.7%. The mean SVA was 14.6 ± 8.4 mm at post-operation, also showing significant improvement (t = 2.32, p = 0.036). At the last follow-up, no significant loss of correction was observed. Scores of function domain (3.8 ± 0.3 vs. 3.6 ± 0.4, p = 0.019) and self-image domain (3.9 ± 0.3 vs. 2.9 ± 0.4, p < 0.001) at the last follow-up were significantly higher than that at preoperation. Intraoperative neurophysiological monitoring events were reported in 10 patients, with 6 patients suffered from new neurological deficit. Rod breakage occurred in 1 patient at the

48-month follow-up, and revision surgery was performed. Additionally, proximal junctional kyphosis developed in 5 patients during follow-up. At the last follow-up, firm bony fusion was observed in all patients. **Conclusion:** The SRS-Schwab Grade 6 osteotomy, which provides substantial correction, could represent an effective option for SPK patients. It is imperative to underscore the importance of heightened vigilance towards the associated risks and the implementation of preventive measures aimed at mitigating neurological complications.

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A134: Three-column osteotomy for the surgical treatment of dropped head syndrome due to the cervicothoracic-upper thoracic proximal junctional failures following adult spinal deformity surgery: radiologic and clinical outcomes

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Introduction: Severe proximal junctional failures (PJF) following adult spinal deformity surgery can result in Dropped head syndrome (DHS) is characterized by severe kyphotic deformity at the cervicothoracic-upper thoracic (CT-UT) spine. Severe kyphotic deformity causes significant sagittal imbalance, horizontal gaze difficulty and chin-on chest deformity. Surgical treatment of the severe kyphotic deformity requires three-column osteotomies (3CO) for correction. Aim of this study is to analyze the efficacy and safety of three-column osteotomies in the management of dropped head syndrome due to severe CT-UT PJFs. **Material and Methods:** 13 (6M, 7F) patients who had undergone revision surgery with 3CO for dropped head syndrome were included. These patients had undergone their primary adult spinal deformity surgeries at different centers and were admitted to our clinic for revisions. Pre-revision, post-revision, and f/up whole spine standing x-rays were evaluated for cervical and global sagittal alignment parameters. **Results:** The mean age was 42 (18-79) years and the mean f/up was 5 (2-15) years. 3COs were performed between T2-T4 levels. 3 patients had PSO, 2 patients had Bone-disc-bone resection and 8 patients had PVCR for deformity correction. Preop mean local kyphosis angle of 66° improved to 14° (79%). All global and cervical sagittal alignment parameters improved postoperatively. Gradual anterior column lengthening technique following PVCR provides proper sagittal alignment restoration both regionally and globally and also avoids iatrogenic neurologic deficit by

preventing dural bucking. 7 patients who had preop neurologic deficits had at least one-grade improvement at the final f/up. The most common complication was dural tears in 3 patients (23%) during PVCR. ODI decreased from 63 to 17. Solid fusion was achieved in all patients. **Conclusion:** Three-column osteotomy enabled significant correction of severe proximal junctional failures causing kyphotic and rigid deformity, improved neurological deficit and provided proper global and regional sagittal alignment. Anterior column lengthening at the level of osteotomy following PVCR procedure enables greater and safer deformity correction.

2519

A135: What are the risk factors for not reaching a patient-acceptable symptom state (PASS+) using the Oswestry Disability Index (ODI) after adult deformity surgery in patients above 60 years?

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Introduction: Assessment of patient-reported outcomes in patients with adult spinal deformity commonly involves condition-specific outcome measures such as the Scoliosis research score (SRS22) and back-specific questionnaire ODI. As some improvement after complex deformity surgery will most likely be present, the improvement level depends on multiple factors. Measurement of important improvement, using e.g., the Minimum Clinical Important Difference (MCID) or Substantial Clinical Benefit (SCB) was discussed controversially, as those depend on the starting point and don't indicate if improvement was sufficient. We, therefore, used the method of PASS as introduced by A. Mannion, to assess the level of symptoms patients are ready to accept after complex ASD surgery in an elderly age group, and present risk factors for not reaching PASS. **Methods:** We performed a prospective, multicenter, multi-continental, observational longitudinal cohort study including patients $\geq$ 60 years, undergoing ADS with a minimum of 5 levels involved. 219 Patients were enrolled. As recently published[1], we used the PASS+ Score cutoff for ODI of 29 at the two-year follow-up of our cohort. Multivariate logistic regressions were performed to identify factors associated with being ODI PASS+ at 2 years and stepwise selection and Bonferroni correction were

implemented to identify the most influential variables. **Results:** 168 patients fulfilled inclusion criteria with a follow-up time of 2 years. The median number of spinal levels fused was 9 [Q1 = 5.0, Q3 = 12.0]. Two-year mean (95% CI) ODI improvement was 19.3% (16.7%; 21.9%; p < .001) for all age groups. The descriptive mean ODI score at 24 months was 26.4% ± 17.3%, 106/168 (63.1%) patients reached MCID ≥ 11. In the PASS+ (ODI ≤ 29) group, 89 of 168 ASD patients reached PASS+, including 80.9% who reached MCID ≥ 11, whereas in the PASS- (ODI ≤ 29) group 49.3% reached MCID ≥ 11. Patients with higher back pain at baseline (OR = 0.71; p-value < 0.001), lower Coronal Balance (OR = 1.01*; p-value = 0.016), higher ASA grade (III-IV) (OR = 0.50; p-value = 0.042), Older age (OR = 0.93; p-value = 0.041) and with lower EQ-5D VAS at baseline (OR = 1.02; p-value = 0.012) were less likely to be in ODI PASS+ at 2 years. **Discussion:** Even though a total of 62.7% of patients reached MCID ≥ 11 of ODI, it does not automatically show how satisfied patients are with the result of their ASD surgery. 19% in the PASS+ group and about 50% in the PASS- group didn't reach MCID. Reaching a clinically important difference doesn't mean the patient will be happy with the result. Especially in the elderly, general risk factors such as age and overall health, as well as preoperative back pain seem to be relevant factors influencing patient-related outcomes. Coronal imbalance is an important factor that the elderly might not be able to compensate well, leading to higher rates of dissatisfaction.**References**1. Mannion et al. What level of symptoms are patients with adult spinal deformity prepared to live with? A cross-sectional analysis of the 12-month follow-up data from 1043 patients. European Spine Journal. https://doi.org/10.1007/s00586-020-06365-z

OP16: Current Concepts in Spine Surgery

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A136: Lumbar epidural hypertension as a determining factor in the disability of patients with lumbar spinal stenosis: 1-year follow-up period

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Introduction: Lumbar Spinal Stenosis (LSS) is a major medical concern due to its high prevalence among elderly and its impact on patient's quality of life. Multiple studies (Mariconda; Boden; Schonstrom; Matsumoto; Herno; Webber.) have not found a relationship between the widening of the spinal canal and improvement of symptoms. Neurogenic compression and vascular hypoxia of rootlets tried to explain LSS pathophysiology. We propose to include Epidural Hypertension (EH)as a new theory that explains dynamic stress of neural structures in this disease and its intimate relationship with the genesis of the patient's symptoms. **Material and Methods:** Two Groups. A: LSS diagnosed by MRI (n = 6). B: Patients undergoing spinal surgery for other diagnosis (WLSS) (i.e:spinal cord stimulation) (n = 5). LSS patients underwent laminectomy as standard of treatment. Previously, careful dissection of flavum fibers was performed and pressure microsensor inserted into epidural space in stenotic segment. Pressure was measured in 0° and then 50° surgical-table-extension in order to extrapolate EPV to standing position.-SCCSA and DSCSA were measured in pre-operative MRI. 1-year follow-up period including VAS, ODI and JOA scales was performed. **Results:** We found statistically significant differences between EPV in LSS and WLSS in both 0° (p = 0.005) and 50° (p = 0.006). 1-year VAS, ODI, JOA evidenced significant and sustained improvement (p = 0.042; 0.045; 0.045) with a JOA mean recovery rate of 49%. In our cohort we did not find relationship between symptoms and SCCSA and DSCSA, however we found a strong correlation between EPV and SCCSA (0° Rho: -.809) (50°: -.833) and DSCSA (0° Rho: -.775) (50°: -.850). We found a tendency to correlation between pre-operative ODI and 0°EPV (Rho: .698). **Conclusion:** EH may play a fundamental role in dynamic stress of neural structures in LSS contributing to mechanical compression and vascular hypoxia. EH could be a determining factor for disability and could be considered a special treatment target in patients with LSS.

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A137: Safety evaluation and functional testing of antimicrobial-coated spinal stabilization devices

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Introduction: In spinal fusion surgery, bacterial contamination of spinal instruments presents a significant challenge. As antimicrobial surfaces become more prevalent, it's crucial to ensure these additions don't inadvertently impair the primary function of spinal instrumentation. This research focused to

confirm that adding antimicrobial surfaces did not diminish the device's essential role in stabilizing the spine, and to ensuring this antimicrobial addition did not bring new safety risks. This study aimed to assess the performance and safety of an innovative antimicrobial pedicle screw system against a conventional one, utilizing a two-level posterior lumbar fusion (PLF) in sheep. The underlying hypothesis was that the antimicrobial feature would not negatively impact the device's primary stabilizing function. **Material and Methods:** Twelve sheep underwent PLF procedures at the L2-L3 and L4-L5 segments, covering two separate functional spinal unit (FSU) fusions. The Colorado State University Animal Care and Use Committee provided approval for the use of the animals. Control group utilized the conventional pedicle screw system, whereas Treatment group was fitted with the antimicrobial pedicle screw variant. A total of 24 fusion segments from both groups were scrutinized. Radiographic evaluation was conducted post-operation and subsequently at 4, 12, and 26-week intervals. Furthermore, CT examinations were performed at specified interval. At 26-week, animals were humanely euthanized. Then, ex vivo tests incorporated manual palpation evaluations by three separate reviewers. Additionally, biomechanical pedicle screw pull-out testing, MicroCT analysis, and histological evaluation were performed. **Results:** A PLF procedure was uniformly executed across all animals, with no difference in the surgical placement between Control and Treatment systems. The Antimicrobial Pedicle Screw System showed no adverse events. Lumbar CT scans demonstrated a 100% fusion rate in the Control group at 26 weeks post-operation, while the Treatment group registered a 92% fusion rate. Fusion rates were similar between groups (p = 0.3185). No surgical site complications were observed. Both groups had similar manual palpation scores: 3.9 ± 0.4 for Treatment and 4.0 ± 0.0 for Control. Biomechanical measurements showed no significant differences. MicroCT assessment revealed that fusion occurred on the dorsal side of the vertebral bodies in the spinous process region of all FSUs. Semi-quantitative microCT PLF scoring revealed similar fusion outcomes between groups. No statistically significant differences were measured in microCT bone volume or bone mineral density between groups. Histopathological analysis displayed a minimal host tissue response surrounding the pedicle screws in all samples. Both groups exhibited minimal inflammation, no moderate or heavy fibrosis, and no significant presence of giant cells. The fusion masses in the intertransverse spaces showed no significant disparities between control and treatment animals. Histomorphometry analyses of the pedicle screw and intertransverse regions of interest did not show significant differences in bone area, fibrous tissue area, and void space area. **Conclusion:** This study offers comprehensive insights into the performance and safety profile of antimicrobial pedicle screw systems in comparison to standard systems. Additionally, this antimicrobial surface technology could promote safer surgical practices and potentially reduce hospital stay durations and associated costs.

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A138: Role of percutaneous vertebroplasty or kyphoplasty for the treatment of symptomatic Schmorl's nodes - A systematic review and meta-analysis

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Introduction: Schmorl's nodes represent herniation of intervertebral disc material through the endplates into the vertebral body. Patients may present with pain like an acute vertebral compression fracture. Majority of the patients improve symptomatically with conservative management. However, patients with refractory back pain who do not respond to conservative measures may need intervention in the form of vertebroplasty. The literature available on the use of percutaneous vertebroplasty or kyphoplasty for the treatment of symptomatic schmorl's nodes is quite sparse. Hence, we performed a systematic review on the efficacy of vetebroplasty/kyphoplasty for this condition. **Materials and Methods:** The systematic review was conducted as per PRISMA guidelines using the search phrase "Schmorl's nodes AND (Vertebroplasty OR Kyphoplasty)". Isolated case reports, case series with patients less than 10 and non-English language papers were excluded. Analysis was done using descriptive statistics. **Results:** 5 articles that met the inclusion criteria were analysed. 4 articles were retrospective case series (class IV) while 1 article was a prospective cohort study (class III) according to Oxford Centre for Evidence-Based Medicine (OCEBM) levels of evidence. 189 patients (90 males and 99 females) with a mean age of 68.4 years were included. Mean follow up was 44.2 months. Symptomatic schmorl's nodes were most frequently seen at the thoracolumbar vertebrae (T10-L2) - 62%. 32 patients underwent kyphoplasty while the remaining 157 patients underwent vertebroplasty. All patients underwent MRI scans which demonstrated (T2 and STIR) hyperintense and T1 hypointense signals surrounding the schmorl's node which was suggestive of bone marrow oedema. All patients underwent a trial of conservative management of minimum of 6 weeks before embarking on the vertebroplasty procedure. The average duration of the procedure and average cement volume injected was 24.2 minutes and 3.9 mls respectively. The average preoperative VAS score was 8. Post operatively, the VAS scores improved to 2.17, 2.05 and 2.07 at 4 hours postoperative, 1 month and 6 months respectively. The average ODI scores improved from 69.9 (preoperatively) to 24.4 (postoperatively). The complications included cement leak to the adjacent disc in 4.2% patients and adjacent level fractures in 2.1% patients. **Conclusions:** Percutaneous vertebroplasty or kyphoplasty is a safe and effective treatment option in the management of symptomatic schmorl's nodes refractory to conservative treatment.

1255

A139: Efficacy of allograft cage versus bioactive glass-ceramic cage in anterior cervical discectomy and fusion: a randomized controlled study

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Introduction: Anterior cervical discectomy and fusion (ACDF) is a well-established surgical technique for treating cervical spine disorders, including cervical myelopathy and radiculopathy. The procedure's efficacy hinges on successful vertebral fusion, which is influenced by the choice of graft material. While autogenous bone grafts have historically been the gold standard due to their osteoinductive and osteoconductive properties, they pose issues like donor site pain and potential for infection. Allografts provide an alternative but introduce their own limitations, such as graft rejection and disease transmission. In this context, our study introduces bioactive glass-ceramic (BGs) cages as a promising innovation. These materials not only offer mechanical robustness but also have the unique ability to chemically bond with bone, facilitating osteointegration. Through a randomized controlled trial (RCT), we aim to rigorously compare the clinical and radiological outcomes of using BGs cages against traditional allografts in ACDF surgeries. **Material and Methods:** We designed a prospective, single-center RCT to assess BGs cages and allografts in ACDF for cervical degenerative disc disease. Ethical approval was obtained, and participants gave written consent. Inclusion criteria encompassed adults aged 18-75 showing clinical symptoms and radiological evidence of cervical degenerative disc disease, with failed non-surgical treatment for 3-6 months. Exclusion criteria included prior surgeries, severe osteoporosis, and certain medical conditions like infection or malignancy. Blinding was partial due to the nature of the intervention. Randomization employed a computer-generated sequence, and both assessors and data analysts were blinded. Surgery was performed under a single experienced neurosurgeon using standardized protocols. Follow-up visits were scheduled at 1-, 3-, 6-, and 12-months post-surgery for outcome measures. Primary outcomes included postoperative pain levels and Neck Disability Index. Secondary outcomes focused on return to daily life and surgical details like operation duration and blood loss. Radiological assessments included metrics like cervical lordosis and fusion status, assessed via Bridwell interbody fusion grading system. Statistical analyses used multilevel mixed-effects linear regression and Generalized Estimating Equations for intergroup differences and longitudinal changes, respectively. The study adhered to the Declaration of Helsinki and Good Clinical Practice guidelines. **Results:** Of the 45 assessed, 40 participants were included, with 18 in the allograft cage group and 22 in the BGs cage group. By the 12-month follow-up, both groups exhibited significant improvements in pain levels and disability scores, with no notable inter-group differences. Radiological assessments revealed stability in cervical spine post-intervention for both cage types. Subsidence increased in both groups at the 12-month follow-up, with 25% of allograft cages and 32.14% of BGs cages experiencing over 3 mm of subsidence. Fusion rates remained consistent across both cage types. No significant differences were observed between two groups in terms of complications. **Conclusion:** Both the allograft and BGs cages are effective in ACDF surgeries for cervical degenerative disc disease, with both showing substantial post-operative improvements. The cage showed marginally better disc height maintenance at 6 months, and overall results were consistent between the groups. Future research with a larger cohort and longer follow-up is required to confirm these preliminary findings.

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A140: Deep learning model for detection and classification of central canal and neural foraminal stenosis combined with vertebral segmentation on cervical spine MRI

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Introduction: Assessment of degenerative cervical spondylosis on MRI is repetitive and time-consuming. Deep learning (DL) could improve the productivity and consistency of reporting. In this study, we developed a DL model to automate key aspects of cervical spine MRI reporting. This included automated detection and classification of central canal and neural foraminal stenosis to detect sites of spinal cord and nerve root compression, and vertebral body segmentation to facilitate further analysis of intervertebral discs, fractures and spondylolisthesis. **Material and Methods:** In this retrospective study, cervical spine MRIs performed from January 2015 to July 2021 were included. Studies

with instrumentation, suboptimal image quality, and scoliosis were excluded. Axial T2-weighted gradient echo and sagittal T2-weighted spin echo images were utilized. The internal training/test set split was 90/10%, respectively. Training data were labelled by a subspeciality musculoskeletal radiologist (12-years-experience) using pre-defined gradings. For stenosis gradings, a convolutional neural network-based backbone (ResNet50) was adopted for feature extraction, and a transformer encoder-decoder architecture was employed to detect the objects of interest via a fixed small set of learned object queries. Vertebral segmentation was performed with the Segment Anything Model (SAM), by incorporating prompts derived from the detected bounding boxes. The internal test set was labelled by the subspeciality musculoskeletal radiologist and served as the reference standard. Detection recall (%), accuracy and sensitivity/specificity were calculated for stenosis gradings. Dice coefficient and Intersection over Union (IoU) were calculated for vertebral body segmentation. **Results:** Overall, 504 cervical spine MRIs were analyzed (504 patients, mean age = 58 ± 13.7(SD), 202 women) with 454 (90%) for training and 50 (10%) for internal testing, respectively. The DL model achieved 95.7% recall for axial central canal and neural foramina, and 85.7% for sagittal central canal. Dichotomous classification (normal/mild vs moderate/severe) showed high accuracy for axial central canal (96.1%,95%CI = 95.1-97.0%), axial neural foramina (93.8%,95%CI = 91.5-95.7%) and sagittal central canal (93.2%,95%CI = 91.5-94.6%). High specificity was achieved at all regions (range: 95.7-98.3%) with slightly lower sensitivity (range: 78.9-83.7%). For segmentation, the DL model achieved a Dice coefficient of 0.92 and high IoU score of 0.86. **Conclusion:** A deep learning model showed high accuracy for detection and classification of central canal stenosis and neural foraminal stenosis on cervical spine MRI, and robust vertebral body segmentation with high DICE and IoU scores. The deep learning pipeline has potential to improve the productivity and consistency of reporting.

1787

A141: Behaviour of main thoracic curve following Non Fusion Anterior Scoliosis Correction (NFASC) of lumbar curve in Lenke type 6 adolescent idiopathic scoliosis (AIS) patients- a single center comparative study

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Introduction: NFASC is a growth modulating and fusionless treatment option that is considered as a new promising method

for the management of AIS. In double curves, correcting the major lumbar curve results in spontaneous correction of compensatory thoracic curve. Unlike studies on selective thoracic fusion, there is a visible dearth in clinical data regarding the this thoracic curve correction, with no conclusive guidelines regarding case indications, proper technique and possible complications. The purpose of this study is to analyse the response of main thoracic curve following NFASC of Thoraco Lumbar/ Lumbar (TL/L) curve in selected cases of idiopathic scoliosis patients. **Material and Methods:** A total of 30 patients of Lenke type 6 who underwent NFASC of TL/L curve with a mean follow up of 26 ±12.2 months (12 -60 months) were included in the study. Pertinent clinical and radiological data collected regarding skeletal maturity, curve type, cobb angle, surgery details and SRS-22r questionnaire. Magnitudes of both the thoracic and lumbar curves were recorded pre operatively, immediate post op, 3 months, 1year and at 2 years post op. Lumbar curves were graded as per their lumbar modifier (A, B or C). A Post hoc analysis following repeated measures ANOVA test was used to examine statistically significant trends. **Results:** 30 patients (27 Female, 3 Male) enrolled, with a mean age of 14.96 + 2.69 years. The mean Risser and Sanders's score was 4.22 ± 0.7 and 7.15 ± 0.74 respectively. The mean TL/L cobb angle significantly improved from preoperative (51.45 ± 11.26) to the first follow-up (13.48 ± 5.11) and last follow-up (14.24 ± 4.85) (p < 0.05). Thoracic curve spontaneously corrected (Figure 1) from 35.90° + 9.34° pre operatively to 13.2° + 4.32° following Lumbar surgical correction (58% correction) in 26 patients. 2 patients had persistent residual thoracic curves post operatively but none had any further progression of the curve. None of them required revision surgical correction of the thoracic curve. **Conclusion:** Majority of the patients in our cohort were skeletally mature patients, showing spontaneous correction of thoracic curve by 56.2% in 76% of the cases. As the indications of NFASC are being redefined, with better surgical technique and experience, this data provides new insight on response of thoracic curves following Lumbar curve NFASC.

1042

A142: The correlation of iliac crest morphology and safe working zone for lateral lumbar interbody fusion: Radiographic and MRI study

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Introduction: Lateral lumbar interbody fusion (LLIF) is a minimal invasive surgery which has been increasingly used in degenerative spine problems. Iliac crest morphology in the aspect of height and slope on lateral plain radiograph could have a correlation with safe working zone (SWZ) on MRI. This could be essential when the procedure is performed especially at L4-5 level. Our objective is to study the correlation of iliac crest morphology in the aspect of iliac height and slope on standing plain radiograph and safe working zone on axial MRI at L4-5 intervertebral disc level. **Material and Methods:** The consecutive adult patients who presented with low back pain to the orthopedic out-patient department at Ramathibodi Hospital between January 2021 – March 2022 were reviewed. The standing lateral radiograph and MRI of these patient were analyzed. All patients were reviewed for demographic data (age, gender and BMI). According to the lateral radiograph, Iliac crest height was classified into 4 types (1 to 4 from low to high) and Iliac crest slope also was classified into 2 types (A; high slope and B; low slope) with cut-point at 20 degrees. MRI was reviewed and data of SWZ, lumbar plexus position and oblique corridor was collected. **Results:** Ninety-eight patients were included. Iliac height was classified that 24 patients (24.5%) was type 1, 30 patients (32.7%) was type 2, 35 patients (35.7%) was type 3 and 9 (9.2%) was type 4. For iliac slope, patients were classified in iliac slope type A in 72 patients (73.5%) and type B in 26 patients (26.5%). Iliac height type 1 and 2 had statistically significant wider SWZ on the left side compared with type 3 and 4 (p = 0.007). Moreover, left lumbar plexus position was statistically significant anterior in the group of iliac height type 3 and 4 compared with type 1 and 2 (p = 0.007). The iliac slope showed similar result, there were statistically significant wider SWZ (p = 0.003) and less anterior left sided lumbar plexus position in iliac slope type A (p = 0.002). **Conclusion:** The low iliac crest height (type 1 and 2) and high iliac slope type A had a correlation with more widening SWZ and more posterior lumbar plexus position on axial MRI, but not L4-5 oblique corridor. This classification should be taken in consideration and applied for preoperative evaluation when trans-psoas or pre-psoas lateral lumbar interbody fusion is performed.

1066

A143: Prediction of proximal junctional kyphosis after corrective surgery for adult spine deformity: an MRI-based model combining bone and paraspinal muscle quality metrics

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Background: The traditional prediction tools, based on postoperative sagittal plane parameters for predicting mechanical complications of adult spinal deformity (ASD) surgery, have limitations due to variations in spine and pelvis morphology between races. Preoperative risk assessment models that can provide surgeons with early warning in predicting proximal junctional kyphosis (PJK) in ASD patients still need to be developed. **Objective:** To investigate the utility of the combined prediction model to evaluate the risk of PJK after corrective surgery for ASD using MRI-based preoperative bone and paraspinal muscle quality assessment. **Methods:** We performed a retrospective review of patients who underwent ≥ 5-segment fusion for adult spinal deformity with a follow-up of ≥ 2 years. Each patient's VBQ score and U-VBQ score were calculated using preoperative T1-weighted MRI and the fat infiltration rate (FI%) of paraspinal muscle (PSM) was calculated using preoperative T2-weighted MRI. Basic data were input to logistic regression to verify the important risk factors. The receiver operating characteristic curve (ROC) was plotted to explore the prediction value of U-VBQ, FI of PSM, and their combined prediction. **Results:** A total of 148 patients were included in this study. The mean age was 68.3 ± years, and 121 were female (81.7%). Among them, 28 patients (29.3%) developed PJK. Mean U-VBQ scores were 3.23 ± 0.76 for patients with PJK and 2.46 ± 0.69 for patients without (p < 0.001). Mean FI of PSM at L3/L4 disc level was 34.13 ± 7.46 for patients with PJK and 23.46 ± 8.49 for patients without (p < .001). On multivariate analysis, U-VBQ score and FI of PSM$_{(L3/L4)}$ were significant independent predictors of PJK after corrective surgery for ASD, with predictive accuracy of 70.2% and 75.6%. The predictive accuracy of the novel preoperative combined prediction model is 81.2%. **Conclusion:** In patients undergoing corrective surgery for ASD, higher U-VBQ score and FI of PSM$_{(L3/L4)}$ were independent risk factors for PJK. The utilization of preoperative U-VBQ score combined with FI of PSM$_{(L3/L4)}$ as a predictive tool for PJK in ASD patients is a preliminary and viable approach.

Keywords: adult spinal deformity; proximal junctional kyphosis; vertebral bone quality score; paravertebral muscle

642

A144: Comparison of therapeutic effects between 3D microscope and 2D optical microscope in anterior cervical surgery

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Introduction: The use of 3D microscopy is increasingly common in cervical spine surgery. 3D microscope can achieve better stereoscopic visualization. While reports on its application are becoming more frequent, it is still in its early stages. This study aims to compare and analyze the advantages and

disadvantages of 3D microscopy and 2D optical microscopy in anterior cervical spine surgery and highlight subtle differences related to the learning curve. **Material and Methods:** A retrospective study was conducted on patients undergoing anterior cervical spine surgery. Data was collected from the same group of surgeons performing microscope-assisted anterior cervical spine surgery between January 2018 and December 2022. The cases were categorized into the 2D group (n = 98) and the 3D group (n = 178) based on the type of microscope used. Comparison was made regarding intraoperative blood loss, visualization quality, operation time, microscope time as a percentage of total operation time, and surgical outcomes. **Results:** The postoperative ODI score and VAS score in both groups were better than those before surgery (p < 0.05). There were no significant differences in operation time, intraoperative blood loss, and postoperative hospital stay between the two groups (p > 0.05). No surgery-related complications occurred. The subjective quality of visualization of key anatomical structures during surgery was comparable between the two groups. However, the time of 3D microscopy accounted for 42.9% of the total operation time, compared to 27.1% for the optical microscope (p < 0.05). 3D microscopy provided higher magnification potential, but at higher magnification levels, visual quality deteriorated and depth perception was distorted. The 2D optical microscope demonstrated better results. **Conclusion:** 3D microscopy is an effective visualization tool for anterior cervical spine surgery, comparable to 2D optical microscopy. However, 3D microscopy offers higher-resolution 3D visualization, more flexible lens movement, and greater operational space. It has a shorter learning curve and significant ergonomic advantages.

OP17: Optimizing Management of Infections

1559
A145: The use of endoscopic aspiration in the identification of bacterial pathogens causing discitis

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Background: Vertebral osteo-discitis in adults is often the result of hematogenous seeding. Due to its limited vasculature and additional unique characteristics, the intradiscal space may be susceptible to infections, more often of an indolent nature. It has been suggested as a cause of low back pain. Diagnosis is difficult to establish, and even more so is achieving microbiologic identification. Identification of the etiologic organism is essential in directing antibiotic therapy, and biopsy with demonstration of the infectious organism is the gold standard for diagnosis. In many cases cultures may be negative despite the presence of infection. **Objectives:** The aim of this study was to evaluate the positive culture rate in biopsies obtained by minimally invasive disk endoscopies, in cases of suspected discitis, and to identify infecting organisms. In addition, we assessed patient outcomes according to microbiologic data and baseline characteristics. **Methods:** All patients with suspected discitis between November 2021 and September 2023 in a referral center were collected. Disc aspirations and lavage with 200 CCs of normal saline using endoscopy was performed in as a minimally invasive procedure, guided by fluoroscopy. Patients were awake and mildly sedated for the procedures. Patient data were collected retrospectively and categorized into three groups based on the clinical suspicion level of vertebral osteo-discitis (VO): high, intermediate, and low. To characterize the intradiscal environment accurately, we employed both bacterial cultures and molecular techniques. **Results and conclusion:** 57 endoscopies were performed for patients with a suspected discitis. 46 patients who were considered highly suspicious as vertebral osteo-discitis were identified. In 33/46 (71%) a causing pathogen was identified, by either culture or molecular methods. In 11 of the remaining 13 cases, cultures were taken under or soon after antibiotic treatment. In 11 cases of intermediate suspicion, culture results determined need for further treatment. There was one case of Mycobacterium tuberculosis and one case of Bartonella. Only two of the patients in the cohort needed additional surgical intervention, for healing of the VO. There were no procedure related complications. **Discussion:** Endoscopic aspiration and lavage is an efficient procedure for VO. It results in a higher rate of positive cultures than reported in current literature. The ability to wash out the disc space with high precision allows a better way to reach source control in these infections, thus obviating the need for further surgery. Avoiding general anesthesia, has the advantage of performing the procedure even on highly morbid patients.

1581
A146: Delphi-based survey for surgical indications in biopsy proven active adult spinal tuberculosis

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Introduction: The existing lack of consensus and individual preferences lead to the requirement for the development of guidelines for surgical indications for adult patients with TB spine. Such a consensus can be obtained through a Delphi-based approach involving experts with substantial experience in treating such patients and with significant contributions to the existing literature on this issue. Our survey aimed to develop a national consensus through a Delphi survey on the indications of surgery in biopsy-proven active adult tuberculosis of the spine. **Study Design:** Delphi survey. **Objectives:** To obtain an expert consensus on various dilemmas in the surgical treatment of adult spinal tuberculosis (TB) patients. **Methods:** Stage I included a literature review, stage II the identification of 40 Key Opinion leaders (KOLs) and a set of 46 questions, stage III included analysis of three rounds of the Delphi survey, and stage IV had final analysis and recommendations. For each question, the level of agreement needed to reach a consensus was set at greater than or equal to 70.0%. **Results:** The first and second Delphi survey rounds received 62 and 58 responses, respectively, with 16 questions having more than 70% and two questions having 100% agreement in the first stage. The second stage saw a 70% agreement on six questions. Thus, a consensus was obtained on 22 questions. The recommendations that emerged were as follows: neurodeficit with corresponding radiology and neurological deficit appearing/deteriorating while on anti-tubercular chemotherapy(ATT) are absolute indications for surgery, duration of ATT before neurological deterioration need not be considered, epidural abscess does not need decompression unless concordant clinical neurological findings are present, pain not responding to medical management is not a surgical indication, active pulmonary TB, drug-resistant TB, and tubercular sacroiliitis are not considered as surgical indications, and hemoglobin and other health markers have little contribution to surgical indications. **Conclusion:** In order to resolve several conundrums in the surgical treatment of adult spinal TB, this Delphi survey is the first to achieve a national consensus from spine experts. The final recommendations cover the serological, radiographic, and clinical aspects of spinal TB. **Keywords:** spinal tuberculosis; Delphi method; surgical indications; consensus

1830

A147: Comparison of mini open vs traditional anterior spinal debridement and reconstruction in the management of infective spondylodiscitis- a single center cohort study

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Introduction: Traditional anterior approaches to the thoracic or lumbar spine are reported with a significant morbidity from a large wound field; therefore, minimally invasive thoracoscopic and VATS anterior procedures have been recently introduced. However, these techniques require a long and steep learning curve, require expensive disposable endoscopy material, and may be little suited for management of any untoward complications. Alternatively, mini-open anterior approach has advantage of familiar approach, less blood loss and earlier post operative recovery. **Material and Methods:** 60 patients of infective spondylodiscitis tubercular/ pyogenic/ fungal/ non specific) who underwent debridement, anterior reconstruction were included in the study. Group A- 30 of the case details were retrospectively gathered from the Medical Records section who were operated through traditional anterior surgery (2000 to 2014). Group B- 30 patients who underwent the procedure through mini open anterior exposure were compared with the traditional group (2014 to 2020). A transthoracic (n =18), transthoracic transdiaphragmatic (n = 11), or retroperitoneal (n = 31) approach was conducted. **Results:** The overall mean age of the enrolled cases was 50.8 + 15.9 years, comparable between the study groups (p > 0.05). The mean surgical duration was 140 minutes, and the average blood loss was 86mL in the group B compared to 178min duration and 240ml blood loss in the group A. The mean length of incision in group B was 5.8 + 1.2 cms compared to group A of 14.7 + 3.6 cms (p value 0.0001). The most common organism isolated from the operative specimen was Mycobacterium tuberculae in 40% of the group B cases, 27% in group A. Among the pyogenic variety, which constituted 11 cases group B and 8 of the group A cases, it was Staphylococcus aureus (64%), Streptococci & Enterococci (20% of the cases). Organism couldn't be isolated in nearly 25-27% of the cases in either of the groups. Lumbar region was most common site - 47% in group B, 57% in group A, followed by Thoracic (30%) and then Thoraco-lumbar region (18%). There was no neurological worsening. On a VAS from 0 to 10, the mean local pain from the traditional anterior approach was 3.9 at 3 months postoperatively, 2.8 at 12 months, and 2.3 at 24 months, whereas it was 2.7 3months post op, 2.4 1yr post op and 1.7 at 2yr post op in the mini open anterior group. Fusion was found in all patients at 9 months after surgery. Six transient complications occurred in the group B, in contrast to the significant complications requiring revision surgeries encountered in the traditional approach. **Conclusion:** The anterior approach for selected patients of Infective spondylodiscitis can provide significant improvement in neurological improvement, better VAS & ODI scores at a minimum 2 year follow up, with the newer Mini Open anterior technique showing significantly lesser blood loss, operative time, earlier recovery and similar kyphosis correction compared to the earlier traditional anterior technique.

945
A148: The impact of illicit drug use on native spine infection outcomes

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Introduction: Primary pyogenic spinal infections represent a heterogeneous group of infections ranging from discitis to more significant epidural abscesses. Spinal infections can be devastating with reported mortality rates as high as 20% in developing countries. A majority of the treatment for spinal infections centers on a cooperative patient willing to participate in the close monitoring and subsequent follow up necessary to eradicate these sometimes fatal infections. However, social factors may be a limiting factor in appropriate treatment for certain populations such as intravenous drug users (IVDU). The purpose of the current study was to compare social and clinical outcomes in patients with primary spinal infections with and without IVDU. **Material and Methods:** A retrospective review was performed from 2016-2022 to identify patients with primary spinal infections at our urban, academic tertiary care center. Patients were at least 18 years old with primary pyogenic spinal infection not previously treated surgically. Two cohorts were constructed based on the presence of IVDU. All patients were retrospectively reviewed for demographic information (age, sex, race, BMI) and comorbidities (Charlson Comorbidity Index, smoking status, diabetes, AIDS/HIV). Diagnostic information gathered from EMR review included maximum temperature on presentation, WBC count, ESR, CRP, and microbial culture data. Information regarding treatment and outcomes were tabulated, including duration and mode of antibiotic administration. Operative treatments were assessed for surgical approach (anterior, posterior, or combined), number of levels fused, and number of surgical interventions. Outcome measures included LOS, leaving the hospital AMA, 90-day readmission rates, mortality, and need for revision surgery. **Results:** A total of 76 patients who developed primary spinal infections were identified; 51 had a history of IVDU while 25 did not. There were no significant differences in temperature (p = 0.644), WBC count (p = 0.943), ESR (p = 0.667), and CRP (p = 0.405) on admission between the two groups. The IVDU cohort was more likely to have an infection with MRSA (44.1% vs 11.8%, p = 0.028), but less likely to have an infection with E. coli (2.9% vs 23.5%, p = 0.037) or Candida spp. (17.6% vs 0%, p = 0.033). There were no significant differences in MSSA (p = 0.532), Strep spp. (p = 1.000), Enterobacteriaceae

(p = 0.653), Pseudomonas spp. (p = 0.547), and polymicrobial (p = 0.387) infections between groups. The IVDU cohort was more likely to leave AMA (37.3% vs 0%, p = 0.001), require readmission within 90 days (60.8% vs 32.0%, p = 0.034), and seek care at multiple hospital systems (45.1% vs 16.0%, p = 0.013). There was no significant difference in length of stay (p = 0.699), complication rate (p = 0.522), mortality (p = 0.087), or revision surgery (p = 1.000) between both groups. **Conclusion:** Our study highlights the impact of IVDU on social and clinical outcomes in patients with spine infections. Patients with IVDU tend to be younger, current smokers, complicated by bacterial resistance, increased rates of leaving AMA and have worse rates of follow-up as compared to those without IV drug use. These findings emphasize the need for a comprehensive and multidisciplinary management strategies for patients with spine infections and history of IVDU.

1273
A149: Surgical management of pediatrics spinal tuberculosis: a 7- years' experience

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Background: Due to the growth modulation and progressive deformity of spine following spinal tuberculosis in growing children, the threshold for surgical intervention is very less. However, outcomes following surgical intervention of paediatrics' spinal tuberculosis are not clearly evaluated. This study aims to evaluate the outcomes of surgical management of paediatrics' spinal tuberculosis. **Methodology:** A retrospective study was conducted between January 1, 2015, and December 31, 2022. Medical data records of paediatric patients who had undergone surgical intervention for spinal tuberculosis during that period were explored. Patients with follow-up duration of at least 1-year were included in the study. Demographics and radiological data were collected from medical records and Picture Archiving and Communication System (PACS). Outcome measures were sagittal parameters, clinical and neurological improvements. **Results:** A total of 31 paediatric patients underwent surgical intervention for spinal tuberculosis. Out of 31, 26 (83.87%) underwent outcome evaluation. Of 26, 14 (53.86%) were females, and the average age at surgical intervention was 10.3 ± 5.2 years. The mean follows up duration was 5.3 ± 1.3 years. Mean sagittal parameter was improved from 69.7 ± 5.7 degree preoperative to 18.3 ± 5.6 degree at final follow up.75% had at least 2 radiological spines at risk sign at presentation, however there was no progression of deformity following surgical intervention. Most common neurological involvement at presentation was ASIA C (46%) followed by ASIA D (23%) however all of them recovered to ASIA E. Along with

moderate to severe back pain, 96 % patients had deformity of back and 86 % had weakness and difficulty in walking at presentation, however only 15% had mild residual back pain. One (3.8%) patient had proximal junctional kyphosis requiring proximal extension and 2 (7.7%) patients had implant breakage. **Conclusion:** Surgical intervention in children with spinal tuberculosis not only restores the sagittal parameter of spine but also provides good clinical and neurological outcome.

Keywords: paediatrics; surgical intervention; spinal tuberculosis

2431

A150: The effectiveness of infection control and the spinal balance in patients receiving percutaneous endoscopic debridement and drainage (PEDD) for infectious discitis of thoracolumbar spine: a retrospective cohort study

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Introduction: Thoracolumbar discitis could usually be treated non-operatively with antibiotics. However, rapid diagnosis and treatment are still essential to achieve infection control while preserving spinal stability and neurological function. Except for the gold standard, CT-guided biopsy and culture, Percutaneous endoscopic decompression and drainage (PEDD) offered another unfolding technique for obtaining tissue while performing decompression for neurological symptoms. However, various diagnostic accuracy and the absence of research on subsequent spinal instability remain controversial issues. Therefore, this study aims to investigate the positive culture rate and impact on spinal instability in patients under PEDD for deteriorated discitis after initial antibiotic treatment. **Material and Methods:** From 2015 to 2021, 80 patients received PEDD for their deterioration of hemodynamic or neurologic status secondary to infectious discitis. After culture sampling, debridement, and drainage, the antibiotics continued until symptoms were resolved or normalized by the Inflammatory biomarkers, majorly ESR and CRP. Besides, the functional status represented by the Visual Analogue Scale (VAS), Oswestry Disability Index (ODI), and modified Macnab's satisfactory criteria were evaluated preoperatively, 1-week, 4-week, 6-month, 12-month and 24-month postoperatively, representing the effectiveness of symptom relief. The positive culture rate was recorded as the diagnostic accuracy. At the same time, the change of radiographic parameters, including the sagittal vertical axis (SVA) and Cobb's angle of the thoracolumbar spine, were measured

to evaluate the impact on the stability of the affected levels or global spine. **Results:** 93% of cases achieved symptom relief immediately postoperatively, and 85% got infection controlled within 1 week postoperatively. There were 45% of cases found stably motion-preserved, while 29% of cases got infected level fused at the last follow-up. The favorable outcomes guaranteed the effectiveness of PEDD. Despite the significant local kyphotic change over the infectious level after 6 months to 24 months postoperation, the SVA remained at a similar level, representing the compensatory mechanism of the global spine. However, 14% of cases had no choice but to receive instrumented fusion over lesion levels due to symptoms arising from local kyphosis or instability within 2 years post-PEDD. Thus, whether concomitant fusion or not is still an issue of controversy and warrants further study to determine. **Conclusion:** Despite the technique-demanding, the minimally invasive nature, effectiveness on infection control, and timely symptom relief made PEDD an optimal strategy for certain patients who could not sustain traditional open debridement for discitis. Although no significant instability was found within the postoperative 2 years, the gradual local kyphotic change may warrant further study to identify the need of concomitant fusion.

2112

A151: Can we extrapolate SINS Score to evaluate instability in spinal tuberculosis?

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Introduction: Though guidelines exist for detecting structural instability in paediatric spinal tuberculosis, unequivocal objective criteria to detect instability in adult spinal tuberculosis are lacking. SINS has been proposed to evaluate structural instability of spine in neoplastic conditions. Hence, the present study was carried out to assess feasibility of utilizing SINS to assess structural instability in spinal tuberculosis. **Material and Methods:** Patients with diagnosis of spinal tuberculosis included. SINS scoring done. Inter and intra observer variability for the scoring done for various components of scoring system. Patients classified as "indeterminate stability" managed with/without surgery based on other parameters including medical comorbidities. **Results:** Eighty [thirty-nine males, forty-one females] patients prospectively evaluated with mean age 46.74 + 17.3 years. Classification done into stable [n = 7], indeterminate [n = 45] and unstable [n = 28] groups based on SINS scoring. All the patients in unstable group were treated with surgical stabilization whereas none in the stable group required surgical stabilization. In the indeterminate group, twenty-six patients underwent surgical stabilisation, while nineteen treated non-operatively. Major determinants predisposing to surgical intervention in

'indeterminate group' were pain [fourteen of twenty-six patients] and neurological status [eleven of twenty-six patients]. Mean follow-up 38.5 + 22.61 months with minimum follow-up being twenty-four months. Preoperative VAS score for pain improved from median of 9/10 to 1/10 following surgery [p < 0.0001]. In the non-operative group, the improvement was from median score of 6/10 to 1/10 [p < 0.0001]. Preoperative ODI improved in non-operative and operative group from median of 42% and 70%, respectively to 10% and 12%, respectively in the postoperative period [p < 0.0001 for both groups]. **Conclusion:** SINS scoring can be a helpful tool in surgical decision-making even in spinal tuberculosis. Further refinement of the score can be done with a larger, multicenter study.

1633
A152: Whole-body 18FDG-PET/CT findings in patients with spinal tuberculosis: preliminary results from the Spinal TB X cohort

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Introduction: Spinal tuberculosis (STB) accounts for up to 10% of Extrapulmonary tuberculosis (EPTB) and often leads to lifelong debilitating disease. Little is known with regards to the extent of disease and isolated STB as well as a disseminated form of STB have been described. Whole-body 18FDG-PET/CT (PET/CT) has been shown to be able to detect sites of infection and monitor treatment success. In this preliminary analysis we assessed the PET/CT findings of the first 17 participants enrolled in Spinal TB X (clinicaltrials.gov: NCT05610098). **Material and Methods:** The Spinal TB X cohort is an ongoing prospective cohort study describing the clinical phenotype of spinal TB using whole-body PET/CT and MRI at baseline with repeated PET/CT at six- and 12-months to monitor treatment respond. In addition, gene-expression profiling is being conducted at these time-points. Sputum, urine samples and abscess aspirations undergo GeneXpert Ultra (XP) and MGIT culture (CX) investigations. Tissue samples undergo XP, CX and histological (HX) workup. **Results:** At the time of submission, 49 patients were screened for eligibility. Eleven of the 17 enrolled patients (78.6%) showed microbiologically (CX or XP) proven STB. Of these confirmed cases, 18.2% were female and 18.2% were HIV-infected. The median age was 48.0 years (IQR 23.0). Additional pulmonary lesions on PET/CT were found in five

(45.5%) of the assessed patients with no difference by HIV status (p = 1.0). Sputum XP was positive in four patients which positively correlated with PET/CT findings (p = 0.004, Pearson 0.816). Spinal skip lesions were detected in three patients who were all HIV-uninfected (27.3%). The mean lesion count was 1.4 (SD 0.7) on PET/CT compared to MRI 1.2 (SD 0.6; p = 0.157). The mean count of affected vertebrae per lesion was 2.8 (SD 1.1) on PET/CT compared to MRI 2.4 (SD 0.5; p = 0.131). Of all eleven confirmed STB cases, seven (63.6%) showed psoas abscesses. HIV-status did not have an influence on psoas abscess formation (p = 0.491). The median Total Lesion Glycolysis (TLG) on PET/CT was 273.8 (IQR 473.2) with no difference by HIV status (p = 0.455). The median SUVmax values were 17.4 (IQR 6.8) with no difference by HIV status (p = 0.455). **Conclusion:** In our preliminary analysis, isolated STB appeared to be the dominant entity (54.5% of the cases) on PET/CT. Spinal skip lesions were uncommon. HIV infection does not seem to play a role in the distributional pattern as well as PET/CT parameters. With increasing sample size, we aim to confirm these findings.

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A153: Spinal cystic echinococcosis: a never ending disease

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Introduction: Echinococcosis is a zoonosis mainly caused by Echinococcus granulosus. Main locations are hepatic and pulmonary. Spine locations are rare. Symptoms of spine Echinococcosis vary from pain to spinal cord compression Our objective was to assess the long-term results of operated spinal echinococcosis. **Material and Methods:** A retrospective study was conducted from 1996 to 2021 including operated spinal echinococcosis. We collected demographic, clinical with type and timing of surgery if urgent or non-urgent and evolutionary data. **Results:** In this series, 28 patients were operated all originating from a rural environment. The total number of surgeries was 67. 15 patients had neurological deficit for whom surgery consisted in a two-stage surgery: first stage consisting in a decompression, laminectomy using a posterior approach and a posterior construct, followed by an anterior corporectomy and graft, in a second intervention. Neurological recovery was partial with a remaining deficit in all patients. Neurologically intact patients underwent a debridement-corporectomy and graft with posterior construct in a one-time surgery. All patients received Albendazole. Recurrence was noted at least once in 24

patients that required another surgical decompression. **Conclusion:** Spinal hydatic cysts management is challenging. The goals of the treatment are: neurological recovery or stabilization, mechanical stability and "carcinologic" resection which can be hard to achieve. Treatment is medical and surgical. Recurrence is the norm.

OP18: Tumors: Surgical Considerations

1942
A154: Cervical spine chordomas: surgical outcome assessment in a multicenter cohort from the Primary Tumor Research and Outcomes Network (PTRON)

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Introduction: Chordomas are rare, locally aggressive and infiltrative primary neoplasms. Cervical spine localization of chordomas is rare and poses significant therapeutic challenges due to the proximity to critical structures and the mechanical constraints of the mobile cervical spine. This prospective case series aims to explore the clinical and patient-reported outcomes of surgically treated cervical chordomas in a large multicenter cohort extracted from the Primary Tumor Research and Outcomes Network (PTRON) Database. **Materials and Methods:** This study is a multi-center case series analysis utilizing data from the prospective AO Spine Primary Tumor Research and Outcomes (PTRON) registry. The study population was restricted to patients with pathologically confirmed cervical chordomas involving C0 to C7, who underwent surgical treatment in one of the participating centers and for whom both the initially planned and post-operatively pathologically confirmed surgical margins were documented. Patient demographics, overall survival, recurrence-free survival, neurological function, type of surgery, surgical margins, complications and adjuvant treatments received were retrieved. Patient reported outcome assessment scores including SOSGOQ, EQ-5D, SF36, NRS and NDI were included. Statistical Analysis was performed using Multivariate Analysis. **Results:** We identified 36 patients in the PTRON database fulfilling the eligibility criteria, among which, 10 benefitted from En-bloc resection, 8 had failed En-Bloc resection and 18 intralesional resection. The importance of En-Bloc resection in oncological control when compared to failed En-Bloc resection and intralesional resection is underlined by the overall survival within the study period (100% vs 75% vs 66.7%) and recurrence freedom (90 vs 62.5% vs 77.8%). As could be expected, surgical adverse events are however higher with planned extensive surgery (85.7% within 90 days), when compared to planned intralesional resection (38.9%). **Conclusion:** This multi-center case series analysis provides critical insights into the clinical and patient reported outcomes in the largest cohort of surgically treated cervical spine chordomas described to date and highlights the importance of wide resection for oncological control. It further establishes the associated morbidity related to the surgical strategies available. We believe these descriptive findings will contribute valuable evidence to guide clinicians in optimizing patient care and ultimately improving patient outcomes.

1098
A155: The application of 3D-printed artificial vertebral body in en bloc resection and reconstruction of thoracolumbar spinal tumors: a comprehensive report of 86 cases from a single center

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Introduction: A 3D-printed artificial vertebral body is considered an effective approach to reconstruct large spinal defect, with its customized shape and innermost porous structure inducing bone ingrowth, leading to reduced hardware-related complications. This study is prompted to investigate the clinical results of the application of 3D-printed artificial vertebral body in en bloc resection and reconstruction of thoracolumbar tumors by reviewing 86 consecutive cases treated in a leading medical institution. **Material and Methods:** This was a retrospective analysis of prospectively collected data of 86 consecutive patients who underwent surgical treatment for thoracolumbar tumors at our hospital from May 2016 to October 2022. En bloc resection was performed based on the Weinstein-Boriani-Biagini surgical staging system, and anterior reconstruction was performed using a 3D-printed artificial vertebral body. There were 35 cases of a malignant primary tumor, 42 cases of an aggressive benign tumor, and nine cases of solitary metastases. Tumors involved multilevel in 41 patients. Perioperative complications were evaluated. Local recurrence and survival were estimated using Kaplan-Meier method. Bone-implant interface fusion, implant subsidence and hardware failure were evaluated by CT, and the disappearance of radiolucency between the artificial vertebral body and the bone was considered to be an interface fusion. **Results:** The median follow-up was 30 (range 12-75) months. A customized truss-structured 3D-printed artificial vertebral body was used in 50 patients, an auto-stable prosthesis was used in 8 patients, and an off-the-shelf standard prosthesis was used in the other 28 patients. A total of 122 perioperative complications were observed in 62 (72.1%) patients, including 25 major complications in 18 (20.9%) patients. Local recurrence was 13.9% at 2-year and

17.4% at 5-year postoperatively, which was influenced by tumor pathology (p = 0.021). Survival was 92.3% at 2-year and 73.7% at 5-year, which was influenced by tumor pathology (p = 0.013), previous surgical history (p = 0.003), and number of involved vertebrae (p = 0.001). Bone-implant interface fusion was achieved in 61.2% of the patients at 1-year and 79.1% of the patients at 3-year. Implant subsidence occurred mainly within six months after operation, and the anterior subsidence (0.90 mm, p = 0.001) was greater than the posterior subsidence (0.22 mm, p = 0.371), which led to the reduction of sagittal lordosis (2.58°, p = 0.039). Rod breakage occurred in four patients, three of whom used standard prostheses, one at the occipitocervical junction, two at the thoracolumbar junction. The other used a truss-structured prosthesis in the lumbar spine, which had an abdominal urinary fistula and did not form a fusion. Hardware failure was more likely to occur in patients receiving postoperative radiotherapy (p = 0.009). **Conclusion:** The application of 3D-printed artificial vertebral body in en bloc resection and reconstruction of thoracolumbar spinal tumors appears to be risky, but also feasible and beneficial. The small amplitude of implant subsidence with truss-structured 3D-printed prostheses can offer immediate and robust stability. However, when the tumor is located in the junctional area or the patient needs postoperative radiotherapy, it is still necessary to be alert to the occurrence of hardware failure.

1893

A156: Novel pedicled tibia and fillet of thigh flap reconstruction for spinopelvic discontinuity after external hemipelvectomy with sacrectomy for en bloc tumor resection: technical approach and outcomes in 16 cases

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Introduction: External hemipelvectomy with sacrectomy +/- lumbar vertebrectomy is a formidable surgical procedure performed to achieve en bloc tumor resection in cases of massive spinopelvic tumors. The surgical resection results in significant spinopelvic discontinuity with major instability. Reconstruction of such a destabilizing procedure remains a major challenge. In this study, we present a novel approach to spinopelvic reconstruction using a pedicled tibia and fillet of thigh flap, and we report the outcomes of this technique over a decade-long series. **Material and Methods:** Retrospective chart review was performed on all cases using this technique. The novel reconstruction utilizes a fully pedicled fillet of thigh and vascularized tibia which is fixed between the remaining spine and pelvis. This technique is best indicated when a portion of the ipsilateral ischium can be salvaged and used as the distal docking site for the tibial graft. All cases were staged over a 2-day period. On the 1st day the patient is positioned prone for spinopelvic stabilization, laminectomies, nerve root sacrifice, and provisional osteotomies. On the 2nd day the patient is positioned lateral for en bloc resection thru an ilioinguinal approach. Stereotactic navigation was employed in all cases. **Results:** Sixteen cases have been successfully performed over a 10-year period from 2013-2023. The histological profiles of the tumors treated in this study included osteosarcoma, chondrosarcoma, dedifferentiated chondrosarcoma, and rectal adenocarcinoma. The patients ranged in age from 12 to 84 years, with an equal distribution between genders. All patients survived the surgery and there were no 90-day mortalities. There were no major intraoperative complications. There was one return to OR 7 days postop for acute bleeding. There were no 90-day return to OR for any flap related complications. The most common complication was wound complication at 44%. 14/16 patients underwent surgery with curative intent. The median follow-up duration was 29.5 months, and 8/15 patients are currently alive (excluding 1 patient who is 3 months postop). Seven patients are deceased, with five deaths attributed to metastatic disease, one due to secondary leukemia, and one due to unknown cause of death. Median survival was 45.5 months for those patients that underwent surgery with curative intent with at least 2-year follow-up. Surgical margins were negative in all cases except for one palliative case. **Conclusion:** Our study demonstrates the feasibility and efficacy of utilizing a pedicled tibia and fillet of thigh flap for spinopelvic reconstruction following external hemipelvectomy with sacrectomy +/- lumbar vertebrectomy for en bloc tumor resection. The technique consistently achieved spinopelvic stability and negative surgical margins. This series of 16 cases over a 10-year period contributes valuable insights into the management of complex spinopelvic tumors and the importance of meticulous reconstruction techniques to enhance the functional and oncological outcomes of patients undergoing extensive spinopelvic en bloc amputative resections. Further studies with longer follow-up periods are warranted to validate our findings and refine the surgical approach.

1445

A157: Does intraoperative cell-salvaged autologous blood transfusion in metastatic spine tumour surgery improve long-term clinical outcomes: a prospective clinical study

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Introduction: Allogeneic blood transfusion (ABT) is the current standard of blood replenishment for metastatic spine tumour surgery (MSTS) despite known complications. Salvaged blood transfusion (SBT) addresses majority of such complications that is related to ABT. However, surgeons remain reluctant to employ SBT in MSTS despite ample laboratory evidence. This can be due to a current lack of literature regarding the long-term outcomes of SBT in MSTS patients. This prompted us to conduct a prospective clinical study to ascertain the long-term clinical outcomes of intra-operative cell salvage (IOCS) in MSTS. **Material and Methods:** Our prospective study included 98 patients who underwent MSTS from 2014 to 2017. Demographics, tumour histology and clinical findings related to both the primary tumour and skeletal metastases were collected. We also recorded clinical and investigational findings at the time of diagnosis of Metastatic Spine Disease (MSD) including neurological assessment, Frankel score, ambulatory status (ECOG Score), number of extra-spinal skeletal, vertebral and visceral metastases and Karnofsky Performance Scale (KPS). These were used to calculate overall modified Tokuhashi score. Operative variables collected included the surgical approach, number of spinal levels decompressed and instrumented and intra-operative blood loss and blood transfusion (BT) details. Patients were divided into three groups based on their BT type: no blood transfusion (NBT), SBT or ABT. Primary outcomes assessed post-operatively were overall survival (OS), and tumour progression was evaluated using RECIST (v1.1) employing follow-up radiological investigations at 6, 12, 24, 36 and 48 months, classifying patients with nonprogressive and progressive disease. **Results:** Our study had a total of 98 patients [57:41(M/F)] with a mean age of 64 years at the time of surgery. Overall median follow-up and survival were 30 and 21 months, respectively. All three groups were comparable for demographics and tumour characteristics (p = 0.648). Overall median blood loss was 647 mL, and median BT was 900 mL. 32 (32.7%) patients received SBT, 39 (39.8%) ABT and 27 (27.5%) NBT. Comparison of total blood loss among the three groups revealed no significant difference between SBT and ABT. There was also no significant difference in the total amount of blood transfused between SBT and ABT (p = 0.293). Females had lower OS and higher risk of tumour progression in our study. SBT had better OS as compared to the ABT and NBT groups. On multivariate analysis, SBT also showed to have lowest risk of tumour progression compared to the ABT and NBT groups. Total blood loss was not associated with reduced overall survival or tumour progression. Infective complications other than SSI were also shown to be significantly (p = 0.023) higher in ABT than NBT/SBT groups. **Conclusion:** Patients of SBT had OS and tumour progression that was better than the ABT

or NBT groups on long term clinical follow-up. This is the first long term prospective study to report on the clinical outcomes of SBT in comparison with control groups in MSTS and affirms the role of SBT in MSTS.

Keywords: metastatic spine tumour surgery; intraoperative cell salvage; salvage blood; allogenic blood; overall survival rate; tumour progression

1064

A158: Patterns of treatment delay in patients with symptomatic metastatic epidural spinal cord compression

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Introduction: Delayed treatment in patients with symptomatic metastatic epidural spinal cord compression (MESCC) is significantly associated with poorer functional outcomes. There is a need for early recognition of signs and symptoms of MESCC. In this study we aim to identify the patterns of treatment delay in patients with symptomatic MESCC and factors predictive of post-operative ambulatory function. **Material and Methods:** Retrospective review of patients with symptomatic MESCC treated surgically between January 2015 to January 2022. Demographic, oncological, and surgical data was collected. MESCC symptoms were categorized into symptoms suggesting cord compression requiring immediate referral and symptoms of pain characteristics suggestive of spinal metastases. Multivariate analysis was performed to identify factors predictive of post-operative ambulatory function. Delays in treatment were identified and categorized into patient delay (onset of symptoms till initial medical consultation), diagnostic delay (medical consultation till radiological diagnosis of MESCC), referral delay (from diagnosis till spine surgeon review) and surgical delay (from spine surgeon review till surgery). These types of delay and total delay were compared between patients with or without factors predictive of ambulatory function. **Results:** 178 patients were identified. In this cohort 92 (52.0%) patients were able to ambulate independently, and 86 (48.3%) patients required a walking aid or were non ambulant post-operatively. 139 (78.1%) of patients had symptoms of cord compression and 93 (52.3%) had neurological deficits (Frankel A-D) on

presentation. On multivariate analysis, pre-operative neuro-logical deficits (p = 0.01) and symptoms of cord compression (p = 0.01) were significantly associated with post-operative ambulatory function. Mean Total delay was 66 days, Patient delay was 41 days, Diagnostic delay was 16 days, Referral delay was 3 days and Surgical delay was 6 days. In patients with neurological deficits, there was a significant decrease in diagnostic delay (p = 0.016) (12 vs 20 days), referral delay (p = 0.034) (2 vs 4 days), surgical delay (p < 0.001) (4 vs 9 days) and total delay (p = 0.032) (58 vs 75 days). However, there was no significant improvement in patient delay (p = 0.0754) (40 vs 42 days). There was no significant difference in all forms of delay and total delay in patients with or without symptoms of cord compression. **Conclusion:** In patients with neurological deficits, there is a significant decrease in treatment delay once the patient is seen by a physician. However, there is still a need for increased patient and physician awareness education on recognizing the symptoms of cord compression in MESCC.

2428
A159: What is the optimal management of metastatic spine patients with intermediate spinal instability neoplastic scores: to operate or not to operate?

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Introduction: In patients with extradural metastatic spine disease, we sought to systematically review the outcomes and complications of patients with intermediate Spinal Instability Neoplastic Score (SINS) lesions undergoing radiation therapy, percutaneous interventions, minimally invasive surgeries, or open spinal surgeries. **Material and Methods:** Following PRISMA guidelines for systematic reviews, MEDLINE, EMBASE, Web of Science, the Cochrane Database of Systematic Reviews and the Cochrane Center Register of Controlled Trials were queried for studies that reported on SINS intermediate patients who underwent: 1) radiotherapy, 2) percutaneous intervention, 3) minimally invasive, or 4) open surgery. Dates of publication were between 2013-22. Patients with low- or high-grade SINS were excluded. Outcome measures were pain score, functional status, neurological outcome, ambulation, survival, and perioperative complications. **Results:** Thirty-nine studies (n = 4554) were included that analyzed outcomes in the SINS intermediate cohort. Radiotherapy appeared to provide temporary improvement in pain score; however, recurrent pain led to surgery in 15-20% of patients. There was limited evidence for radiofrequency ablation. Nonoperative treatment like radiotherapy and radiofrequency ablation can provide temporary palliation and a good outcome in many patients, which may be the most appropriate option in some cases. Percutaneous vertebral augmentation provided improvement in pain. When comparing MIS with open surgery, pain scores were improved in both MIS and open cohorts, but ambulation was not significantly improved in the MIS group. There was less blood loss

and shorter time to radiation therapy in the MIS cohort, but no difference was found in operating time, duration of hospital stays or time in ICU. The postoperative complication rate was equal in one study while higher in the open surgery group in another study. There was no difference between open and MIS surgery in terms of pain changes, neurological function, or survival time in SINS intermediate patients. While there were no clear advantages of MIS over open surgery in this specific patient population, MIS have been shown to be associated with better AE profile in the metastatic spine population as a whole. The results of this systematic review should not be misinterpreted as a recommendation that surgery should be recommended for every patient in the SINS intermediate category. It should however be considered when mechanical pain is present. The SINS on its own was not designed to determine the need for surgery. **Conclusion:** In the SINS intermediate group, radiotherapy was associated with temporary improvement of pain but may require subsequent surgery. Both minimally invasive surgery and open spinal surgery achieved improvements in pain, quality of life, and neurological outcomes for patients with spine metastases. Open surgery may be associated with more complications.

2568

A160: Carbon fiber reinforced polyetheretherketone (PEEK) spinal reconstruction following primary spinal tumour resection: The potential challenges of reconstruction

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Introduction: The use of Carbon Fiber Reinforced Polyetheretherketone (PEEK) Spinal Reconstruction systems following Primary Spinal Tumour Resection has many potential appeals compared to established titanium based reconstructions including: less artifacts in CT & MRI ensuring better visualization of the surrounding soft tissue and implants; negligible backscattering and attenuation allowing for more precise radiation of residue tumor with minimal collateral damage; and enhance biomechanical properties including increase strength and fatigue resistance. We aim to report the medium-term results for these challenging cases whilst focusing on the biomechanics of the reconstruction. **Material and Methods:** The study is a retrospective analysis of prospectively collected data. The primary inclusion criteria was spinal surgery for primary spinal tumor with the use of carbon fiber reinforced PEEK implants. Surgical outcomes, complications, and radiographic assessments were examined.

Additionally, a review of relevant literature was conducted to summarize existing evidence on the advantages and limitations of such implants specifically regarding biomechanics and longevity of spinal reconstruction. **Results:** 33 patients were included in the study over the period of January 2016 to May 2023. The study population included 14 females and 19 males, with an age range of 17 to 77 years (mean age of 48 years). 26 patients (79%) had primary bone tumors, whilst 7 (21%) had primary soft tissue tumors. The most common primary bone tumor was chondrosarcoma, followed by chordoma. The presenting complaints which prompted investigations and diagnosis were axial spine pain (72%), myelopathy (18%) and radiculopathy (9%). Surgical techniques were bespoke based on tumour morphology and most (23 cases, 70%) were total vertebrectomies (21 single level, 1 two level, and 1 three level), followed by partial vertebrectomies (8 cases, 24%), spinal decompression (1 case, 3%), and local excision (1 case, 3%). Anterior column cage reconstruction with posterior instrumentation was used in 14 cases (42%), whilst 19 patients (58%) underwent posterior instrumentation only. The average fusion length was 6 vertebral segments and the mean clinical follow-up time was 36 months (range 8-85 months). The observed reconstruction related complications included cage migration (3 cases, 21%), rod failure (6 cases, 18%), screw loosening (2 cases, 6%) and subsequent revision surgery (11 cases, 33%). This compares with reports of up to 30% implant related complications with spinal reconstruction following extensive resections. **Conclusion:** There is growing use of Carbon Fiber Reinforced PEEK implant systems following Primary Spinal Tumor Resection and it can be effective for spinal stabilization and restoration of vertebral column integrity. This study confirms some of the challenges of such reconstructions. Undoubtedly these implants have a significant use-case in these complex case and despite its limitations this study confirms the need for ongoing research pertaining to the optimum composite material that can effectively replicate the native biomechanical environment, appropriately stabilize the spine thus facilitating fusion and optimize essential radiological tumour follow up and precision adjuvant radiotherapy.

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A161: En bloc resection with sacrectomy of locally advanced colorectal carcinoma invasive into the sacrum improved overall survival

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Introduction: Five-year survival of locally recurrent colorectal carcinoma after initial surgical excision, when managed non-surgically with chemotherapy and radiation alone, is extremely low. En bloc resection may afford the greatest chance of progression free (PFS) and overall survival (OS). In cases where colorectal carcinoma invades the sacrum, sacrectomy may be necessary. In this study, we sought to examine how sacrectomy, as well as the sacrectomy level, in colorectal carcinoma patients with sacral invasion can affect PFS and OS. In addition, we sought to examine the relationship of the surgeon's intent, whether curative or palliative, to these same metrics. **Material and Methods:** Demographic, comorbidity, clinical, tumor specific, level of sacrectomy, surgeon's intent and outcome data were collected on all patients who underwent resection of recurrent colorectal carcinoma with concurrent sacral resection between 2005 and 2022. The primary outcomes recorded were PFS and OS. **Results:** Twenty two patients (mean age 53 years, range: 30-76, 54.5% female) underwent sacrectomy for recurrent colorectal carcinoma. 14 patients were classified into a curative cohort and 8 into palliative based on surgical intent. Non-curative surgical intent was based primarily on the presence of distant metastases. Patients were also dichotomized according to the location of the proximal transverse osteotomy above or below the S2-3 disc space. Overall mean PFS was 33.6 months and OS was 41.1 months. Patients in the curative cohort had mean PFS of 48.6 months vs 7.4 months in the palliative cohort (p = 0.002). In the curative cohort, mean OS was 55.2 months vs 16.4 months in the palliative cohort (p = 0.011). PFS and OS for patients with transverse osteotomy above the S2-3 disc space was not significantly different than those below. **Conclusion:** In our cohort, PFS and OS improved when stratified based on curative vs palliative intent and were similar in patients regardless of the upper extent of the sacrectomy. These results suggest that en bloc resection of colorectal carcinoma invading the sacrum with concurrent sacrectomy, in properly selected patients, should be considered.

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A162: Anterior spinal reconstruction with structural femoral allograft post en-bloc spinal tumour resection. A case series with median 7 year follow up

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Introduction: The achievement of a stable construct with early bone fusion post en-bloc resection of spinal tumours is a key surgical goal. Structural femoral allografts possess biomechanical properties which make them an effective and less costly alternative to synthetic implants. To our knowledge this article is one of first to describe the time to fusion and long-term outcomes when using femoral allograft to reconstruct the spinal column post spinal tumour resection. We also wish to report our technique of stabilisation of the allograft by pre-inserting a pedicle screw which is then connected to the posterior pedicle screw and rod construct. **Material and Methods:** This is a retrospective review of patients who underwent enbloc vertebrectomy for primary spinal tumours or solitary spinal metastases of the thoracolumbar spine followed by anterior column reconstruction with fresh frozen femoral structural allograft and posterior instrumentation with pedicle screws between 1994 to 2022. Each femoral allograft had a pedicle screw placed prior to implantation for connection to the pedicle screw/rod construct.Demographic, Oncological and Surgical Data was collected. Primary outcomes were fusion and time to fusion, local recurrence and duration of local recurrence free survival, and death and duration of survival. **Results:** 14 patients were treated, 7 females and 7 males with a mean age of 36 (range 11-63). 9/14 of the patients had primary tumours of the spine and 5/14 had solitary spinal metastases. Median follow up was 66 months (range 12-324 months). An all-posterior approach was utilized for 13/14 of the patients with only one requiring an anterior approach. Iliac crest bone graft was used to pack the allograft for all patients except in 2 patients where cement was used instead. In the first two patients of this series, a Roy-Camille and Steffee Plate was used for posterior stabilisation respectively, and conventional titanium rods were used for the other patients. The mean time to fusion was 11 months (range 6-14). There were 2 cases of local recurrence. The mean local recurrence free survival was 106 months (range 12-324). The mean survival in the primary tumour group was 160 months (range 12-324) and 47 months (range 24-84) in the spinal metastases group. There was one case of implant failure

required revision posterior instrumentation with placement of additional sacral screws and posterolateral bone grafting. This occurred in the patient who had underwent short segment posterior fixation and anterior stabilization with screws. There was also one case of femoral allograft fracture prior to implantation requiring cerclage. **Conclusion:** Structural Femoral Allografts are a cost-efficient and biomechanically suitable alternative for spinal reconstruction post spinal tumour en-bloc resection. It's compatibility with imaging modalities makes it ideal for post-operative surveillance and radiotherapy. Our technique of posterior stabilisation of the allograft with pedicle screws ensures mechanical stability and removes the need for an anterior approach and stabilisation.

OP19: MIS Lumbar Surgery

609
A163: Results of instrumented fusion surgeries on lumbar spine with regard to "sagittal balance" parameters after posterior, anterior and combined approaches

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Introduction: Sagittal balance has become a frequent topic in spinal surgery, mainly because of its impact on fusion surgery outcomes as well as of life post surgery. Inconsistency of sagittal parameters is associated with degeneration of adjacent segments, increased risk of revision surgery, flatback syndrome and decrease in quality of life post surgery. The goal of our work is to compare the influence of the operative approach as well as the cage angle on the changes in postoperative sagittal parameters. **Material and Methods:** Our prospective study examines and compares radiological parameters before and 12 months after the surgery from the point of view of the surgical approach and the degree of lordosis of the implanted intervertebral disc replacement in patients undergoing lumbar interbody fusion surgery in the years 2017-2022 at the Neurosurgical Clinic of UVN Ružomberok and at Neurosurgery Clinic UNLP Košice. The total number of patients in the file is 852. We divided the patients into two main groups, patients who underwent one-segment fusion surgery and patients with two-segment fusion surgery. For 1-segment surgical procedures, we classified patients according to the surgical approach into 4 groups: TLIF, AxiaLIF, LLIF, ALIF. We also focused on monitoring the influence of the cage angle on the resulting changes in lumbar lordosis (LL). For 2-segment surgical procedures, we classified the category of

surgical approaches into 4 groups. Combination of posterior approaches, combination of anterior and lateral approaches, lateral approach, and combination of anterior or lateral approaches with posterior access. **Results:** In 1-segment fusion surgery, the results of the study show that the best potential for lumbar lordosis correction is LLIF, an improvement of 5.1°, ALIF by 4.9°, TLIF by 1.7° with statistical significance $p < 0.05$. The only surgical approach in which LL worsened post surgery was AxiaLIF with a worsening of 2.9°. The results of the cage angle influence in changing of LL show us that patients in whom an anatomical cage was used as well as patients with a cage with an angle of 1-5° have the same average results, namely a deterioration of LL by 2.7°. The best results were achieved in a patient with a cage angle of 10° and more, where there was an improvement of 4.4°. In 2-segment fusion surgeries we have achieved an improvement in LL in all groups of operative approaches. We achieved similar results in all groups where anterior and lateral approaches were used (improvement of 4.7°-4.2°) in comparison with the group of two posterior approaches where the improvement reached a value of 2.7°. When evaluating the impact of the cage angle, we measured the improvement of LL in the lordotic cage group (3.7°, 3.2°, 3.1°) with the 2-segment approach. The deterioration was achieved in the anatomical cage group by 1.8° with $p < 0.05$. **Conclusion:** The results of our prospective work confirm the assumption that anterior and lateral approaches have a higher potential for adjusting sagittal parameters compared to posterior approaches. Also, the results of our work show that lordotic cages improve LL more significantly compared to anatomical cages.

1587
A164: Revisiting revision lumbar surgery: a deep dive into MAS-TLIF primary vs revisionary outcomes & complications

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Introduction and Aim: Comparative studies indicate that primary minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) surgeries may provide benefits such as reducing reoperation rates and enhancing patient-reported outcomes when compared to other surgical methods. However, there is a scarcity of research regarding the clinical effectiveness of revision surgeries for MIS-TLIF. As such, this study focuses on the clinical outcomes of revision MIS-TLIF surgery, specifically through maximum access surgery TLIF

(MAS-TLIF) (Nuvasive, San Diego CA) when compared to outcomes for primary MAS-TLIF surgery. We aim to compare primary and revisionary clinical outcomes in MAS-TLIF surgery. **Materials and Methods:** A total of 126 patients with degenerative lumbar conditions who underwent MAS-TLIF (Nuvasive, San Diego, CA) were retrospectively reviewed. Intra and inter-groups comparisons of pre-operative and post-operative Numeric Rating Scale (NRS), the modified AAOS-Modems disability outcomes, Oswestry Disability Index (ODI) and Short Form 36 item questionnaire (SF-36) were conducted. Occurrence rate of complications was evaluated as well. Due to the non-normal distribution of the data, the nonparametric Mann-Whitney U test was used to compare clinical outcomes. **Results:** A total of 126 MAS-TLIF surgeries were performed as primary (n = 96, Group I) or revisionary (n = 31, Group II). Both Group I and II demonstrated significant improvements in ODI while only Group I showed significant improvement in physical function, energy fatigue, emotional wellbeing and pain components of the SF-36 questionnaire. There were no differences of either Group shown in the modified AAOS-Modems disability outcomes. There was a complication rate of 22% (n = 7) in Group II while 14% (n = 14) in Group I. **Conclusions:** MAS-TLIF yielded similar long-term clinical outcomes for both primary and revision surgeries in terms of PROMS such as ODI, NRS and AAOS-Modems disability. However, only primary surgeries showed significant improvement in SF-36 questionnaire. Additionally, the revision group demonstrated 60% higher rates of complications.

2223
A165: Type of nerve root compression in lumbar foraminal stenosis predicts clinical outcome following posterolateral lumbar foraminotomy

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Introduction: Although posterolateral lumbar foraminotomy (PLF) has been considered as an effective option to treat lumbar foraminal stenosis, the prognosis of PLF based on etiology of foraminal stenosis has not yet been established. The aim of the present study was to assess the surgical outcome according to the type of foraminal stenosis seen on preoperative MRI.

Material and Methods: Fifty-six patients who received either tubular or endoscopic PLF at single level were analyzed and their types of foraminal stenosis were classified as transverse, vertical, or mixed regarding to the direction and structures causing the nerve root compression on T2-weighted sagittal images of preoperative MRI showing the most stenotic lesion. 1-year surgical outcomes and their association with the types of foraminal stenosis were estimated. **Results:** Forty-four patients (78.6%) achieved favorable outcome after 1-year operation. Among 21 patients classified as transverse type, one patient (4.8%) showed unfavorable outcome. However, 9 out of 21 patients (42.9%) classified as vertical type showed unfavorable outcome (p < 0.01). Multivariate logistic regression analysis showed that vertical type stenosis was significantly associated with unfavorable outcome compared to transverse type stenosis (Odds ratio 15.0, 95% CI 2.4-94.0, p = 0.02). Kaplan-Meier survival analysis showed that 1-year probability of maintaining a favorable outcome was $95.2 \pm 4.6\%$, $50.9 \pm 11.1\%$, and $85.7 \pm 9.4\%$ for those who had transverse, vertical and mixed type stenosis, respectively (p < 0.01). **Conclusion:** The prognosis of PLF can be assessed by the type of foraminal stenosis. PLF is an effective treatment of choice in case of transverse type stenosis. However, regarding to vertical type stenosis, PLF alone may not provide sufficient decompression, necessitating additional procedures, such as discectomy or pediculectomy, or interbody fusion may be a more appropriate treatment of choice.

1889
A166: Comparison of minimally invasive and the conventional lumbar interbody fusion techniques in terms of restoration of spinal curvature and its role in clinical improvement

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Background: Restoration of normal spinal curvature during interbody fusion has been associated with better clinical postoperative results. The interbody fusion is being performed with both the conventional open and minimally invasive technique. Thus, comparison of the techniques in terms of restoration of the curve is important as it can predict better clinical results following the fusion. **Aim:** Objective is to compare the two techniques in terms of restoration of normal spinal curvature and asses its role in pain and disability improvement. **Methodology:** The patients undergoing transforaminal lumbar interbody fusion (TLIF) at Ghurki Trust Teaching Trust Hospital, Lahore were retrospectively assessed. The patients were grouped into two cohorts on basis of the surgical technique implied. A total of 116 patients that underwent TLIF from 1st January 2017 to 30th May 2023 were divided into those operated by open technique, O-TLIF (group

1, n = 76) and those operated via minimally invasive technique, MI-TLIF (group 2, n = 40). Clinical outcome was assessed in terms of improvement of pain (on Visual Analogue Score, VAS) and disability (as per Oswestry disability index, ODI). Spinal curvature was assessed at index vertebra level in terms of segmental lordosis (SL), anterior disc height (ADH), posterior disc height (PDH) and foraminal height (FH); as well as lumbo-pelvic level in terms of lumbar lordosis (LL), pelvic incidence-lumbar lordosis (PI-LL) mismatch, sacral slope (SS) and pelvic tilt (PT). **Results:** Mean age of the sample was 43.42 ± 12.06 yrs, BMI was 30.42 ± 5.11 kg/m^2 and mean follow-up period was 35.16 ± 13.7 months. Fifty-two percent (61) patients were males, 50.9% (59) patients had ASA score of more than 2 and L$_{4-5}$ was the most commonly involved segment (56.9%). Among the radiologic parameters assessed only two parameters showed significantly more improvement in MI-TLIF group in comparison to O-TLIF. MI-TLIF group showed segmental lordosis (SL) improvement of $3.04 \pm 2.64°$ (from $7.23 \pm 3.25°$ to $8.75 \pm 3.22°$) that was significantly higher ($p < 0.001$) from SL improvement of O-TLIF group (that was $1.52 \pm 0.53˚$). Similarly, anterior disc height (ADH) improvement in MI-TLIF group was 4.58 ± 2.49 mm (from 10.02 ± 3.41 to 14.6 ± 2.32) and this value was significantly higher from improvement of 1.36 ± 1.62 mm seen in O-TLIF ($p < 0.001$). The improvement in the rest of the index and lumbo-pelvic radiographic features didn't show any statistically significant difference among the two group. The clinical parameters i-e pain (VAS) and ODI showed higher improvement in MI-TLIF group: but the results weren't statically significant: pain improvement in MI-TLIF group was 3.12 ± 0.82 and in O-TLIF was 3.07 ± 1.04 and ODI improvement was 29.4 ± 10.62 in MI-TLIF in comparison to 28.63 ± 9.51 in O-TLIF. **Conclusion:** MI-TLIF restores the lordosis more effectively at index-level vertebra but this was not found associated with better restoration of lumbar spine curvature as a whole. This probably results in the fact that both the approaches have similar results in terms of clinical improvement of the patients.
Keywords: transforaminal lumbar interbody fusion; minimally invasive interbody fusion; lumbar lordosis

1225
A167: Oblique lumbar interbody fusion using hybrid type interbody cages in treatment of degenerative lumbar spinal disease

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Introduction: Oblique lumbar interbody fusion (OLIF) is a popular technique for the treatment of degenerative lumbar spinal disease. Indirect decompression effect via OLIF is

obtained by restoration of disc height and foraminal height. There is no study discussing about the novel hybrid type of interbody cages in multi-level OLIF patients. The purpose of this study was to analyze the surgical outcomes of OLIF using hybrid type interbody cages. **Material and Methods:** This is a single-center retrospective cohort study reviewing patients who underwent OLIF surgery for degenerative lumbar spinal disease between March 1, 2018 and May 31, 2021. The inclusion criteria were patients who received OLIF using hybrid type of interbody cages. The subset of those with versus conventional cages were identified and matched 1:4 based on patient age and sex. The minimum follow-up time was 12 months. The clinical and radiological outcomes were recorded at pre-OP, post-OP and the last follow-up time. **Results:** There were matched 15 patients with hybrid type cages and 60 patients with conventional type cages. In the radiological parameters, the improvement ratio of disc height and foraminal height were larger in the conventional cage group. There was no statistically significant difference in foraminal width, segmental lordosis and lumbar lordosis between groups. The occurrence of high-grade cage subsidence was significantly higher in the hybrid cage group, with a rate of 26.7%, in comparison to the conventional cage group, which had a lower rate of 11.7%. All the patients achieved adequate spinal fusion on image presentation at the last follow-up time. The clinical outcomes including VAS of back and leg, ODI and EQ5D had no significant difference between these two groups in the follow-up period. **Conclusion:** The radiological outcomes for OLIF with hybrid-type cages were inferior to those with conventional cages, although short-term clinical outcomes were similar. The use of smaller cages may raise concerns regarding cage subsidence.

1215
A168: Evolution of minimally invasive lateral sacro-iliac fusion - From X-rays to robotics

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Introduction: Sacro-iliac (SI) joint dysfunction considered to be one of the causes of low back and/or leg pain in patients with failed back surgery syndrome (FBSS). SI joint fixation and fusion is a therapeutic option for patients in whom conservative treatment failed. **Material and Methods:** From 2015 to 2023, we performed minimally invasive lateral fixation on 42 SI joints of 24 patients. All patients underwent a strict diagnostic protocol based on the failure of conservative

management of FBSS at a single chronic pain center. Evaluation of pain signs, positive provocative maneuvers, negative radiological evaluation of spine and hip joints (X-rays and MRI), psychological and PET-NAF CT evaluation, quantitative gait analysis, positive SI joint injections, and informed consent comprised the selection strategy of patients for surgery. The first two patients were treated using intraoperative X-ray navigation, the following 13 patients were operated using intraoperative CT-guided control, and the final nine patients were treated using robotically guided screw insertion. **Results:** One patient in the CT-guided group had temporary S1 dysesthesia due to K-wire migration. No other intra- or postoperative complications were identified. In all groups, there was not a single case of screw malposition. The robotic guided technique of SI fusion reduced operating time and skin incision (up to 20 minutes per side, 4 cm incision for three 10 mm screws), eliminated radiation exposure to the surgical team and enhanced procedure safety by eliminating the risk of K-wire migration. There were no clinical differences in the outcome, with all groups experiencing a reduction in ODI score of approximately 20 points. **Conclusion:** In selected cases of FBSS, SI fixation and fusion is beneficial. The robotic guide insertion technique increased surgical efficiency and patient safety. Based on strict indication criteria, regardless of the type of navigation procedure, the clinical outcomes are identical.

539

A169: Accuracy of cage placement in oblique lateral interbody fusion (OLIF 25) and its effects on radiological outcome in lumbar degenerative disease

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Introduction: This retrospective study aimed to check how accurately cages were inserted and how they affected the X-ray results in OLIF25. **Material and Methods:** A total of 137 patients, consisting of 58 (42.3%) males and 79 (57.7%) females, with an average age of 66.5 ± 9.5 years (ranging from 30 to 87 years), and diagnosed with lumbar degenerative disease, were included. In this study, we considered 184 intervertebral discs. Cage positions were assessed using MRI. We used both Uribe's classification and a new cage deviation classification system to determine cage insertion accuracy in OLIF. Cage deviation types were categorized into anterior and posterior deviations. Cage deviation angles (CDA) were classified into four groups: minimal ($0°$-$5°$), mild ($> 5° \leq 10°$), moderate ($> 10° \leq 15°$), and severe ($> 15°$), based on the angle formed by the long axis of the cage and the horizontal axis of the vertebral body. Using X-ray, we measured anterior disc height (ADH), posterior disc height (PDH), left and right foraminal height (FH), segmental angle (SA), lumbar lordosis (LL), and surgical segment angle (SSA). We also determined the cross-sectional area of the thecal sac (CSA) by outlining it in T2-weighted axial magnetic resonance images. **Results:** After examining 184 cages through postoperative MRI, we found that 19 were in zone III (10.32%), 163 were in zone IIIII (88.59%), and 2 were in zone III~IV (1.09%). The median cage deviation was $4.97°$. The Kruskal-Wallis test of CDA revealed no significant differences (H = 2.479, p = 0.290 > 0.05) among different segments. Anterior cage deviation occurred in only 10 discs (5.43%), while posterior cage deviation was 94.57%. The distribution of minimal, mild, moderate, and severe cage deviation was 89 (48.4%), 51 (27.7%), 30 (16.3%), and 14 (7.6%), respectively. There was one case of transient contralateral traversing nerve root injury at the L4,5 level. ADH, PDH, FH, and FA increased in lumbar spinal stenosis, degenerative spondylolisthesis, and lumbar degenerative scoliosis, as well as in different levels after surgery (p < 0.05). PDH and FH did not show significant changes postoperatively (p > 0.05) at the L2/3 level. LL and SSA underwent significant changes in all three OLIF levels, and DSA was also substantially altered after surgery. CSA notably increased from 109.0 ± 40.6 mm^2 to 128.6 ± 43.6 mm^2 overall. **Conclusion:** Approximately 98.91% of cages were placed in zones III and IIIII. Cage deviation occurred anteriorly in 5.43% and posteriorly in 94.57% of cases. Among the total 184 levels, minimal and mild CDA constituted 92.4%, while severe CDA was 7.6%. Despite using C-arm biplanar fluoroscopy during surgery, minimal to moderate cage deviation did not impact radiological outcomes significantly. However, avoiding severe cage deviation is crucial to prevent contralateral traversing nerve root injuries.

2310

A170: 3D printed drill guides for long cortical bone trajectory screw placement in elective thoracolumbar fusion surgeries: results of 335 planned and performed pedicle screws

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Introduction: Cortical bone trajectory (CBT) is an alternative technique for pedicle screw placement in thoracolumbar fusion surgery. CBT allows a decrease of skin incision and spine exposure, making it nearly a minimal-invasive procedure. Since finding the correct entry point and the optimal ascending and diverging angle for maximizing the screw length are crucial steps, pre-operative planning of 3D printed drill guides using CT imaging has proven to be safe and accurate for long CBT-pedicle screw placement. We report on three-dimensional parameters of 335 planned long CBT-screws.

Material and Methods: A single center retrospective analysis was performed including patients with thoracolumbar degenerative disease who have been transferred to elective fusion surgery. All surgeries were performed between 3/2019 and 9/2023. Preoperative CT was used to plan optimal screw placement in CBT technique for each patient. A commercial, approved 3D printed drill guide was generated, sterilized and used as a patient matched guide to safely place CBT screws. Angles of the planned screws in the sagittal and transversal, screw length and diameter were obtained and analysed. The coordinates of the screw entry point were described in the horizontal and vertical distance to the center of rotation in the coronal plane. An additional parameter was the safety margin between the tip of the long CBT screw and the anterior corticalis. Further more we measured duration of OR time and estimated blood loss. **Results:** 61 patient (mean age 64.5 years ± 10y) with a total number of 335 CBT screws were included. The amount of planned screws per vertebra varied from 2 (in T8, 9 and 10) to 100 (in L4). There was a consistency of low standard deviation in the planned screw length and diameter for each vertebra: longer screws were planned in L1-L4 (41.25 mm ± 2.5 mm to 44.44 mm ± 2.8 mm). Taking into account that a safety gap between 5.15 and 6.76mm was present, a 45mm screw could be chosen during the surgery. In L5 and S1 significantly shorter screws had to be planned: 37.66 mm ± 3.98 mm in L5 (safety gap of 4.98mm) and 35.14 mm ± 4.99 mm in S1 (safety margin of 4.52 mm). The screw diameter rised from 5mm in the mid thoracic spine to 6mm in the thoracolumbar junction and the lumbar spine. The maximum mean diameter was 7 mm, planned in S1.The mean angle in the transversal plane showing the divergent character of the CBT screws from the central canal was highest in L5 ($5.77° ± 2.6°$) and lowest in L1 ($0.50° ± 2.7°$), while the most ascending screws in the sagittal plane were in L4 to S1 (under $-20°$) and near zero or descending in the thoracic spine. **Conclusion:** In this cohort CT-planned and 3D printed drill guides for long cortical bone trajectory screws provided the possibility for accurate screw positioning with safety margins allowing to implant a long enough screw in the biomechanically optimal trajectory in the vertebral body. As the overall standard deviation was low, surgeons may use these data as guidance for navigation or even freehand technique.

2251
A171: Minimally invasive surgery microscopic and endoscopic decompression in patients with lumbar adjacent segment disease

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Introduction: Lumbar Adjacent Segment Disease (ASD) is a common complication following lumbar spinal fusion surgery, causing significant pain and disability in affected patients. Over the years, various treatment options have been explored to address this issue, with Minimally Invasive Surgery (MIS) Microscopic/Endoscopic Decompression emerging as an innovative and promising approach. **Material and Methods:** This study sought to assess the effectiveness of minimally invasive surgical (MIS) techniques, either microscopic or endoscopic decompression, for the management of lumbar adjacent segment disease (ASD). A retrospective cohort design was employed, involving 58 patients with diagnosed lumbar ASD who had undergone either MIS microscopic or endoscopic decompression procedures. Comprehensive clinical data were collected, including details on the affected lumbar segments, types of previous surgeries, time intervals between prior fusion and MIS decompression procedures, and relevant radiological parameters. A one-year post-operative follow-up evaluation was conducted to gauge clinical outcomes. **Results:** From the one-year post-operative follow-up, it was found that most patients with lumbar ASD who underwent MIS microscopic and endoscopic surgery experienced a notable improvement in clinical outcomes. **Conclusion:** In conclusion, our study demonstrates that MIS techniques, including both microscopic and endoscopic decompression, offer a promising and effective approach in the management of patients diagnosed with lumbar ASD. Further research and long-term studies are warranted to validate these outcomes and refine the surgical approach.

OP20: Surgical Complications: Strategies to Minimize Complications

1629
A172: Pseudomeningocele - A rare complication following thoracic spinal decompression surgery: clinical features, treatment guidelines, technical notes, and evaluation of results

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Introduction: Pseudomeningocele (PMC) is an abnormal extradural accumulation of cerebrospinal fluid in the soft tissue of the back, communicating with the subarachnoid space and eventually forming a fibrous capsule. It is well accepted that most asymptomatic PMCs can be observed, but for symptomatic PMCs, optimal treatment remains controversial. Moreover, most studies have described the PMC based

on a small cohort of lumbar and cervical spine patients. Therefore, the aim of this study is to assess the clinical features and treatment of PMC and provide the technical notes with revision surgery in thoracic spine. **Material and Methods:** Between January 2010 and December 2019, patients who developed PMC after posterior thoracic surgery were enrolled. An additional 25 patients who suffered cerebrospinal fluid leakage (CSFL) but did not develop PMC in the same period were randomly selected. General data, intra-operative factors, CSFL position, cost, modified Japanese Orthopaedic Association (mJOA) scores, patient satisfaction, and clinical features were recorded and compared between the two groups. **Results:** Eighteen patients were diagnosed with PMC after thoracic spinal surgery. The average length, width, and depth were 16.25 ± 5.73 cm, 6.96 ± 3.61 cm and 4.39 ± 2.2 cm, respectively. The most common symptom was neurological deficits following incision problems and headache. Compared with the control group, the PMC group showed a longer duration of initial surgery, greater estimated blood loss, an increased rate of CSFL on the ventral side, reduced mJOA scores, and lower patient satisfaction at the final follow-up. **Conclusion:** PMC is a rare complication of thoracic surgery with an incidence of 1.12%. PMC typically occurs at the upper and lower thoracic spine, resulting in increased health care costs, poorer neurological recovery, and a lower rate of patient satisfaction. The management of PMC should be individualized depending on diagnosis time and symptoms.

1686

A173: The quality of sex after posterior lumbar fusion surgery - the most neglected chapter

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Introduction: Sex is one of the most important determinants of quality of life. Lack of satisfactory sex pose stress in everyday life. Low back pain significantly affects the sexual function in both the sex. Literature is sparse regarding the aftermath effect of posterior lumbar fusion surgeries in sexual function though it is the commonest done procedure for various lumbar spine pathologies. We aimed to analyse the influence of these surgeries in the sexual activity. **Material and Methods:** It is a prospective study done in 51 patients (32 male and 19 female) who underwent Posterior lumbar fusion surgery for disc prolapse, stenosis and lysis. Patients with organic sexual disorder, psychiatric illness, trauma, tumour were excluded. Outcome was assessed at the end of 3 months postoperative period using Brief Male sexual function inventory for males and Female sexual function inventory for females along with factors like resuming sex after surgery, favourable position, masturbation. Patients were asked to fill the questionnaires and results were analysed using SPSS software. **Results:** Mean age was 34.31 with range (27-40) and 32.79 with range (25-41) for male and female. There were statistically significant affection of sex after spinal fusion surgery with improvement in sexual activity in male with p value < 0.001 and deterioration in sexual activity in female with p value < 0.001 postoperatively, found using paired t test. Female sexual distress scale (FSDS) showed severe distress in 26.3% and only 5.3% showed very low or no distress at all. Resume of sexual activity in males were 3 weeks post op and females were 4 weeks post op period. Preferred sexual positions in male and female were cowgirl and missionary. 47% of female could involve in masturbation with 36.8% achieved orgasm. Almost 100% of males could involve in masturbation with 100% achieved orgasm but was earlier with pain and frequency was less comparable to preoperative period. **Conclusion:** The overall sexual functions were improved in male and deteriorated in female in early post operative period. Proper counselling has to be given to both male and female regarding various aspects of safe sexual practices for the betterment of mental health and quality of life by the concerned surgeon. Further more studies are needed to support the results obtained.

1414

A174: Study of a novel external anal sphincter recording technique for the prevention of intraoperative bladder and rectal dysfunction

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Introduction: I previously encountered cases where the presence of intraoperative damage could not be assessed, resulting in postoperative cauda equina syndrome. Bladder and rectal dysfunction is a severe intraoperative complication that significantly impacts the patient's quality of life. However, assessing the amplitude of the external anal sphincter (EAS) is often challenging due to its small amplitude. Recently, our department has revisited the monitoring technique for EAS and developed a new recording method. In this study, we compared the conventional method with the new recording method to evaluate their utility. **Material and Methods:** We conducted spinal surgeries in 25 cases (male:female ratio 17:8, average age: 67.2 years) under intraoperative nerve monitoring. The conditions treated included lumbar spinal stenosis in 14 cases, lumbar disc herniation in 5 cases, cervical spondylotic myelopathy and ossification of the posterior longitudinal ligament in 4 cases, and others. We recorded the external anal sphincter (EAS) using Brain-evoked muscle-action potential (Br-MsEP) stimulation. The conventional

recording method, referred to as anal1, involved recording the EAS on both sides using paired needle electrodes. The new recording method, referred to as anal2, measured the potential difference between the EAS and the coccyx. Br-MsEP amplitudes greater than or equal to 30μV were considered effective, and we compared the derivation rates and recorded potentials of anal1 and anal2 as evaluation criteria. We also investigated postoperative complications. **Results:** The derivation rates were anal1:anal2=31.8%:96.0%, with anal2 demonstrating significantly better derivation rates. Additionally, the recorded potentials were 32.4μV:89.7μV, with anal2 being significantly larger (p = 0.00824). Among the two patients with preoperative constipation among those with stenosis, one patient showed improvement in postoperative constipation. No other patients exhibited a decrease in EAS amplitude during surgery, and there were no postoperative bladder or rectal dysfunctions observed. **Conclusion:** In the literature, it is generally considered more useful to record the external anal sphincter (EAS) by inserting needle electrodes directly into the sphincter itself rather than using plug electrodes, mainly due to its association with the circular muscle. However, EAS amplitudes are often small, making assessment challenging. In particular, the lower derivation rate observed with anal1 in this study was attributed in part to the influence of inhalational anesthesia. Conversely, anal2 demonstrated a higher derivation rate compared to anal1 and notably larger amplitudes than reported in other studies. The new recording method appeared to be beneficial even in cases where cauda equina syndrome was detected preoperatively. Furthermore, the larger amplitudes made it easier to assess cauda equina syndrome intraoperatively, suggesting its potential utility in preventing intraoperative EAS nerve damage.

2096
A175: Topical tranexamic acid (TXA) is non-inferior to intravenous TXA in adult spine surgery - A systematic review

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Introduction: Tranexamic acid (TXA) has long been utilized in spine surgery and can be administered through intravenous and topical routes. Although, topical and IV administration of TXA are both effective in decreasing blood loss during spine surgery, complications like deep vein thrombosis (DVT) and pulmonary embolism have been reported with the use of intravenous TXA (ivTXA). These potential complications may be mitigated through the use of topical TXA (tTXA). **Objective:** To assess optimal dosing protocols and efficacy of topical TXA in spine surgery. **Methods:** Embase, Ovid-MEDLINE, Scopus, Cochrane and clinicaltrials.gov were queried for original research on the use of tTXA in adult patients undergoing spine surgery. Data parameters analyzed included blood loss, transfusion rate, thromboembolic and other complications. Data was synthesized and confidence evaluated according to the Grades of Recommendation, Assessment, Development, and Evaluation approach. **Results:** Nineteen studies were included in the final analysis, with 2,197 patients. Of the 18 published studies, 9 (50%) displayed high levels, 8 (44%) displayed low levels, and 1 (6%) displayed moderate levels of evidence. Protocols that used 1g of tTXA in 100 mL saline showed higher post-operative blood loss but lower risk for transfusion than protocols that used more than 1g of tTXA in 100 mL saline when compared to controls, but these findings were not statistically significant (Mean Difference -103.00, Mean Difference, -106.52; Log Risk Ratio -1.05, Log Risk Ratio -0.84, respectively). When comparing ivTXA to tTXA, tTXA showed lower risk for transfusion, and lower risk for complications, however, these associations were also not statistically significant. Complications associated with tTXA included DVTs and wound infections. **Conclusion:** In this systematic review, topical TXA was non-inferior to intravenous TXA with similar efficacy and complication profiles for bleeding control in spine surgery; however, more studies are needed to discern benefits and risks.

2439
A176: Intraoperative neuromonitoring increases perioperative costs for lumbar fusion with no effect on complications and reoperation risks

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Introduction: Several prior studies have been conducted analyzing the utility of all types of intraoperative neuromonitoring (IOM) with a recent emphasis on the overall increase in cost for index posterolateral lumbar fusion (PLF) and the overall impact it has on patient-facing factors such as length of stay. However, there is limited analysis on the relationship of routine IOM electromyography, short-term postoperative cost and incidence of postoperative complications in the context of more complicated index PLF including one or more levels of fusion. **Material and Methods:** The PearlDiver database was used to isolate patients who underwent PLF from the years 2010 to 2018. Patients identified were divided into groups based on the number

of levels fused ranging from 1-level (n = 52,501), 2-level (n = 23,879), 3-level (n = 28,091) and 4-level (n = 1,667). These groups were further subdivided into groups that received IOM and those who did not and were subsequently matched based on age, gender and Charleston comorbidity index. Statistical analyses were performed to determine the impact of IOM on 14-day revision and incidence of neurological signs as well as relative average 90-day postoperative cost, which was further divided by payer to include Medicare, Medicaid and commercial insurers. **Results:** IOM significantly increased the postoperative 90-day cost in almost all levels of PLF, regardless of insurer type, with an average cost increase of 3.9%. There were no significant differences in postoperative neurological signs detected between the groups. The incidence of 14-day revision was significantly increased in patients who received IOM for 2-level PLF (p = 0.004), but the difference was insignificant for one-, three, and four-level PLF (p = 0.22, p = 0.53, and p = 0.89, respectively). **Conclusion:** The use of IOM is commonly used in PLF operations in an effort to decrease the risk of intraoperative neurological injury and short-term complications. This practice has not shown cost effectiveness in our study, and may be of benefit to patients in cases of more complex operations, despite its cost.

2123
A177: Previous lumbar spine fusion increases the risk of complications following total hip arthroplasty in patients with hip-spine syndrome: a systematic review and meta-analysis

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Introduction: With life expectancy on the rise, there has been an increase in patients with concomitant degenerative hip and spine pathology, namely hip-spine syndrome (HSS). Patients with HSS may require both total hip arthroplasty (THA) and lumbar spinal fusion (LSF), but there is a paucity of data regarding how the sequential timing of these procedures may affect outcomes. The aim of this study was to compare postoperative complications and spinopelvic parameters in patients with HSS who underwent either LSF or THA first, as well as to compare these outcomes between patients who have undergone prior LSF with subsequent THA versus THA only. **Material and Methods:** A systematic search of Pubmed and Scopus databases was performed through April 2023. Randomized and nonrandomized studies investigating clinical

outcomes and spinopelvic parameters in patients with HSS who had undergone THA and LSF were included. The Methodological Index for Non-Randomized Studies (MINORS) tool was utilized to assess the risk of bias of included studies. Relevant outcomes were pooled for meta-analysis. **Results:** Ten articles met the eligibility criteria and were included in this study. Six of these studies compared patients who underwent both THA and LSF with specific mention of sequential timing of these procedures. There was a significantly higher hip dislocation rate in patients who had undergone LSF first compared to THA first (OR: 3.54, 95% CI 1.24-10.08, p = 0.02). However, no significant difference was found in terms of THA aseptic loosening (OR: 0.86; 95% CI 0.32-2.32, p = 0.77) and THA revision rate (OR: 1.18, 95% CI: 0.53-2.62) between these two groups. Additionally, 4 studies included comparison of patients who had undergone LSF prior to THA versus THA only. Individuals who received THA only had a significantly lower risk of hip dislocation (OR: 0.14, 95% CI: 0.08-0.25, p < 0.00001) and THA revision rate (OR: 0.22, 95% CI: 0.14-0.36, p < 0.00001) compared to patients with a previous LSF. **Conclusion:** In HSS patients who undergo both LSF and THA, those who receive LSF first are at increased risk of hip dislocation after subsequent THA. Additionally, the relative risks of dislocation and revision rate are significantly lower in patients who have undergone THA only when compared to THA patients with a history of previous LSF. Due to the impact of LSF on spinopelvic biomechanics, caution must be exercised when performing THA in individuals with instrumented spines.

2458
A178: Recovery patterns and de-novo neurological deficits associated with intraoperative neuromonitoring (IONM) alerts in cord level severe spinal deformity surgeries - results from an international multi center prospective Spinal Deformity Intraoperative Monitoring (SDIM) study

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Introduction: To report on the recovery patterns during surgery and the de-novo neurological deficits at discharge associated with IONM alerts during severe spinal deformity surgeries. **Material and Methods:** 20 international centers prospectively documented the intraoperative neuromonitoring, demographics,

radiographic findings, and surgical events of patients undergoing spinal deformity correction based on a standardized created data collection form. Enrolled patients met the following inclusion criteria: age > 10 and < 80 years, neurologically intact, undergoing spinal deformity correction with a major Cobb > 80° or undergoing a posterior column or 3-column osteotomy with EMG, SSEP and MEP monitoring. Detailed neurological examination was performed at baseline, immediately post-op and prior to discharge from hospital. IONM change was defined as a loss of amplitude of > 50% in SSEP or MEP from baseline or sustained EMG activity that lasts > 10 seconds. **Results:** 555 patients, of which 349 (63.9%) were cord level were included. IONM alerts occurred 81 times in 57 cases (16.3%) with 62 alerts of MEP only (33 unilateral, 29 bilateral), 1 SSEP only, 2 EMG only. 10 patients had MEP + SSEP alerts, 5 had MEP + EMG and 1 had all 3 combined. Hence MEP change was found in 78 of 81 alerts, 16 patients had multiple alerts. Out of the 78 MEP changes, 63 (80.8%) recovered fully, 4 (5.1%) recovered on one side, 11 (14.1%) did not recover. Out of the 44 unilateral MEP changes, 8 (18.2%) did not recover and out of the 34 bilateral MEP changes, 3 (8.8%) did not recover on both sides, 4 (11.8%) recovered on one side only. Average recovery time to improved signal on the right and left side was 3.2 (±1.2) and 3.2 (±1.4) [RT1] minutes respectively with the maximum time of 6 minutes for both. A de-novo neurological deficit was defined as postoperative decrease of 1 point from baseline in ASIA Lower Extremity Motor Score (LEMS) and/or worsening in sensory function from baseline and/or presence of spinal cord syndrome, all evaluated at the time of discharge. 13 (22.8%) out of 57 patients who had IONM alert(s) and 14 (4.8%) out of 292 who did not have IONM alerts had de-novo neurological deficits. Worsening of sensory function from baseline was found in 3 (5.3%) out of 57 patients who had IONM alert(s) and 4 (1.4%) out of 292 who did not have IONM alerts and presence of spinal cord syndrome was found in only 1 patient, and they had an IONM alert. **Conclusion:** 57 of 349 (16.3%) patients undergoing cord level surgery for spinal deformities had a total of 81 IONM alerts with 78 MEP changes, 19.2% did not fully recover. 13 (22.8%) out of 57 patients who had IONM alert(s) and 14 (4.8%) out of 292 who did not have IONM alerts (false negatives) had de-novo neurological deficits at the time of discharge.

1060
A179: The effect of intravenous corticosteroid on clinical and radiological postoperative dysphagia in anterior cervical spine surgery: a randomised trial

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Study Design: Prospective, double-blinded, randomized controlled trial design. **Objective:** Aim is to quantitatively assess the impact of perioperative intravenous steroid administration on postoperative dysphagia and prevertebral soft tissue (PSTS) swelling. **Introduction:** Anterior cervical surgeries are usually approached using Smith-Robinson technique. Though a very safe technique, multiple complications such as dysphagia, airway compromise, vocal cord paresis/paralysis, and vascular injury have been reported. Dysphagia is the most common among them with incidence rates ranging from 1% to 79% and is associated with prolonged hospital stays and increased medical costs. **Material and Methods:** Total of 58 patients were randomised into drug (28) and placebo (30) group. Patients in drug group received a total of 3 doses of intravenous dexamethasone: the initial dose of 0.3 mg/kg preoperatively, followed by two doses of 0.15 mg/kg at 8 and 16 hours. Patients allocated to the placebo group received an equivalent volume of saline. The primary aim of assessing dysphagia was done using the EAT-10 score and Bazaz scale, calculated at different time intervals (pre-operative and post-op 1 day, 2 days, 1 week, 1 month, and 4 months). Other clinical scores like mJOA, Nurick, Neck disability Index and VAS score for neck pain were also calculated. Radiological assessment of PSTS was performed through X-ray soft tissue neck lateral views conducted preoperatively and postoperative day 1, 4 months. Multiple other confounding factors and related complications were also noted. **Results:** EAT-10 scores were significantly better in drug group on post-op day 1 and 2 (p value of 0.005 and 0.05) and showed only mild difference at 1 week. By 1 month both groups mean scores were similar. Bazzaz scale also showed similar outcomes. We did not find any statistically significant difference of PSTS values between the two groups. All the clinical outcome scores had improved post-op from pre-op with no significant difference between two groups. During the period of study we did not notice any steroid related complications. **Conclusion:** To summarize perioperative administration of intravenous dexamethasone resulted in a significant reduction in the occurrence of dysphagia during the initial month following an anterior cervical surgical procedure. We could not establish any significant correlation between PSTS and dysphagia scores. It is an efficient, cost-effective and safe method for improving patient outcomes following anterior cervical surgery.

975
A180: Prevention, diagnosis, and management of intraoperative spinal cord injury in the setting of spine surgery: development of guidelines and an evidence-based care pathway

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Introduction: ISCI is a feared and challenging complication in spine surgery. IONM has been developed to detect intra-operative changes in neural function. We report on a multi-disciplinary, international effort through AOSpine and PRAXIS to apply rigorous GRADE methodology to develop a definition for intraoperative spinal cord injury (ISCI), categorise high risk cases for ISCI, quantify the incidence and risk factors for ISCI, establish the sensitivity, specificity and accuracy of the intra-operative neuro monitoring (IONM) modalities gain consensus over use of IONM in high-risk cases and to develop an evidence-based care pathway algorithm for ISCI. **Materials and Methods:** Three literature reviews were registered on PROSPERO and performed according to PRISMA guidelines: 1) Definitions, frequency, and risk factors for ISCI. 2) a diagnostic-test-accuracy (DTA) meta-analysis of the use and accuracy of intra-operative neuro-monitoring for 3) Reported management approaches for ISCI and related events. The results were presented in a consensus session using the GRADE ap-proach with an 80% threshold for inclusion to decide the definition of IONM and recommendation of its use in high-risk cases. **Results:** An operational definition for ISCI, based on literature review and a Delphi-based approach was established: "a new or worsening neurological deficit attributable to spinal cord dysfunction during spine surgery that is diagnosed intra-operatively via neurophysiologic monitoring or immediately post-operatively based on clinical assessment". Reported in-cidence of deficits was higher in intramedullary tumour spine surgery (0-61%) with more persistent deficits (26.9%) com-pared to deformity surgery (0-17.8% and 8% respectively). High-risk patient categories for ISCI were identified: These included rigid thoracic curve with high deformity-angular-ratio, revision congenital deformity with significant cord compression and myelopathy, extrinsic intradural or extradural lesion with cord compression and myelopathy, intramedullary tumor, un-stable fractures (bilateral facet dislocation and disc herniation, extension distraction injury with ankylosing spondylitis, ossi-fication of posterior longitudinal ligament (OPLL) with severe cord compression and moderate to severe myelopathy. The overall sensitivity, specificity, DOR and AUC for SSEP were found to be 71.4% (54.8-83.7), 97.1% (95.3-98.3), 41.9 (24.1-73.1) and 0.899, respectively; for MEP, these were 90.2% (86.2-93.1), 96% (94.3-97.2), 103.25 (69.98-152.34) and 0.927; for EMG, these were 48.3% (31.4-65.6), 92.9% (84.4-96.9), 11.2 (4.84-25.97) and 0.773; for multimodal, these were found to be 83.5% (81-85.7), 93.8% (90.6-95.9), 60 (35.6-101.3) and 0.895, respectively. Using the GRADE approach, the following two recommendations were made: 1) "We recommend that intra-operative neurophysiologic monitoring be employed for high-risk patients undergoing spine surgery" and 2) "We suggest that patients at "high risk" for ISCI during spine surgery be pro-actively identified; that after identification of such patients, multi-disciplinary team discussions be undertaken to manage patients; and that an intraoperative protocol including the use of IONM be implemented." Based on a literature review of management strategies for ISCI an intra operative checklist and care-pathway was developed. **Conclusion:** This is the first evidence based comprehensive guideline and care pathway for the prevention, diagnosis, and management of ISCI using GRADE methodology. This will reduce the ISCI incidence and improve outcomes. We welcome implementation and validation of these guidelines and care pathways in prospective studies.

OP21: Complex Pediatric Deformity

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A181: Distal foundation augmentation enhances the "Bridge" role of single traditional growing rod in the treatment of severe early-onset scoliosis: a retrospective comparative cohort study

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Introduction: Dual traditional growing rod (dTGR) im-plantation may not always be feasible for patients with severe early-onset scoliosis (EOS). The concave single traditional growing rod (sTGR) can serve as a starting construct. Distal foundation augmentation (DFA) with four pedicle screws with a cross-link can increase the spinal control provided by a dTGR. However, DFA has yet to be used with a sTGR. This study investigated the efficiency of DFA in patients with severe EOS who underwent sTGR implantation. **Material and Methods:** From 2010 to 2021, 74 consecutive patients with severe EOS (major curve ≥80°) who underwent tradi-tional growing rod implantation (48 sTGR and 26 dTGR) with a minimum 24-month follow-up were recruited. The sTGR cohort was further divided into two groups by whether or not DFA was performed. In our center, patients who were admitted for sTGR implantation after 2018 routinely underwent DFA. The implantation of a dTGR was based on the severity of thoracic torsion and BMI. Baseline clinical characteristics, complications, and radiographic parameters preoperatively, postoperatively, and at the last follow-up before conversion to a dual rod instrumentation were compared between the three groups. **Results:** There was no significant difference in baseline clinical characteristics between the three groups (p > 0.05). Twenty-four patients in the sTGR cohort underwent DFA. There was no significant difference in preoperative radiographic parameters between the DFA and non-DFA group (p > 0.05). Compared with the non-DFA group, the DFA group had superior results at the last follow-up in terms of maintaining the correction of the major curve (p = 0.001),

maximal kyphosis correction (p = 0.001), the distance between the C7 plumb line and the central sacral vertical line (p = 0.036), and distracting the growing thorax (p = 0.032) and trunk (p = 0.044). Furthermore, the incidence of implant-related complications (p = 0.019), especially at the distal foundation (p = 0.033), was significantly lower in the DFA group. There was no significant difference between the DFA and dTGR groups in radiographic outcomes or complications at the final follow-up (p > 0.05). **Conclusion:** For patients with severe EOS who undergo sTGR implantation, DFA might better maintain the deformity correction, distract the growing spine, preserve balance, and decrease the incidence of implant-related complications. The efficiency of sTGR with DFA was comparable to that of the gold-standard dTGR treatment. Further multicenter randomized controlled trials are needed for more convincing conclusions.

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A182: A prospective multicenter > 2 years clinical study of the active apex correction (APC) technique in early onset scoliosis (EOS) patients

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Introduction: Active apex correction (APC) is a posterior tethering technique for correction of early onset scoliosis (EOS) via reverse modulation at the apex. APC has been increasingly used worldwide. The aim of this study was to assess the short-term outcomes of a multicenter study with ≥ 2 years of APC on spine length, curve correction, complications, unplanned surgeries, and the proposed low incidence of crankshaft phenomena. **Material and Methods:** This is a prospective multicenter study including 25 patients with EOS treated by APC which involves inserting and compressing pedicle screws on the convex side of the apex proximal and distal to the most wedged vertebra allowing modulation of the apex according to the Hueter-Volkmann law. Excluded patients with follow-up <2years and in whom APC was not the primary surgical intervention. **Results:** Mean age 7.11 ± 2.62 years, 68% congenital scoliosis and mean follow-up post-surgery 2.84 ± 1.11 years. At final follow up, there was a statistically significant

improvement in Cobbs angle (Δ = 32.91%, p = 0.0001), spinal length T1-T12 (Δ = 12.72%, p = 0.009) and T1-L5 (Δ = 13.59%, p = 0.003) but not in apical vertebral translation (AVT) albeit clinical improvement (Δ = 12.74%, p = 0.25). 10 complications requiring 3 unplanned surgeries were recorded in all patients including 2 broken rods, 2 adding-on and 4 screw dislodgement. **Conclusion:** APC is a novel technique that has been incorporated in several countries as a treatment modality for EOS. Short-term outcomes are promising in terms of clinical improvement, complication rates and decreased need for multiple operations or unplanned surgeries.

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A183: Traditional versus magnetically controlled growing rods in early onset scoliosis surgical treatment

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Introduction: Growing rod surgeries are common methods in the treatment of EOS. MGR surgery in particular has gained popularity in the last 10 years. The aim of our study is to compare the effects of traditional and magnetic controlled growing rod techniques on the efficacy, safety, spinal growth and lung development. **Methods:** 24 TGR and 17 MGR patients from 2 centers were analyzed retrospectively. Inclusion criterias were patients under the age of 10, if there was a curve exceeding 40° or if there was a progression of more than 10° in the 4-6 month follow-up for curves between 25-40°. Only patients with double growing rods were included in the study. The patients' age at first operation, follow-up period, number of lenghtenings and complications were noted. Major curve Cobb angle, thoracic kyphosis angle, SAL index, sagittal and coronal balance, T1-S1 height values were recorded from preoperative, early postoperative and final follow-up examinations. **Results:** Etiological type of scoliosis, gender distribution, mean age at first surgery and follow-up period and mean preoperative Cobb angle, T1-S1 heigth, coronal balance, SAL index were similar in both groups. There were 9 male and 15 female in the TGR cohort and 7 male and 10 female In the MGR cohort. The mean ages at first surgery were 6.1 and 7.1 respectively. Major curve Cobb angles of TGR were preop. 51.5°, postop. 21.4° and 18.1° at final follow-up. In MGR cohort 60, 4-41, 8-36.4 respectively. In TGR cohort mean T1-S1 heigth were measured preop.

261 mm, postop. 288 mm and 309 mm at the final follow-up. In MGR cohort it was 256 mm - 274 mm - 304 mm respectively. The mean T1-S1 lengthening velocity was calculated as 1.12 cm/year (0.9318 mm/month) in the TGR and 1.27 cm/year (1.0571 mm/month) in the MGR. In TGR cohort 24 initial surgeries, 75 additional procedures (5 lengthening during unplanned surgery due to complications; 4 revision, 1 debridement), a total of 99 procedures were performed. In MRG cohort there were performed a total of 25 surgical procedures, including 17 initial surgeries, 7 additional procedures (3 debridements, 5 revisions). **Conclusions:** In this study, we found that TGR system provided better correction in the coronal plane and was superior in kyphosis restoration than MGR system. No statistical difference was found with the T1-S1 growth rate reported in the healthy population. Although both systems were successful in lengthening. Complication rates were a bit higher in MGR cohort. The most common complication was the pull-out of the proximal anchors, it was more common in the MGR. Both TGR and MGR were found to be effective treatments. Lengthening without surgery is a major advantage of the MBR system, but it has a high revision rate and Cobb angle correction was found to be less effective than the TGR.
Keywords: early-onset scoliosis; traditional growing rod; magnetically controlled growing rod

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A184: Scoliosis in spinal muscular atrophy - Single center review of 28 cases

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Study Design: Cohort Study – Retrospective analysis of prospectively collected data. **Aims and Objectives:** Our study aims to report (i) Presentation and pattern of spinal deformity in a cohort of patients with Spinal muscular atrophy (SMA) (ii) Progression of the deformity in SMA children (iii) Outcomes of treatment. **Introduction:** SMA, is an autosomal recessive disorder affecting anterior horn cells of the spinal cord, producing muscle weakness (proximal more than distal), and leading to extensive disability in the locomotor, respiratory and gastrointestinal systems. In SMA types II and III, scoliosis prevention attempts are made by bracing, administering disease modifying drugs, regular physiotherapy and orthotic management, and, lastly, surgical spine stabilization. Currently, there is no published literature on scoliosis in SMA patients in the Indian population. **Materials and Methods:** Monocentric retrospective analysis of prospectively collected patient data between 2005-2023 was done. All patients underwent Whole spine radiographs at the initial visit and at 6-monthly intervals. Data were obtained regarding functional status (SRS 22, HFMSE and GMFCS

scores), associated orthopedic deformities, pulmonary function, Cobbs progression, and different management. **Results:** A total of 28 patients (M:F = 14:14, age 1 - 19 years) with Type I (n = 1, age - 1 year), Type II (n = 24, mean age - 9.88 years), and Type III (n = 3, mean age – 13.33 years) of SMA confirmed by genetic testing were included. The incidence of scoliosis was 92.85% (26/28) and the mean Cobb angle was 65.76^0 $(20-130^0)$. The mean curve progression was 12.6^0 /year with pelvic obliquity and loss of sitting balance in 71.4% (n = 20/28). 57.14% (n = 16/28) had hip dislocations. 85.71 % (24/28) were on bracing treatment, and the mean Cobb correction was 18^0 $(12-26^0)$. 20 patients were sitters (out of them 14 could only sit with a brace and support), 4 patients could stand but were unable to walk (2 out of them could only stand with some support), 3 patients could walk (1 out of these 3 patients could walk only with some support) and one patient had very poor neck holding & could sit as well. Only 28.51% (8/28) received medical therapy (Nusinersen/Spinraza-2, Evrysdi/Risdiplam - 6), and their curve progression was 5.8^0 /year and showed motor power improvement (improvement in HFMSE and GMFCS scores). One patient received stem cell therapy and her curve practically remained static in follow-up. The degree of vertebral rotation and pelvic obliquity were predictive factors (Pearson coefficient + 1) for the severity of scoliosis. 5 patients underwent surgical stabilization in the form of spinal fixation and deformity correction from D2 - Pelvis. All of the patients who underwent surgery were given a period of pre-operative Halo gravity traction for a mean of 4 weeks (3 weeks - 6 weeks). Post-operatively sitting balance improved in all of them but 3 patients developed poor neck control for which a SOMI brace was advised while sitting. Gradually their neck control improved over the next 3-6 months to. **Conclusion:** Scoliosis in SMA patients' needs regular follow-ups and multidisciplinary management (including newer therapies) to prevent curve progression. Surgery options should be reserved for severe deformity progression with loss of sitting balance.

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A185: Pre and post-operative respiratory function tests in idiopathic early onset scoliosis (EOS) and its correlation to thoracic height gain

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Introduction: Growth sparing surgical strategies like traditional or magnetic controlled growing rods (MCGR) are routinely employed in Early Onset Scoliosis (EOS) to allow for thoracic cavity growth and lung development along with spinal growth. Pulmonary function tests (PFT) including Vital capacity, FVC, FEV1 are measured in such patients to measure improvement of respiratory functions pre and post-operatively. Such growing rods had proven to be effective in neuromuscular EOS patients with improvement in pulmonary functions. However, PFTs in idiopathic EOS have never been studied or reported in literature so far. The general consensus is that the growth sparing methods are associated with an improvement in pulmonary function compared to early fusion. Our aim was to analyse patients with idiopathic EOS and to compare the pre and post-op PFTs to assess whether there is any statistically significant improvements in the lung functions. **Material and Methods:** We conducted a retrospective study of all surgically managed patients with idiopathic EOS with age at diagnosis < 10 years of age. All the patients included in the study had magnetic controlled growing rods (MCGR) inserted when the cobbs angle reached more than 50 degrees and were progressive with growth. The MCGR were sequentially distracted remotely under ultrasound guidance every 3 months and patients with minimum 2 years follow up were included in the study. Demographics, radiological parameters and pulmonary function tests were observed and compared. The FEV1 and FVC were measured, and the age predicted values were calculated along with z score change of FEV1 and FVC pre and post-operatively. The Cobbs angle and T1-T12 height were calculated pre-op, post-op and at 2 years follow up. The correlation between thoracic height gain and change in PFTs were also calculated. **Results:** Overall, 28 patients had underwent growing rods insertion for EOS in 2016-18 at Alder Hey NHS Children's Hospital, Liverpool, UK. 17 idiopathic EOS patients were included in the study. Out of 17, only 8 (2 male, 6 female) patients had a reproducible pre and post-operative pulmonary function tests. The rest of the 9 patients had either just a post-operative PFTs or could not adequately perform PFTs pre-operatively and hence were excluded. The cobbs angle averaged 71 degrees pre-operatively and 35 degrees at 2 years follow-up (p < 0.0001). The average T1-T12 height gain was 2.5 cms with a range of 1.8-3.2 cms (p < 0.0001). Both the mean FEV1 and FVC increased with age (p < 0.0001) due to the lung growth along with MCGR distractions. However, the mean age predicted percentage values were decreased for both FEV1 (79.475 vs 71.075, p < 0.05) and FVC (82.262 vs 72.4, p < 0.01). The z scores were also reduced/negative for both values (p < 0.05). **Conclusion:** This study suggests improvement in FEV1 and FVC with thoracic height gain. A decline in age predicted percentage of FEV1 and FVC were noted, at minimum 3 years post-operatively, inspite of improvement in absolute values with growth. Longer term studies are essential to demonstrate the efficacy of treatment related to pulmonary functions in idiopathic EOS.

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A186: Relationship between preoperative flexibility and postoperative magnitude of unfused lumbar curve in thoracic curve fusion for adolescent idiopathic scoliosis

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Introduction: The flexibility of lumbar curve plays a pivotal role in determining the extent of spinal fusion required for treating adolescent idiopathic scoliosis (AIS) with a major thoracic curve. Conventionally, 25° on bending films is used as a cutoff to differentiate flexible/non-structural and rigid/structural in minor AIS curves. This study aims to disclose the relationship between the flexibility and spontaneous correction of unfused lumbar curves in thoracic curve fusion (TCF) for AIS. **Material and Methods:** A multicenter retrospective radiological analysis was conducted on AIS patients with Lenke types 1, 2, 3 or 4 curves and lumbar modifier B/C who underwent TCF while leaving the lumbar curve unfused. A patient-matched comparison was carried out between two groups: AIS patients of Lenke type 3/4 and Lenke type 1/2 with minor lumbar curve exceeding 40°. Demographic data, including age, gender, Lenke Classification, lumbar modifier and the level of the lowest instrumented vertebra (LIV) were recorded. Preoperative whole spine radiographs, including side-bending images, were obtained, along with postoperative images taken within one week and at one year after surgery. Cobb's angles were measured for all thoracic and lumbar curves and correction rates were calculated. Statistical analysis was performed, utilizing paired t-tests and two-sample t-tests for group comparisons. **Results:** This study compassed 45 patients, divided into Group 1 (Lenke 1/2, n = 25) and Group 2 (Lenke 3/4, n = 20). The magnitudes of lumbar curves in preoperative side-bending films were significantly larger in Group 2 (14.8° ± 6.5° vs 31.4° ± 7.9°, p < 0.01). Perioperative changes in lumbar curve magnitude were similar between the two groups (23.3° ± 3.6° vs 25.5° ± 5.7°, p = 0.576). While perioperative rates of spontaneous correction in unfused lumbar curves were slightly higher in Group 1 (54.95% ± 8.96% vs 49.73% ± 9.95%, p = 0.072), changes (23.72° ± 5.37° vs 24.95° ± 9.78°, p = 0.492) and correction rates (55.3% ± 14.4% vs 50.67% ± 15.65%, p = 0.314) of unfused lumbar curve were similar in both groups one year after surgery. There were no statistically significant differences in

all other parameters measured. **Conclusion:** The correction of unfused lumbar curves following TCF for AIS of major thoracic curves is not significantly related to preoperative flexibility of these lumbar curves. TCF without fusing minor lumbar curve is viable option for AIS patients with major thoracic curves exhibiting more rigid lumbar curves, defined as lumbar curve magnitude exceeding 25° on preoperative side-bending films. However, long-term follow-up is necessary to monitor the potential late progression of unfused lumbar curves, and a larger sample size is needed to validate the generalizability of the finding from this study.

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A187: Split cord malformation and tethered cord syndrome

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Introduction: To date, the description of the natural course of concurrent tethered cord syndrome with a low-lying conus medullaris and split cord malformation is lacking in the literature. We report a cohort of adult and pediatric patients with concurrent malformations and long-term follow-up. **Material and Methods:** Patients with concurrent diagnoses of split cord malformation and tethered cord (radiographic evidence supporting clinical symptomatology) were identified between 2000 and 2020. Patients without sufficient documentation or at least 6-month follow-up were excluded. **Results:** Nine patients were identified with an average of 8.9 years follow-up (range 2-31 years). The most common symptoms were radiating leg pain and lower extremity paresthesias, occurring in 44% of patients; and bladder/bowel dysfunction, worsening scoliosis, and acute motor deterioration were less common. Two patients were successfully treated conservatively for mild leg pain and paresthesias. For those who underwent surgery, all experienced symptomatic relief upon first follow-up. Two had late symptomatic recurrence; one 4 and 8 years after initial surgery; and the other, 11, 26, and 31 years after initial surgery. **Conclusion:** The rarity of concurrent split cord and tethered cord syndrome with a low-lying conus makes management difficult to formulate. This series supplements our knowledge of the long-term outcomes and lessons learned from the management of these patients. Approximately 25% of patients were managed conservatively and had symptomatic improvement. For surgically managed patients, with intractable pain or worsening neurological function, symptoms can still recur over a decade after intervention. Reoperation, however, can still be beneficial, can provide years of relief, and should be considered.

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A188: Is the combination of local infiltration and topical application of tranexamic acid, the newer blood conserving method in adolescent idiopathic scoliosis correction? A randomised control trial comparing efficacy of intravenous versus alternate route administration of tranexamic acid in adolescent idiopathic scoliosis surgery

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Introduction: Intravenous tranexamic acid (ivTXA) has almost become a standard for bleeding management in spine surgery. However, the systemic complications associated with it may be rare but not uncommon. To negate these effects, topical application of tranexamic acid (tTXA) has been used recently with good amount of success. Although local infiltration of tranexamic acid (loTXA) has been used in trauma related haemorrhages, till date there is no literature available examining its efficacy in spinal deformity corrections. The purpose of the study is to evaluate the safety and efficacy of tranexamic acid (TXA) in reducing blood loss during scoliotic deformity correction when administered through intravenous (ivTXA) and combination of local infiltration plus topical application (loTXA+tTXA). **Material and Methods:** 36 patients undergoing instrumented deformity correction for adolescent idiopathic scoliosis (AIS) were randomly assigned to either of (1) intravenous administration of TXA one hour prior to the incision (ivTXA) or (2) local infiltration of TXA bilaterally into paraspinal musculature 5 minutes prior to incision + topical application of TXA before wound closure (loTXA+tTXA) or (3) control group. **Results:** Both the groups were found to be effective blood conserving methods when compared to the control group. Intra-operative blood loss significantly reduced in ivTXA (211.5 ± 60.9 ml, p-value 0.0046) and loTXA+tTXA (210.7 ± 75.4 ml, pvalue - 0.0030) when compared to control group (300 ± 80.5 ml). Post-operative blood loss was least in loTXA+tTXA followed by ivTXA and control. None of the TXA groups required blood transfusions when compared to control group. **Conclusion:** In Instrumented Deformity Corrective Surgeries for AIS, ivTXA and loTXA+tTXA were found to be equally effective in reducing intraoperative blood loss. However, loTXA+tTXA group had better post-operative blood loss control when compared with ivTXA. This is the first study to detail about the efficacy and safety on the combined alternate route (local infiltration plus topical application) of tranexamic acid administration in scoliosis correction surgeries, which is safe and effective in reducing both intraoperative and post-operative blood loss.

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A189: Scoliosis and syringomyelia: clinical, radiological features and therapeutic approach - a study of 41 cases

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Introduction: Syringomyelia and scoliosis frequently coincide, with an overlap observed in a significant portion, roughly 40-60%, of patients diagnosed with syringomyelia. These conditions present complex challenges in diagnosis and treatment. This article explores the clinical and radiological characteristics of 41 cases involving this intricate interplay of conditions and discusses the therapeutic approaches adopted to address them. **Material and Methods:** We conducted a retrospective analysis of the medical records and imaging data for a group of 41 patients diagnosed with both scoliosis and syringomyelia. These patients were selected from our institution's database spanning a 10-year period, from 2010 to 2019. In terms of radiological data, X-rays and magnetic resonance imaging (MRI) were utilized for every patient in the cohort. Our study involved a comprehensive review of the therapeutic approaches employed in addressing this intricate patient population. These approaches encompassed medical management, the utilization of specialized equipment such as spinal braces or orthotics, as well as surgical interventions.

"KYSTE INTRA MEDULLAIRE": "INT-MEDULARY CYST"
"MALFORMATION DE CHIARI": "CHIARI MALFORMATION"
"SCOLIOSE 40-60% DES SYRINX": "SCOLIOSIS IN 40-60% OF SYRINX CAS

Results: Our study's findings illuminate the varied clinical manifestations of syringomyelia within the cohort of 41 cases under analysis. Pain was reported by 34 patients, and neurological symptoms were documented in 38 cases. Additionally, various other symptoms, including torticollis (observed in 4 cases), trophic disorders (noted in 2 cases), and ocular signs (recorded in 3 cases), were identified within this diverse patient population. The location of syringomyelia exhibited diversity, with 25 cases predominantly affecting the cervical region, 10 cases affecting the cervico-dorsal region, and 4 cases in the dorsal region. In two instances, the entire spinal cord was affected. In terms of therapeutic interventions, cranio-cervical decompression procedures were performed in 28 cases, kysto-peritoneal derivations were carried out in 10 cases, and 3 cases were placed under surveillance. Among the cases examined, scoliosis exhibited varying patterns of spinal curvature. Right thoracic scoliosis was observed in 9 cases,

while left thoracic scoliosis was present in 20 cases. Additionally, 8 cases displayed thoraco-lumbar scoliosis, and one case had lumbar scoliosis. Three cases were characterized by double curvature. In terms of treatment strategies, orthopedic treatment was recommended for 8 cases. Surgical intervention, on the other hand, was deemed necessary in a majority of cases, with 33 patients undergoing surgical procedures to correct the scoliotic deformities. **Conclusion:** The possibility of syringomyelia should be considered in the evaluation of any case of idiopathic scoliosis. A systematic neurological examination is imperative in such assessments. Particularly, when encountering cases of left thoracic scoliosis associated with hyperkyphosis, a high degree of suspicion is warranted, and MRI examinations are strongly recommended. These observations emphasize the significance of early detection and appropriate diagnostic investigations to uncover potential underlying syringomyelia in individuals presenting with scoliosis, thereby enabling timely and targeted intervention for improved patient outcomes.

OP22: Degenerative Cervical Myelopathy: Predictive Factors

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A190: Pre-operative expectations of patients with degenerative cervical myelopathy: an observational study from the Canadian Spine Outcomes and Research Network

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Introduction: Despite an abundance of literature on degenerative cervical myelopathy (DCM), little is known about pre-operative expectations of those patients. The primary objective was to describe patient pre-operative expectations. Secondary objectives included identifying patient characteristics associated with high pre-operative expectations and to determine if expectations varied depending on the myelopathy severity. **Material and Methods:** This was a retrospective study of a prospective multicenter, observational cohort of patients with DCM. Patients who consented to undergo surgical treatment between January 2019 and September 2022 were included. An 11 domains expectation questionnaire was completed pre-operatively whereby patients quantified the expected change in each domain expectation. The most important expected change was captured. A standardized expectation score was calculated as the sum of each expectation

divided by the maximal possible score. The high expectation group was defined by patients who had an expectation score above the 75th percentile. Predictors of patients with high expectations were determined using multivariable logistic regression models. **Results:** There were 262 patients included. The most important expectation was preventing neurological worsening (40.8%) followed by improving balance when standing or walking (14.5%), improving independence in everyday activities (10.3%), and relieving arm tingling, burning and numbness (10%). Patient with mild myelopathy were more likely to select no worsening as the most important expected change compared to patient with severe myelopathy (p < 0.01). Predictors of high patient expectations were: having less comorbidities (OR -0.30 for every added comorbidity, 95% CI -0.59- -0.10, p = 0.01), a shorter duration of symptoms (OR 0.92, 95% CI 0.35-1.19, p = 0.02), no contribution from "failure of other treatments" on decision to undergo surgery (OR 1.49, 95% CI 0.56-2.71, p = 0.02) and more severe neck pain (OR 0.19 for 1 point increase, 95% CI 0.05- 0.37, p = 0.01). **Conclusion:** This study showed that most patients undergoing surgery for DCM expect prevention of neurological decline, better functional status, and improvement in their myelopathic symptoms. Stopping neurological deterioration is the most important expected outcomes by patients considering surgical treatment of DCM. Our findings highlight the need for further understanding of patients' pre-operative expectations and studying their effects on post operative satisfaction.

and proprioception sensations. The study analyzed the prevalence and correlations between various somatosensory deficits and the severity of the disease. **Results:** A total of 133 DCM participants were categorized into mild, moderate, and severe subgroups based on their mJOA scores. Among the subjects, 17% were asymptomatic, while proprioceptive deficit (PD) had the highest prevalence at 38%. Thermal sensation was the least common, with a 6% prevalence rate. A strong association between disease severity and both PD and discriminative touch was confirmed. PD exhibited the highest correlation with mJOA and demonstrated a significant relationship with disease progression. PD was found to be present at higher mJOA scores, resulting in an area under the curve of 0.801 in the Receiver Operating Characteristic Curve (ROC) analysis. However, subjects with lower mJOA scores rarely presented with a single type of somatosensory deficit; instead, they tended to exhibit more complex somatosensory deficits. **Conclusion:** This study represents the first comprehensive investigation utilizing objective sensory testing to uncover a new pattern of somatosensory deficits in DCM, which occurs along the disease progression from 'mild' to 'moderate' and 'severe' DCM. Disturbances in the spinal cord may advance from isolated proprioceptive deficit (PD) to more complex impairments. Notably, PD is the most prevalent somatosensory symptom, ranging from mild to severe DCM. These findings highlight the importance of evaluating proprioception in individuals suspected of having DCM to enable early identification and prevent delayed diagnosis and intervention.

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A191: The presence and distribution of sensory changes in Degenerative Cervical Myelopathy

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Introduction: Degenerative cervical myelopathy (DCM) is a common spinal disorder characterized by subtle, non-specific symptoms that may impede patient and healthcare professional awareness, resulting in delayed diagnosis and permanent disabilities. The goal of this study was to investigate the manifestation of somatosensory deficits in DCM to promote early identification and, consequently, prevent delayed diagnosis. **Material and Methods:** Chinese DCM patients aged forty-five or older were evaluated using the modified Japanese Orthopaedic Association Scoring System for cervical myelopathy (mJOA) and a comprehensive somatosensory assessment protocol. This protocol included the examination of superficial pain, temperature, discriminative touch, vibration,

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A192: Exploring recent general anaesthesia as a risk for the onset of degenerative cervical myelopathy

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Introduction: Degenerative Cervical Myelopathy (DCM) is a progressive neurological condition caused by mechanical stress on the cervical spinal cord. Surgical exposure in the preceding months of a DCM diagnosis is a common theme of Patient and Public Involvement (PPI) discussions. We hypothesised that operative exposure might be a risk factor for the development of DCM, through biological mechanisms including neck positioning and intra-operative cord perfusion. **Material and Methods:** To assess this, we conducted a propensity matched case-control analysis using the UK BioBank. UK Hospital Episode Statistics (HES) data for each participant. We defined cases as those with a primary diagnosis (ICD-10) code compatible with DCM. All other

episodes within the cohort were used as controls, and were propensity score-matched by age, sex, and date of episode. We defined the exposure as a primary operation (OPCS-4) code compatible with general anaesthetic. For each hospital episode, we examined the number of exposures within a preceding window period (24 to 6 months). We used a directed acyclic graph (DAG) to uncover and control for potential confounders. We analysed the exposure in terms of absolute number of operations, binarised operations (0 vs ≥ 1), and categorical operations (0 vs 1 vs ≥ 2). **Results:** We analysed 806 DCM and 2287432 non-DCM hospital episodes. Cases and controls were not significantly different in age, date of episode, occupation, or presence of comorbidities (p > 0.1). Cases had a significantly higher male preponderance (57.8% vs 45.8%, p < 0.0001), smoking history (31.2 vs 27.0 pack years, p = 0.0006), and body mass index (28.6 vs 28.2, p = 0.016) than controls. On logistic regression analysis, the risk ratio (2.5%, 97.5%) for the effect of operative exposure on risk of developing DCM was 1.05 (0.985, 1.12) for numerical exposure, 1.36 (1.05, 1.75) for a binarised exposure, and 1.25 (1.07, 1.46) for a categorised exposure. **Conclusion:** This analysis has uncovered recent surgical exposure as a potential risk factor for the development of DCM. The association displays temporality, dose-response relationship, and biological plausibility at an epidemiological level. Further work is needed confirm the basis of this observation, and establish if it can be used to modify clinical trajectories.

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A193: Radiological factors associated with increased intramedullary signal intensity based on X-ray and MRI - Implications in our understanding of degenerative spondylomyelopathy

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Introduction: Increased intramedullary signal intensity (IISI) on T2 weighted MRI scan (T2WI) in patients with Degenerative Cervical Myelopathy (DCM) can be a radiological feature of spinal cord damage. However, the association of IISI to degeneration of the spinal column remains unclear in literature. The purpose of this study was to determine the prevalence of IISI and analyze the independent relationship between IISI and cervical degenerative parameters in patients with and without DCM. **Material and Methods:** A retrospective review of MRI, X-ray, and radiology data for 144 adult patients with DCM with both cervical MRI and X-ray scans was conducted. A total of 39 patients with IISI was identified. The remaining 105 patients without IISI made up the control group. **Results:** IISI was prevalent in 27.1% of patients and most frequent in C6-C7 cervical levels. The likelihood of having IISI was 1.947 (Exp(B) 1.947, 95%CI [1.004-3.776]) times higher in segmental levels with facet joint degeneration. There was an increased likelihood of IISI within the spinal cord with increasing age (Exp(B) 1.034, 95%CI [1.008-1.060]), maximum spinal cord compression (MSCC) (Exp(B) 1.038, 95%CI [1.003-1.075]), rotational angle (Exp(B) 1.082, 95%CI [1.020-1.148]) and posterior herniation width (Exp(B) 1.333, 95%CI [1.017-1.747]) and decreasing Torg-Pavlov ratio (Exp(B) 0.010, 95%CI [0.001-0.068]). **Conclusion:** IISI had a prevalence in 27.1% of DCM patients. Increased age, facet joint degeneration, MSCC, rotational angle, posterior herniation width and decreasing Torg-Pavlov angle were found to be independently associated with IISI. Radiological degenerative changes associated with IISI indicate value in the assessment of patients with possible DCM.

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A194: Reintervention in a cohort of patients operated for degenerative cervical myelopathy

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Introduction: To analyze reoperation rate and reasons for reoperation in a cohort of patients operated for degenerative cervical myelopathy (DCM). **Material and Methods:** A total of 175 consecutive patients who underwent surgery for DCM at Geneva University Hospital between 2008 and 2023 were analyzed regarding reintervention rate and postoperative complications. **Results:** The reoperation rate was 19.4% (34/175) with a mean time to second surgery of 552.5 ± 919.6 days. Median age at first surgery was 59.5 years [range: 34-79 years]. The main reason for reintervention was persistence of stenosis in 29.4% (N = 10) followed by a postoperative hematoma (N = 6, 17.6%). The most performed second procedure was anterior cervical discectomy and fusion (ACDF) (N = 6, 17.6%), as well as hematoma evacuation (N = 6, 17.6%) and posterior fixation with decompression (N = 5, 14.7%). Eight patients (23.5%) underwent a third procedure in a mean time of 361.3 ± 759.9 days. The most performed procedure at third surgery was posterior fixation and decompression (N = 3, 37.5%) and the main reason was persistence of stenosis. Overall, these 34 patients underwent 76 surgical procedures with a postoperative hematoma rate of 9.2% (N = 7), postoperative infection rate of 3.9% (N = 3), and hardware revision rate of 6.6% (N = 5). **Conclusion:** Reoperations in DCM might be related to

postoperative complications in the short term, while in the long term they seem to be due to further treatment of the disease by anterior or posterior approach. This may be related to the persistence of cervical stenosis, as well as the development of a new stenosis elsewhere.

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A195: Cervical spinal cord signal changes in the absence of apparent compression indicate dynamic insult-insights from load-bearing positional sitting MRI in patients with degenerative cervical myelopathy

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Introduction: Degenerative cervical myelopathy (DCM) often manifests with MRI-detected cord signal changes, even in the absence of apparent cord compression at the level of compression. To understand the reasons behind these signal changes, we conducted a comprehensive study using positional MRI in supine and sitting with neck in flexion and extension. This investigation aimed to explore dynamic compression and associated MRI signal changes resulting from positional alterations. **Materials and Methods:** Study included a specific cohort of 10 DCM patients exhibiting cord signal changes without evident cord compression on MRI. These patients underwent sitting MRI with their necks in neutral, flexion, and extension postures. The cross-sectional area of the cord, disc bulge and ligamentum flavum thickness at the levels of cord signal changes using Image J software. These measurements were then compared between offloaded supine MRI and loaded sitting positions. **Results:** Cervical Cord signal changes without obvious compression is commonest at C3-4 level (six out of ten). All patients showed evidence of dynamic compression corresponding to cord signal changes during the sitting MRI. Dynamic compression due to increased disc bulge (more prominent during sitting in a neutral position) was seen in six patients, and ligamentum flavum thickness was notably increased during sitting with neck in extended position. Stretching of the cord against the disc was noted during flexion, and buckling of the ligamentum flavum was observed during extension at the level of cord signal changes, indicating ongoing dynamic compression. Sitting in a neutral position worsened disc bulge by 48% whereas ligamentum flavum thickness increased by 25.4%. Sitting in flexion increased disc bulge by 14.5%, where as extension in sitting position increased ligamentum flavum thickness 30.9%. It was interesting to note that the flexion in sitting position significantly worsened the disc bulges at lower

cervical levels whereas extension in sitting position increased ligamentum flavum thickness at all cervical levels. **Conclusion:** DCM patients with spinal cord signal changes but without apparent cord compression on supine MRI exhibited significant spinal cord compression under axial loading. This research unravels the aetiology of cord signal changes in the absence of overt cord compression. The identification of dynamic compression, notably through ligamentum flavum buckling during sitting with the neck in extension and increased disc bulge during sitting with the neck in neutral, challenges traditional diagnostic and therapeutic approaches. These findings deepen our understanding of DCM's pathophysiological mechanisms and aid in determining surgical management strategies, especially considering stabilization in addition to decompression.

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A196: Impact of T1 slope as a predictor of the loss of cervical lordosis and health-related quality of life after laminoplasty in patients with ossification of the posterior longitudinal ligament

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Objective: Laminoplasty is a widely used surgical method for the management of multilevel ossification of the posterior longitudinal ligament (OPLL). Loss of cervical lordosis (LCL) was identified as potential risk factors associated with suboptimal postoperative results. This study aims to identify the risk factors associated with LCL in patients with multilevel OPLL following laminoplasty and analyze their relationship with Health-Related Quality of Life (HR-QoL) scores. **Materials and Methods:** We retrospectively collected data from patients who underwent laminoplasty from January 2013 and December 2022 at Chonnam National University Hospital. Occupying ratio of OPLL, K-line, C2-C7 SVA, center of the gravity of head to C7 SVA (CGH-C7 SVA) and T1 slope (T1S), cervical lordotic angle (CLA), ROM of cervical spine, extension capacitiy, flexion capacity, extension ratio, TK, PI, LL, C7 SVA, PI-LL were meausre in preoperative, postoperative, 6 months, 1 year, and then annually follow-up. HR-QoL and clinical outcome evaluations was performed through nVAS, aVAS, EQ5D score, NDI score, JOA score in preoperative, postoperative, 6months, 1year, and then annually follow-up. The group with LCL of -10 or less was classified as the more-LCL group, while the group with LCL greater than -10 was classified as the less-LCL group. We retrospectively analyze the preoperative radiologic values related to LCL and the preoperative radiologic values related to HR-QoL. **Results:** We analyzed the data of 109 patients (92 males, 17

females; mean age 60.31 ± 10.80 years). More-LCL group experienced a deterioration in both the nVAS score and the JOA score following laminoplasty than less-LCL group (Δ nVAS: 0.57 ± 1.85 vs 3.01 ± 1.37; Δ JOA score: -0.91 ± 3.30 vs 2.05 ± 2.77, p < 0.001). Multivariate longistic regression analysis showed that the patients with high T1S had a higher probability of developing LCL (OR, 1.420; p < 0.001), the lower the extension ratio, the higher the probability of developing LCL (OR, 0.883; p = 0.019), and the higher PI-LL, the higher the probability of developing LCL (OR, 1.091; p = 0.023). T1S was identified as a excellent predictor, with a cut-off value of 27.80° associated with increased LCL risk (p < 0.001, AUC = 0.918, sensitivity = 0.826, specificity = 0.872) at Receiver Operating Characteristic (ROC) curve analysis. Analyzing the relationship between LCL risk factors and subsequent change in JOA score showed that T1S was the only LCL risk facotors associated with change in JOA score after laminoplasty ($\beta = -0.278$, p = 0.007). **Conclusion:** In patients with multilevel OPLL who underwent laminoplasty, a postoperative LCL of -10° or less was associated with a poor clinical outcome. LCL tended to increased as the T1 slope increased, the extension ratio decreased, and the PI-LL increased. Of these, T1S is correlated with the clinical outcome after laminoplasty, and the higher T1S, the worse the clinical outcome, and its cut off was 28°. Thus, a T1S over 28° should be considered a significant factor when performing laminoplasty in patients with multilevel OPLL.

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A197: Influence of regional and global sagittal radiographic parameters on the preoperative disability in degenerative cervical myelopathy

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Introduction: Interaction of regional and global sagittal parameters in cases of DCM (Degenerative cervical myelopathy) along with their impact on myelopathy severity has not been thoroughly investigated. In this study we intend to analyze the correlations of sagittal alignment parameters and preoperative disability in operated cases of DCM. **Material and Methods:** We analyzed 55 operated DCM cases from March 2019 to April 2021 using whole spine standing radiographs. Regional cervical parameters included- cervical lordosis (CL), C2-C7 sagittal vertical axis (C2-C7 SVA), T1 slope(T1S) and T1S-CL. Global alignment and lumbopelvic parameters included sagittal vertical axis (SVA), thoracic kyphosis, lumbar lordosis, pelvic incidence, pelvic tilt and sacral slope. The modified Japanese Orthopaedic Association (mJOA) scoring

system, Nurick grading, VAS score were used for clinical evaluation. Statistical correlation between the clinical and radiographic parameters were analyzed. **Results:** There was significant sequential correlation between the spinopelvic parameters. Preoperative disability had strongest correlation with the SVA (r = 0.54, p < 0.001) and T1S-CL (r = 0.41, p < 0.001). Other significant correlations included CL (r = -0.31, p < 0.001), T1 slope (r = 0.21, p < 0.01), and C2 C7 SVA (r = 0.20, p < 0.03). No direct relationship between the cervical and spinopelvic parameters could be established. **Conclusion:** Preoperative myelopathic disability worsens with global sagittal malalignment represented by a larger SVA. Sequential correlations exist between the spinopelvic parameters and cervical parameters indicating indirect effect of lumbopelvic alignment on myelopathy severity. Surgical strategy for DCM should be carefully selected considering global balance.

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A198: Prognostic value of conventional MRI and diffusion tensor imaging in surgically treated degenerative cervical myelopathy patients

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Introduction: Degenerative cervical myelopathy (DCM) is a common cause of acquired spinal cord impairment and surgical decompression remains an important treatment option. There is no valid and standardised method to incorporate quantitative radiological findings into the assessment of the patient's prognosis. We aimed to analyse the usefulness of MRI [compression ratio (CR), transverse area (TA), signal intensity ratio (SIR)] and DTI [fractional anisotropy (FA), Apparent diffusion coefficient (ADC), Relative anisotropy (RA), Volume ratio (VR)] indices in predicting the prognosis in DCM patients, managed surgically and to study percentage change in the MRI and DTI indices following surgery, and if there is any correlation of these parameters with clinical outcome. **Material and Methods:** 66 patients of DCM managed surgically were enrolled. Pre op assessment included clinical (mJOA score, Nurick grade, NDI and VAS scores) and radiological (MRI and DTI scans) parameters. Clinical parameters were recorded at 1 month and at final follow up scans were repeated and clinical parameters noted. Patients were divided into group A (poor outcome) and group B (good outcome) based on clinical recovery (mJOA recovery rate). **Results:** 66 patients were available for final follow up at 4months. Group A had 28 patients and group B had 38. All the clinical parameters improved more in group B compared to group A, with significant p values. Post-operative MRI

parameters of CR and SIR improved significantly in both groups, while TA improved only in group B. Change in TA in group A (52 ± 0.53 mm^2) was significantly higher as compared to group B, having a strong association with outcome. All baseline and final DTI values between groups were comparable, with no significant association with outcome. Area under the ROC curve (AUC) was calculated for 14 parameters, showed only percentage change in TA has an acceptable discriminatory power and is the best predictor of good outcome (cut off value >52.74 mm^2). Subgroup analysis based on pre op mJOA and Nurick done showed pre op ADC had significant association with outcome in moderate myelopathy (mJOA subgroup). AUC for Nurick subgroup showed pre-operative ADC and percentage change in TA was the best predictor of good outcome in mild and moderate subgroup respectively. AUC for mJOA subgroups showed percentage change in TA and pre-operative ADC was the best predictor of good outcome in mild and moderate myelopathy subgroup respectively. **Conclusion:** Among all the radiological parameters only change in TA had significant AUC values. There was some potential for DTI to pick up myelopathy early before MRI and clinical scores revealed them, but nothing conclusive. Subgroup analysis showed pre-operative ADC and change in TA predicted outcome, suggesting that radiological prognostication can be more feasible in mild and moderate cases than severe. Further research and larger studies are needed to validate these results and determine the clinical utility of MRI and DTI in prognosticating cervical myelopathy patients.

OP23: Degenerative Spine

17
A199: The effective analysis of percutaneous endoscopic interlaminar discectomy in the treatment of L4/5 intervertebral disc herniation

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Introduction: The purpose of this study was to analyze the safety and effectiveness of percutaneous endoscopic interlaminar discectomy in the treatment of L4/5 intervertebral disc herniation. **Material and Methods:** This prospective study included 36 patients diagnosed with L4/5 intervertebral disc herniation between December 2018 and July 2020 who were scheduled to undergo minimally invasive surgery: group A underwent percutaneous endoscopic transforaminal discectomy (PETD), and group B underwent percutaneous endoscopic interlaminar discectomy (PEID), after which we

analyzed the effectiveness of PEID in the L4/5 segment. **Results:** A total of 36 patients with an average age of 32.1 ± 14.7 years (16 to 65 years), and an average course of disease of 24.6 ± 10.3 months (6 to 60 months), were enrolled. There was no difference in operation time between group A and group B ($p > 0.05$). However, the average fluoroscopy time of group B was shorter compared to group A ($p < 0.05$). The Visual Analogue Scale (VAS) scores of patients with low back pain and lower limb pain did not significantly differ between the two groups preoperatively, and 24 hours, 72 hours, 3 months, and 1 year after the operation ($p > 0.05$); however, they all significantly improved ($p < 0.05$). Also, there was no significant difference in Oswestry disability index (ODI) scores between the two groups ($p > 0.05$) preoperatively, and 3 months and 1 year after the operation; however, they all significantly improved ($p < 0.05$). **Conclusion:** PEID is a safe and effective treatment method for L4/5 intervertebral disc herniation.

203
A200: "Giant" calcified thoracic disc herniations and its operative outcome - a study of 24 cases

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Introduction: Thoracic disc herniation (TDH) though a rare occurrence (0.15-4%) causes significant neurological deficit. Labelled as Giant if herniated disc occupies > 40% of canal. Calcification is seen in 42% of herniations and intradural extension in 70%. Incidence of myelopathy in Giant TDH ranges from 70-95%. There is a lot of confusion regarding surgical approach and technique to be used in treating these cases. We present our experience of using a unique technique through posterolateral approach for extracting giant calcified thoracic disc. **Material and Methods:** The study included 24 patients of Giant calcified TDH who were operated by posterolateral approach (trans-facetal/trans-pedicular/costotransversectomy approach) and with a post-operative follow up of at least 2years. We retrospectively reviewed the clinico-radiological aspects from the records of these 24 patients who were operated at our institute and were followed up with serial clinical examination and radiographs taken at 1, 3, 6months, 1year and 2years to assess the progress. Clinical parameters taken into account were age, sex, diagnosis and neurological assessment using Frankel grading system, surgical approach, instrumentation, surgical time, post-operative mobilization and peri-operative complications. Radiological assessment included taking pre-operative X-ray, CT and MRI scans and

post-operative radiographs taken immediate post op, at 1, 3, 6 months, 1year and 2years. Radiological parameters studied were location, number of levels affected and percentage canal encroachment. The study was conducted after taking consent from all participants and has been approved by the ethics committee of our institute. The study included only those patients with calcified thoracic disc herniations and patients with non-calcified soft disc herniations were excluded from the study. **Results:** Of 24 patients 18 were male and 6 were female. Mean age was 39.62 years. Most common level was T11-12. Mean canal occupancy was 58.2%. Neurological improvement was seen in 22 patients with no worsening in any of them. There were total 6 complications with 3 dural tears and 3 with suture site infections which were managed appropriately. Mean level of instrumentation was 4.25 levels. Mean duration of surgery was 3.708 hours with mean blood loss of 1.17litres. **Conclusion:** Calcified thoracic disc herniations though a rare entity if not properly diagnosed and treated in time can cause irreversible damage. Study was done to show the method of approaching giant calcified TDH and its long-term outcome. Anterior approach is technically difficult and not everyone can master it as compared to posterolateral approach which is a commonly used approach in most surgeries. Since easy to master, with few modifications as shown above can be used effectively in resecting giant calcified TDH thereby minimizing the complications. The above study is done to promote and encourage surgeons to safely carry out resection of Giant TDH using the modified posterolateral approach technique.

Keywords: giant thoracic disc herniation, calcified disc, posterolateral approach

2179

A201: Exploring non locking standalone cages for anterior cervical discectomy and fusion (ACDF) - Debunking the clinically irrelevant complication called "subsidence"

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Background and Aim: The objective of this study is to examine the short and long term impact of subsidence after anterior cervical discectomy and fusion for compressive cervical disc disease, utilizing solely non-locking stand-alone titanium cage and to analyse the fusion rates. **Methods:** The single-center retrospective study included one and two-level Anterior cervical discectomy and fusion (ACDF) cases from July 2014 to June 2019. Minimum 2-year follow-up was included and titanium cage with autologous bone graft was used. Interbody height (IBH), subsidence and fusion rates were analysed at follow up. Clinically, VAS score for neck and

arm, mJOA score for myelopathy, C2-C7 cobb angle for lordosis improvement were analyzed. **Results:** A sample of 118 patients, was subjected to analysis. The fusion rate was observed to be 96.6%. Eleven instances of subsidence were observed at the 3-month follow-up (p = 0.89). All 11 patients with subsidence had excellent/good functional outcomes on analyzing Odom's criteria. The study observed a noteworthy enhancement in the (VAS) for neck and arm pain, as well as in the (mJOA) score among patients with myelopathy, with a statistical significance of p < 0.05. There was significant reduction in IBH in the subsidence group in comparison to non-subsidence group. Segmental kyphosis angles were also seen to be higher in the subsidence group (p < 0.05). **Conclusion:** According to our study, the subsidence observed did not have a significant clinical impact on outcome scores or patient satisfaction. The utilisation of a stand-alone cage devoid of screw or plate instrumentation has demonstrated favourable long-term outcomes with nearly complete fusion rates. Furthermore, there is no significant difference in outcomes between the subsidence and non-subsidence groups.

Keywords: subsidence; standalone cage; ACDF; cervical DDD; titanium; discectomy; fusion

1387

A202: Comparing outcomes following posterior cervical spine fusions of three or more levels using two different head positioning systems

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Introduction: Head positioning is critical during posterior cervical spine fusion surgery. Bivector traction (BVT) can be used to elevate the head and stabilize the spine, but it requires cables attached to weights to provide traction forces, which are cumbersome and decrease operative space for the surgical team and intraoperative imaging modalities. A recently developed electronically controlled mechanical head positioner (EMHP) allows for controlled intraoperative movements by the surgeon alone without compromising the surgical field. We have noticed an anecdotal trend toward utilizing EMHP over BVT at our institution due to the ease of use, particularly in cases involving intraoperative o-arm based navigation. However, there is currently no data in the literature regarding the EMHP. The goal of this study was to compare pre- and postoperative radiographic spinal parameters and clinical outcome measures for patients who underwent three-or-more level posterior cervical fusion using BVT and the EMHP. **Material and Methods:** We retrospectively reviewed a list of cervical fusions performed by the senior author between 1/1/

2009 and 7/31/2022. Medical records were reviewed to collect demographic and surgical information, head positioner used, and preoperative and minimum six-months postoperative Neck Disability Index (NDI) scores. Pre- and post-operative C2 slope, T1 slope, cervical lordosis, and C2-C7 sagittal vertical axis (SVA) were measured on radiographs. Outcomes of BVT and EMHP cases were then compared. **Results:** A total of 57 patients (16M:41F) were included. Mean age at surgery was 61.0 ± 10.2 years and BMI 29.1 ± 6.6 kg/m^2. EMHP was used in 33 cases (57.9%) and BVT in 24 (42.1%). The average number of levels fused posteriorly was 6.6 ± 2.5; and was higher in the EMHP group versus the BVT group (7.5 vs. 5.3, p < 0.001). Mean operative time (minutes) per level fused was shorter in the EMHP group versus the BVT group (58.7 vs. 70.6, p = 0.10). One patient experienced minor nasal bleeding after their head slipped from the EMHP intraoperatively, which resolved spontaneously prior to completion of the case. Cervical lordosis, T1 slope, and SVA changed significantly in the EMHP group after surgery versus none in the BVT group. Mean preoperative and postoperative NDI scores did not differ significantly between the groups. NDI improved 7.9% in the EMHP group (p = 0.027) versus 10.3% in the BVT group (p = 0.012) at minimum six-month follow-up. We found that the change in NDI scores was strongly correlated with the change in SVA (p = 0.005), and linear regression resulted in the following equation: change in NDI = 4.97*change in SVA – 11.34 (p = 0.002). **Conclusion:** We found both the EMHP and BVT allowed for substantial changes in all radiographic cervical measurements analyzed in this study. NDI improved in both groups, and the change strongly correlated with the change in SVA. While the EMHP has been preferred due to ease of use and efficiency, our results suggest that either head positioner is acceptable in posterior cervical deformity correction surgery.

821

A203: Effective modulation of inflammation and oxidative stress for enhanced regeneration of intervertebral discs using 3D porous hybrid protein nanoscaffold

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Introduction: Degeneration of fibrocartilaginous tissues is often associated with complex pro-inflammatory factors. These include reactive oxygen species (ROS), cell-free nucleic acids (cf-NAs), and epigenetic changes in immune cells. **Material and Methods:** To effectively control this complex inflammatory signaling, it developed an all-in-one nanoscaffold-based 3D porous hybrid protein (3D-PHP) self-therapeutic strategy for treating intervertebral disc (IVD) degeneration. The 3D-PHP nanoscaffold is synthesized by introducing a novel nanomaterial-templated protein assembly (NTPA) strategy. **Results:** 3D-PHP nanoscaffolds that avoid covalent modification of proteins demonstrate inflammatory stimuli-responsive drug release, disc-mimetic stiffness, and excellent biodegradability. Enzyme-like 2D nanosheets incorporated into nanoscaffolds further enabled robust scavenging of ROS and cf-NAs, reducing inflammation and enhancing the survival of disc cells under inflammatory stress in vitro. Implantation of 3D-PHP nanoscaffolds loaded with bromodomain extraterminal inhibitor (BETi) into a rat nucleotomy disc injury model effectively suppressed inflammation in vivo, thus promoting restoration of the extracellular matrix (ECM). The resulting regeneration of disc tissue facilitated long-term pain reduction. **Conclusion:** Self-therapeutic and epigenetic modulator-encapsulated hybrid protein nanoscaffold shows great promise as a novel approach to restore dysregulated inflammatory signaling and treat degenerative fibrocartilaginous diseases, including disc injuries, providing hope and relief to patients worldwide.

1552

A204: The long-term impact of deformity correction with direct vertebral rotation on intervertebral disc degeneration in adolescent idiopathic scoliosis

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Introduction: The association between intervertebral disc degeneration (DD) and unfused lumbar segments have been reported in Harrington's Era. However, there have been conflicting results of intervertebral DD after introduction of pedicle screw instrumentation (PSI) in adolescent idiopathic scoliosis (AIS). This study is aimed to assess the long-term degenerative change of intervertebral disc in the patients with AIS who underwent PSI with rod derotation (RD) and direct vertebra rotation (DVR). **Material and Methods:** A total of 48 AIS patients who underwent PSI with RD and DVR (minimum 5-year follow-up period) were included and divided two groups along with DD: DD group (n = 20), non-DD group (n = 28). Pfirrmann classification were assessed in whole-spine magnetic resonance imaging to assess intervertebral DD and endplate changes, respectively. **Results:** The 41.7% of DD and 4.2% of modic change were observed on mean 11.6 years of follow-up period. The Cochrane-Armitage trend test showed the statistical significance between Pirrmann grade and DD in adjacent LIV (p = 0.003), L4-5 (p = 0.003), and L5-S1 (p < 0.001). The preoperative thoracic kyphosis in

DD group (22.0°) was significantly lower than in non-DD group (31.4°) (p = 0.025). The Pearson's correlation analysis showed significant moderate correlation with preoperative thoracic kyphosis (r = 0.433, p = 0.002), adjacent LIV (r = 0.428, p = 0.003), and L4-5 (r = 0.423, p = 0.003), and high correlation with L5-S1 (r = 0.604, p < 0.001). **Conclusion:** Intervertebral DD in adjacent LIV, L4-5, and L5-S1 were observed on long-term follow-up in AIS patients who underwent PSI with RD and DVR. The preoperative thoracic hypokyphosis was also moderately correlated with long-term intervertebral DD after deformity correction with DVR in AIS.

1584

A205: Circulating extracellular matrix proteins - A potential biomarker for intervertebral disc degeneration

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Introduction: At the molecular level, disc degeneration (DD) has been associated with dissociation of matrix assembly, leading to the loss of structural integrity. We hypothesize that as a result of matrix dissociation, tissue ECM proteins are expected to leak into the peripheral blood via neovascularization of degenerate discs. In this study, we aim to develop plasma biomarkers for disc degeneration by detecting extracellular matrix proteins. **Methodology:** This is an experimental case-control study. To identify the IVD tissue, ECM proteins leaked into plasma, global proteomic analysis was performed on 10 healthy volunteers (HV) and 10 degenerate disc subjects (DD) after depletion of highly abundant proteins such as Albumin and IgG. Tandem mass spectrometric analysis of the plasma samples was performed by Q Exactive™ Plus Hybrid Quadrupole-Orbitrap™ Mass Spectrometer based on the mass/charge ratio. For the separation of peptides, a capillary RSLC column (EASY-spray column pepMap® RSLC, C18, 2μm, 15cm x 50 μm, 100 A° particle size) was used. Samples were loaded onto pre-column (Acclaim PepMap®100, C18, 3μm, 15cm x 75 μm, 100 A° particle size) prior to analytical column separation. Linear gradient separation was followed from 5% B to 100% B over 90 min at a constant flow rate of 300 nL/min. Positive mode electrospray ionization with an ion spray voltage of 1.8 kV, capillary temperature of 270˚C, RF lens voltage of 50, and maximum injection time of 50 ms. Following the mass spectrometric acquisition, the files are in the raw format. Raw data (. raw/.msf files) obtained from the machine was subjected to protein identification using Proteome Discoverer vs

2.5 along with in-built SequestHT and Mascot search engines. Proteins with high peptide confidence and peptide rank 1 were considered for the entire analysis. **Results:** Based on stringent parameters, 28 proteins were identified in plasma as matrix-associated proteins identical to the proteins found in intervertebral disc tissues. Of which, 26 were present in DD, and 21 in HV. Among these candidates, Aggrecan (ACAN) and fibulin 1 (FBLN1) were found to be up and downregulated significantly in the DD group. Interestingly, diseased plasma had a specific expression of COL2A1, native to the nucleus pulposus. **Conclusions:** The upregulated and unique presence of ACAN (aggrecan) and COL2A1 (collagen type 2A1) respectively in diseased plasma remains indicative of intervertebral disc disease degeneration and could be a reliable biomarker for DD. This identification also could aid in a better understanding of disc degeneration.

922

A206: Role of endoscopic sampling and debridement in improving clinical and economic outcome in patients with suspected tubercular spondylodiscitis

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Introduction: Spinal infections resulting in Spondylodiscitis is a severe condition requiring often long periods of work absenteeism and long periods of antibiotic therapy. Patients suffering from Tubercular spondylodiscitis often come from poor socio-economic background and can rarely afford consequences financially. Amongst rising incidence of drug resistance, microbiological diagnosis by means of tissue sampling is necessary. We sought to evaluate role of Endoscopic debridement and sampling in providing rapid pain relief and early return to work in patients of suspected Tubercular Spondylodiscitis. **Material and Methods:** We inducted 60 patients of working population of suspected tubercular spondylodiscitis (based on clinical and MRI evaluation) in our institute which is based in rural part of North India from a period of Jan 2022 till July 2023. We excluded patients with mechanical instability and neurological deficit. The patients who underwent Endoscopic debridement and sampling were compared to those who were subjected to Transpedicular biopsy and conservative treatment. Both the procedures by a single surgeon at a single centre. Patients treated endoscopically were subjected to endoscopic transdiscal biopsy through posterolateral approach and bilateral portal debridement while other patients. The patients were compared in terms of demography, mean monthly income, period of work absenteeism, cost of entire treatment, pain after 1 week, 6 weeks and 3 months of starting therapy and any complications. **Results:** The patients were aged between 21

years and 52 years and were comparable across genders. Patients who underwent Endoscopic treatment were able to return to work much earlier (62.86 days ± 16.64) than other patients. The cost of treatment in such patients was found to be higher by Rs. 12064 ± 64.98. However they required a shorter hospital stay (2.4 days ± 0.8). These patients were able to save an average of Rs. 19672 ± 342.88. 97% of patients treated by Endoscopic procedures were able to retain their jobs as compared to 63% of other patients. Patients of these groups had significantly better pain relief after 1st week (3.3 ± 0.54), 6th week (2.1 ± 0.33) and 3rd month (1.6 ± 0.28). **Conclusion:** Patients with Spondylodiscitis respond better to Endoscopic debridement in terms of pain relief and early return to work. This is especially important for patients in job workforce in developing nations who are often the primary earning members of their family. The increase in cost of procedures is clearly offset by the lowered risk of job loss and earning from reduced work absenteeism. We understand that this scenario will be different in places with high social security, use of health insurance and specific labor laws. More studies are required per geographical boundaries to study impact on medical economics in such cases.

1400
A207: Predictors and postoperative complication risks for revision discectomies following primary lumbar miscrodiscectomy

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Introduction: Lumbar microdiscectomies (MD) are among the most common spine procedures in the USA. Patients may, however, develop subsequent reherniations requiring revision discectomy. The objective of this study is twofold: 1) outline demographic and clinical features predictive of need for revision discectomy and 2) compare postoperative complication profiles between primary MD and revision discectomy. **Material and Methods:** Patients who underwent a primary lumbar MD from 2010 to 2021 were identified using the PearlDiver National database. Patient diagnoses and procedures were obtained using International Classification of Disease, Ninth and Tenth Revision (ICD-9 and ICD-10) and Current Procedural Terminology (CPT) codes. Exclusion criteria were as follows: myelopathy, fusion procedures, simultaneous cervical surgery, trauma, infection, and malignancy. Patients who underwent subsequent revision discectomy were separately identified. Univariate analysis was performed to identify demographic differences, followed by multiple logistic regression to identify independent

predictors for revision discectomy. Nearest-neighbor 1:1 propensity-matching was conducted to match primary MD and revision discectomy cohorts by age, sex, Elixhauser co-morbidity index (ECI), obesity, smoking, number of levels, and other comorbidities. Postoperative complication rates were compared using Pearson's chi-squared analysis with odds ratios (ORs). **Results:** Overall, 49,681 patients underwent primary lumbar microdiscectomy (52.5% male, 47.5% female) with 3,114 (6.27%) requiring subsequent revision discectomy (53.2% male, 46.8% female). On average, patients undergoing revision discectomy were slightly younger (49.7 ± 14 vs. 47.9 ± 13 years; p < 0.001) and more frequently associated with smoking (21.9% vs. 26.7%; p < 0.001), obesity class I (13.4% vs. 14.9%; p = 0.019), excessive alcohol use (6.4% vs. 7.8%; p = 0.002), coagulopathies (5.6% vs. 6.5%; p = 0.035), depression (37.4% vs. 44.3%; p < 0.001), and preoperative opioid use (60.9% vs. 64.4%; p < 0.001). Male sex (OR:1.08, 95%CI: 1.00-117; p = 0.04), smoking (OR:1.23, 95%CI: 1.13-1.34; p < 0.001), depression (OR:1.32, 95%CI: 1.22-1.42; p < 0.001), and persistent postoperative opioid use (OR:1.10, 95%CI: 1.01-1.19; p = 0.034) as independent predictors for revision discectomy. Revision discectomy was further associated with greater risk of neurological complications (OR:1.43, 95%CI: 1.21-1.71; p < 0.001), epidural hematoma (OR: 5.356, 95%CI: 1.56-18.4; p = 0.006), disc reherniation at all timepoints (all p < 0.001), and need for further decompression at six-, eight- and ten years postoperatively (all p < 0.05). **Conclusion:** Predictors for revision discectomy after primary lumbar MD included male sex, obesity, smoking, and depression. Patients undergoing subsequent revision discectomy were at significantly greater risk for short-term perioperative complications, as well as subsequent disc reherniation and need for further decompression out to ten years postoperatively.

OP24: Lumbar Degenerative: Identifying & Managing Complications

1522
A208: Sexual dysfunction after primary anterior lumbar interbody fusion in women: results of a retrospective survey of 84 patients

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Introduction: Anterior lumbar interbody fusion (ALIF) is a well-established and effective treatment method for patients with chronic back pain due to spondylolisthesis or neural compression. However, the surgery can lead to nerve damage

and sexual dysfunction, a complication that has rarely been studied in women. We investigated the incidence and associated factors of sexual dysfunction in women after primary ALIF. **Methods:** This observational study included female patients aged between 18-60 years who underwent a primary ALIF surgery at 1-2 levels between L4-S1 between January 2015 and October 2022 in a high-volume centre. Patients were contacted by postal survey in February-March 2023 and asked to complete and return a specially designed questionnaire. The data collected were analysed using descriptive statistics and multivariable logistic regression. The study was approved by the local ethics committee (BASEC-ID 2022-01832). **Results:** Of 167 contacted patients, 84 (52.0%) responded and were analysed. The mean age at surgery was 46.3 years (standard deviation [SD] 10.0), the level of fusion was L4/L5 in 6.0%, L5/S1 in 78.6% and L4/L5+L5/S1 in 15.5%. The fusion material was Inductos in 82.1%, pelvic crest in 14.3%, and Redygraft/Crunchychips in 3.6%. The mean follow-up time (from surgery to survey) was 4.1 years (SD 2.2). Approximately two thirds of patients (n = 55, 65.5%) reported no change in sexual function, 23 (27.4%) reported a worsening, 2 (2.4%) reported an improvement and 4 (4.8%) were unsure. Among patients with a worsening of sexual function, the most common sexual problems were dyspareunia (60.9%) and impairment of libido (47.8%). Preliminary regression analysis revealed no association of age, level of surgery, fusion material and time since surgery with occurrence of worsened sexual function. Of patients with a worsened sexual function, 60.9% would have the surgery again, compared to 93.4% of patients with no/unclear change or improvement. **Discussion:** The risk of sexual dysfunction after ALIF appears to be considerable and is associated with lower satisfaction with the ALIF-surgery. Adequate and sufficient patient education is essential for an informed decision for ALIF surgery.

1354

A209: Systematic review and meta-analysis of the effect of osteoporosis on reoperation rates and complications after surgical management of lumbar degenerative disease

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Introduction: Currently, there is considerable heterogeneity of findings and lack of consensus with respect to the interplay of osteoporosis and postoperative outcomes of patients with lumbar degenerative spine disease. Therefore, the purpose of this systematic review and meta-analysis is to gather and analyze the current data on the effect of osteoporosis on radiographic, surgical, and clinical outcomes following surgery for lumbar degenerative spinal disease. **Material and Methods:** Following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, we performed a systematic review to determine the effect that a diagnosis of osteoporosis has on the incidence of adverse outcomes following surgical intervention for lumbar degenerative spine disease. First, the Medline (PubMed) database was queried from 1990 through August 2022 using the following terms: "osteoporosis" AND "lumbar" AND ("outcomes" OR "revision" OR "reoperation" OR "complication"). Statistical analysis was performed using the Comprehensive Meta-Analysis program (Version 2). The effects of different studies were summed using the random effects model. Variables included in the study were either (1) categorical or (2) means with reportable standard deviations. **Results:** Following the screening process, 38 articles were included in the final systematic review and 16 in the meta-analysis. The results of the meta-analysis suggest that osteoporotic patients experience increased rates of adjacent segment disease (p = 0.015) and cage subsidence (p = 0.001). However, reoperation rates were found to be lower in osteoporotic patients (7.4% vs 13.1%, p = 0.038). The systematic review also indicates that length of stay, overall costs, rates of screw loosening, and rates of wound and other medical complications may be increased in patients with lower bone mineral density. Fusion rates, as well as patient-reported and clinical outcomes, do not seem to differ significantly between osteoporotic and non-osteoporotic patients. **Conclusion:** In summation, our systematic review and meta-analysis was able to demonstrate that osteoporosis was associated with an increased risk of postoperative screw loosening, adjacent segment disease, and cage migration, as well as having longer hospital stays, incurring larger costs, and developing postoperative complications; however, we were unable to establish a link between osteoporosis and decreased clinical outcome scores. Further research should focus on prospective associations between osteoporosis and postoperative outcomes and endeavor to enroll more osteoporotic patients as part of study cohorts to be able to reliably capture its effect on these patients.

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A210: Loss of lumbar lordosis affects proximal spine first

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Introduction: The research landscape on regional lumbar alignments has evolved rapidly with a specific focus on loss of lordosis. However, few studies have attempted to characterize how and where lumbar lordosis (LL) is lost. Therefore, the purpose of this study is to quantify how much LL is lost in the proximal and distal lumbar spine in patients with degenerative spine disease, and how this may relate to muscle health. **Materials and Methods:** After describing the classic parameters, the cohort's normative L1PA, L4PA, global and regional lordosis were calculated using age-and PI-adjusted formulas. PI-LL offsets from norm were used to create 3 alignment groups: 74 pts with Mild (Mld), 55 pts with Moderate (Mod), and 26 pts with Severe (Sev) mismatch. The range of motion (ROM) of L1-S1, L1-L4, L4-S1 were calculated from flexion/extension films. The 3 alignment groups were then analyzed and compared. **Results:** 155 pts were included (age 56 ± 16, BMI 29.26 ± 5 kg/m2, 57% F) with the following sagittal alignment: PI = $55.4 \pm 10°$, PI-LL = $8.35 \pm 11°$, PT = $20.62 \pm 8°$, L4-S1 = $30.6 \pm 9°$, L1PA = $11.17 \pm 7°$, and L4PA = $11.44 \pm 4°$. Compared to age-and-PI adjusted values, our cohort had a loss of LL (ΔPI-LL: $12.0 \pm 9°$) due to both proximal and distal segments (ΔL1-L4: $-7.1 \pm 8°$; ΔL4-S1: $-4.5 \pm 9°$) leading to a more anterior spine (ΔL1PA:$1.0 \pm 5°$; ΔL4PA:0.4 ± 2) (all p < 0.01). The 3 alignment groups had no differences in sex (p = 0.14), age (p = 0.667), and PI (p = 0.658). Compared to the Norm, patients in "Mld" (PI-LL offset from norm = $4.1 \pm 3°$) had a significant loss of LL in the proximal segments (L1L4: $20.2°$ vs $23.9°$ p < 0.01) but none distally (L4S1: 35.3 vs 35.2 p = 0.9); they also had a slight anterior translation of L1 (L1PA: $8.2°$vs $7.8°$ p = 0.041). Patients in "Mod" (PI-LL offset from norm = $14.4 \pm 3°$) had $8.5°$ loss in the proximal segments (L1L4: $14.6°$ vs $23.1°$ p < 0.001) and $3.8°$ in the distal segments (L4S1: $29.1°$ vs $34.8°$ p < 0.001); L1 vertebra translated anteriorly (L1PA: $11.6°$vs 7.8 p < 0.001) but not L4 (L4PA: $11.3°$ vs $10.7°$ p = 0.06). Finally, patients in "Sev" (PI-LL offset from norm = $29.4 \pm 6°$) had a $14°$ loss of lumbar lordosis both in the proximal (L1L4: $9.8°$ vs $23.8°$) and distal segments (L4S1: $20.4°$ vs $35.2°$); the lumbar spine translated anteriorly as showed by L1PA ($17.9°$ vs $7.8°$, p < 0.001) and L4PA (13.2 vs 11.1, p < 0.001). The "Sev" patients also had a smaller L4-L5 disc heigh (9.03 vs. 11.05mm p < 0.01), less ROM at L4S1 ($6.3 \pm 5°$ vs $10.0 \pm 6°$ vs $11.0 \pm 7°$ p < 0.001), without significant difference in L1S1 ROM. There were no significant differences across groups in muscle CSA (4332 vs 4051 vs 4396, p = 0.332) or Goutallier classification (p = 0.412), but there was a significant difference in Lumbar Indentation between "Mld" and "Mod" (14 vs 10, p = 0.02). **Conclusion:** Our study showed that in a degenerative population the loss of lumbar lordosis begins proximally and progresses to affect the distal portion of the curve.

Furthermore, we noticed that the loss in curvature distally is characterized by the spine translating anteriorly, a reduction in disc space and a loss in distal range of motion.

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A211: Patterns and preferences of fusion selections in the treatment of lumbar spondylolisthesis among spine surgeons

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Introduction: Lumbar degenerative spondylolisthesis is a common clinical condition that spine surgeons across the globe treat routinely. Patients with symptomatic lumbar spondylolisthesis may present with significant variations of clinical presentation and radiographic findings that impact surgeons' treatment decisions. Age-related and other medical and anatomical considerations may alter surgeons' surgical strategies. The current study aims to understand how often surgeons decide to fuse in lumbar spondylolisthesis based on differences in clinical, radiographical, and patient factors. Additionally, the study aims to reveal patterns and preferences of various fusion types from surgeons worldwide. **Material and Methods:** Three lumbar spondylolisthesis cases were electronically presented to AOSpine international members to study surgeons' preferences for treatment considerations. Case 1 included an elderly patient with mainly radiculopathy and severe central stenosis without dynamic instability, case 2 included a younger patient with mechanical back pain and radiculopathy with severe central and neuroforaminal stenosis and significant instability on dynamic x-rays, and case 3 had an older patient with back pain and radiculopathy with instability on dynamic x-rays without severe central stenosis. Data collected includes demographics, training background, years of experience, and treatment decisions based on various radiographical findings, including segmental measures

and global and spinopelvic parameters. The survey was distributed online to over 6000 AO Spine members between July 27 – September 8, 2023. 943 responded, and 479 completed the survey. Responses to questions about decision-making parameters and surgical technique preferences in treating grade 1 L4-5 spondylolisthesis were collected and analyzed. Comparative analysis was performed using the Pearson Chi-Squared Test. **Results:** In all cases, fusion was the preferred treatment among all surveyed surgeons. Even without dynamic instability and mainly radiculopathy, 75.2% responded that they would fuse. Selection of fusion methods were distributed widely across all cases, ranging from 0.3% to 20.2% in case 1 with radiculopathy without dynamic instability, 0.5% to 17% in case 2 with back pain, and radiculopathy associated with dynamic instability with severe central and neuroforaminal stenosis, and 0.2% to 21.8% in case 3 with back pain and radiculopathy associated with dynamic instability without central or neuroforaminal stenosis. Overall, posterolateral fusion with direct decompression was the most common procedure among surveyed surgeons in patients with severe central stenosis without dynamic instability, followed by MIS transforaminal interbody fusion and posterior lumbar interbody fusion (PLIF). On the other hand, anterior and lateral approaches for fusion are less commonly chosen across all three cases. Dynamic instability was associated with increased utilization of anterior lumbar interbody fusion and lateral transpsoas or pre-psoas interbody fusions. There were no significant differences between orthopedics vs. neurosurgery, fellowship vs. no fellowship, academic/university practices vs. private practices, or < 15 years experience vs. > 15 years experience in selecting their surgical approaches. **Conclusion:** Fusion remains the most preferred procedure for treating lumbar degenerative spondylolisthesis by spine surgeons around the globe, and most surgeons favor posterolateral fusion with direct decompression in spondylolisthesis, followed by MIS TLIF and PLIF. There were no significant differences in the selection of fusion methods by subspecialty, fellowship status, practice setting, and years of experience.

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A212: A comparative study of superior facet joint violation with pedicle screw in minimally invasive percutaneous fluoroscopy guided vs robotic assistance in transforaminal lumbar interbody fusion: a short term prospective study

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Introduction: Superior facet joint violation during pedicle screw insertion will lead to adjacent segment degeneration.

Previous studies had compared facet joint violation in open & MIS technique. No study available in literature comparing facet joint violation in Robotic (Excelsius GPS) & MIS in Lumbar TLIF. **Material & Methods:** We studied 63 patients (33 Robotic & 30 MIS) prospectively and analysed facet joint violation & pedicle breach using a CT based grading system (Yson & Gertzbein Robbins). Demographic details & clinical outcome compared among these two groups. radiation exposure of patient & health care staff is also compared. **Results:** The overall incidence of facet joint violation in robotic group is 16.6% & MIS group is 13.33%. (p = 0.601) All the facet joint violation were Grade 1 in both the groups. In our study we found the accuracy with respect to mediolateral breach (Grade 0, 1) to be higher with Robotic group (98.09%) than MIS group (83.56%) (p value = 0.00078). The rate of radiologically significant pedicle breach (grade 2, 3) was more in MIS than robotic group (16.42% (23/140) vs 2.52% (4/158)). The mean total radiation exposure (preoperative & intra operative) to the patient in robotic TLIF is more than MIS group 10.57 >> 3.13 (mSv), whereas the mean intraoperative radiation exposure to the health care staff is more in MIS group 2.93 > 1.356 (mSv). **Conclusion:** This study demonstrates no major difference in facet joint violation in Robotic & MIS groups. Robotic assisted navigation effectively increases pedicle screw accuracy, safety & less radiation exposure to the health care staff than MIS group.

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A213: Nationwide trends in operative management of low-grade, stable degenerative lumbar spondylolisthesis

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Introduction: Operative management strategies for low-grade, stable degenerative lumbar spondylolisthesis remain disparate across spine surgeons, with dichotomous practices pertaining to the use of decompression alone versus decompression with fusion. Decompression with fusion is currently the gold standard, but recent literature suggests equivalent outcomes for patients treated with decompression alone with significant reductions in healthcare expenditures. The purpose of this study is to describe the recent utilization, demographics, complications, and revisions for patients with DLS undergoing decompression or decompression with fusion in the USA (US). **Material and Methods:** Patients who underwent lumbar decompression and fusion (n = 82,287) or lumbar decompression alone (n = 89,409) between 2010-2022 for DLS were queried from the PearlDiver National database.

Demographic and procedural data were identified using ICD-9, ICD-10, and CPT codes. Patients with prior history of lumbar spine surgery, undergoing osteotomy or corpectomy, and with surgical indications for cauda equina, instability, isthmic spondylolisthesis, trauma, malignancy, or infection were excluded. Nearest-neighbor propensity-score matching was performed with student's t-test and chi-squared analysis to assess continuous and categorical data. Conditional logistic regression analysis was utilized to assess risk of 30-day complications, readmission, opioid usage, and revision rates. **Results:** Overall, 171,696 patients were identified between 2010 and 2022, of which 82,287 underwent lumbar decompression and fusion (61.4% female) and 89,409 underwent decompression alone (52.1% female). Annual utilization between 2010-2021 revealed a 402.6% increase in lumbar decompression with fusion compared to only 84.8% increase in decompression alone. Patients undergoing fusion and decompression were younger (62.6 ± 11.2 years vs. 64.3 ± 10.9 years, $p < 0.001$) with lower Elixhauser Comorbidity Index scores (4.7 ± 3.4 vs 5.0 ± 3.4, $p < 0.001$), but had a greater proportion of severe obesity (12.4% vs 11.9%, $p < 0.01$) which was defined as a BMI of 40 or higher. Propensity-matched analysis identified 82,285 patients from each cohort, wherein decompression alone conferred decreased five-year revision risk (OR: 0.45, $p < 0.001$), 30-day complications (OR: 0.83, $p < 0.001$), surgical complications (OR: 0.79, $p < 0.001$), and medical complications (OR: 0.66, $p < 0.001$). There was increased risk of opioid use for the combined lumbar decompression and fusion cohort at 90- (OR: 0.79, $p < 0.001$) and 180-days (OR: 0.74, $p < 0.001$). **Conclusion:** Although patients who underwent decompression and fusion were younger and exhibited less comorbidities compared to those who underwent decompression alone, the latter conferred decreased risk of post-operative complications and revision surgery. Nonetheless, decompression with fusion increased over four times the rate of decompression alone for management of DLS over the last decade within the US. Given recent high-level evidence that decompression alone may be non-inferior to decompression with fusion for management of DLS, these findings present a potential opportunity to significantly reduce healthcare expenditures and improve post-operative outcomes on a nationwide scale.

2029
A214: Relationship between the postoperative variations of paraspinal muscles and adjacent segment degeneration in patients with degenerative lumbar spinal stenosis after posterior instrumented lumbar fusion

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Introduction: This study aimed to quantify pre- and postoperative paraspinal muscular variation following posterior lumbar interbody fusion (PLIF) in degenerative lumbar spinal stenosis (DLSS) patients and measure the association of this variation with adjacent segment degeneration (ASD). **Material and Methods:** Data from 149 patients who underwent L4-S1 PLIF for DLSS were collected. Patients were divided into radiological ASD and control groups according to follow-up radiological materials. Magnetic resonance imaging (MRI) was performed before surgery and at the last follow-up. Muscular parameters including relative cross-sectional area (rCSA), relative functional cross-sectional area (rFCSA), relative total cross-sectional area (rTCSA), and fatty infiltration (FI) of the multifidus (MF), erector spinae (ES), and psoas major muscles (PS) were measured on preoperative and follow-up MRIs of L2-S1. Logistic regression was used to investigate risk factors for ASD. **Results:** The rate of radiological ASD was as high as 42.3% at the final follow-up (25.71 ± 8.35 months). At surgical levels, the rFCSA and rTCSA of the MF and ES decreased. The FI of MF and ES significantly increased after surgery, while the rFCSA and rTCSA of the PS increased and its FI decreased. At adjacent levels, the rFCSA and rTCSA of the MF and ES decreased and their FI increased postoperatively ($p < 0.05$), but the rFCSA and rTCSA of the PS increased and their FI decreased ($p < 0.05$). The FIs of the MF, ES, and PS at adjacent levels significantly differed between the ASD and control groups. Logistic regression analysis indicated that higher body mass index ($p = 0.003$) and FI of PS at adjacent levels ($p = 0.025$) were significant risk factors for ASD. **Conclusion:** Functional area decreased in MF and ES and increased in PS after L4-S1 PLIF. Compensatory postoperative decrease in FI of PS at the adjacent level was a protective factor for ASD in DLSS patients after PLIF.

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A215: Assessment of deviation from preoperative planning and accuracy in transpedicular screw fixation using intraoperative 3D navigation for lumbar spondylolisthesis

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Introduction: In recent years, intraoperative navigation systems have been increasingly employed in lumbar spine surgery. With these systems, the surgeon can perform preoperative planning and visualize the real-time trajectory of the screws, with significant advantages in terms of safety and operative time. The aim of this study was to evaluate the rate of deviation from preoperative planning and to assess the presence of any correlations between pedicle screw deviation and accuracy in patients affected by degenerative spondylolisthesis (DLS). **Material and Methods:** Patients affected by DLS who underwent posterior lumbar interbody fusion (PLIF) using intraoperative 3D navigation with preoperative screw planning since April 2022 were included. Intraoperative cone-beam computed tomography (CBCT, LoopX, Brainlab, Germany) was performed prior to screw planning and following implantation in all cases. The deviation from planning was assessed by calculating linear, angular, and three-dimensional (3D) discrepancies between the planned screws and implanted screws. Pedicle screw accuracy and facet joint violation (FJV) were evaluated using the Gertzbein-Robbins system (GRS) and Yson classification, respectively. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 26. The Pearson correlation coefficient was calculated to correlate deviation parameters with GRS for each screw. The Spearman's test was used to assess the relationship between the deviation and GRS for individual spinal levels. Statistical significance was set at $p < 0.05$. **Results:** This study involved 26 patients with a mean age of 64.23 ± 7.5 years, for a total of 120 pedicle screws. The deviation from the planning was evaluated for 116 pedicle screws. The mean two-dimensional linear deviation of the screw tip in the mediolateral, craniocaudal, and anteroposterior directions was 2.54 ± 2.52 mm, 1.65 ± 1.67 mm, and 2.9 ± 2.8 mm, respectively. The mean 3D deviation of the screw tip was 4.92 ± 3.27 mm. A correlation was found between 3D screw tip deviation and a lower vertebral level ($p = 0.032$). The mean two-dimensional linear deviation of the screw head in the mediolateral, craniocaudal and anteroposterior directions was 1.85 ± 1.83 mm, 1.72 ± 1.67 mm and 3.58 ± 3.14 mm, respectively. The mean 3D deviation of the screw head was 4.98 ± 3.22 mm. The mean deviation of the angular component on the axial plane was $3.58° \pm 3.9$, while on the sagittal plane it was $3.85° \pm 3.48$. Significant correlations were found between the deviation in the anteroposterior direction of the screw tip and head with a lower GRS ($p = 0.02$ and $p < 0.001$, respectively). 97.48% of screws were clinically acceptable (grade A+B). Regarding FJV, 97.48% of the screws were evaluated as grade 0, 1.72% as grade 1 and 0.82% as grade 2. A significant correlation was found between a lower vertebral level and GRS ($p < 0.001$). **Conclusion:** Our results showed a reasonable rate of linear screw discrepancy between the planned screw and the positioned screw on a 3D level. Despite this difference, pedicle screw accuracy was clinically acceptable in almost all cases. Therefore, pedicle screw fixation using intraoperative CBCT, 3D navigation and screw planning is safe and accurate.

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A216: A comparison of transforaminal lumbar interbody fusion (TLIF) cage material on fusion rates: a systematic review and network meta-analysis

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Introduction: A wide variety of materials are used for lumbar interbody fusion, each with their own purported strengths and weaknesses. Several studies have examined the fusion rates of these materials, but there is no unified consensus on the superiority of one material over another. The aim of this systematic review and network meta-analysis (NMA) is to compare and rank the various TLIF interbody materials based on fusion rates. **Material and Methods:** We queried PubMed, EMBASE and Scopus from inception to August 2023 for relevant studies on lumbar interbody fusion outcomes using various commercially available interbody materials, which 2,135 studies were identified. Inclusion criteria were applied for selecting eligible studies based on the PRISMA guidelines, while studies with the expandable cage and the use of bone morphogenic protein (BMP) were excluded. The fusion assessment employed the Bridwell's criteria by using computed tomography (CT) scan or radiographic x-ray with a length of follow-up of at least 12 months. The NMA was conducted to compare multiple approaches from multiple studies through both direct and indirect comparisons using the frequentist framework with STATA16. Results including treatment contrasts were illustrated by a network plot, a forest plot with odds ratio (OR) and 95% confidence interval (CI), as well as surface under the cumulative ranking (SUCRA). **Results:** In total, 13 TLIF studies involving 1,919 patients with 1,981 lumbar interbody levels fulfilled our eligibility criteria. There were seven different cage materials were utilized: polyetheretherketone (PEEK, reference), allograft, autograft, PEEK with titanium coating (TiPEEK), titanium, carbon/carbon fiber reinforced polymer (CFRP) and 3D-printed titanium. The average patient age was 60.9 (SD = 7.5) years old. Local bone graft, demineralized bone matrix and hydroxyapatite/tricalcium phosphate were used in 1,236, 111 and 20 lumbar levels, respectively. Lumbar fusion was assessed using CT scan or radiographic x-ray at a follow-up of 12 months or more. When compared to PEEK, the other six materials did not have a significantly different rate of lumbar fusion; however,

the 3D-printed titanium (SUCRA = 0.8) had the highest probabilities of being the best material for fusion rates. TiPEEK (SUCRA = 0.6) was found to be the second-best material, followed by Ti (SUCRA = 0.5) and allograft (SUCRA = 0.5). The highest probability of being the worst material was PEEK (SUCRA = 0.3). **Conclusion:** Based on a network meta-analysis within the confines of our clinical study, 3D-printed titanium interbody cage appears to have the highest probability of being the best material for promoting fusion in a TLIF.

OP25: Non-Operative Care

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A217: A virtually delivered Tai Chi and Qigong program for chronic and lower back pain: a randomized control trial

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Importance: Heal and Strengthen the Spine with Tai Chi and Qigong (HSSTQ), a fully integrated and virtually-delivered stillness-and-movement mind-body intervention, has not been rigorously evaluated for adults with chronic low back pain (CLBP). **Objective:** To evaluate the effectiveness of HSSTQ at improving physical function, pain, sleep quality (SQ), and quality of life (QOL). **Design, setting, and participants:** This randomized, single-blind clinical trial compared virtually-delivered HSSTQ (n = 175) to usual care (n = 175). Community-dwelling adults primarily from the New York City area aged 21-92 years with CLBP were recruited from July 28 to September 5, 2022. The virtual program was delivered from September 22 to December 19, 2022. Follow-up surveys were completed by January 30, 2023. Eligible participants were at least 18 years old; had experienced CLBP for at least 6 weeks proceeding study enrollment; understood written and spoken English; were willing to complete the 8-, 12-, and 16-week surveys; were not pregnant; had not previously taken tai chi classes; and had not undergone spine surgery within the last 6 months. **Intervention:** HSSTQ was virtually-delivered in 60-minute biweekly group classes for 12 weeks. Both randomization groups continued to receive usual care throughout the study. The waitlist control group received the intervention after the conclusion of the treatment group program. **Outcomes:** The primary outcome was physical function limitation due to CLBP as measured by the Oswestry Disability Index (ODI). Secondary outcomes included pain (measured by two Visual Analog Scale [VAS] questions), SQ (measured by the Pittsburgh Sleep Quality Index [PSQI]), and QOL (measured by the 36-Item Short Form Health Survey [SF-36]). Outcomes were assessed at baseline and 8, 12, and 16 weeks. **Results:** Of the 350 study participants, 278 (79%) were female; mean (SD) age was 58.8 (14.8) years; the survey was completed by 244 (69.7%), 248 (70.9%), and 238 (68%) participants at 8, 12, and 16 weeks, respectively. Fifty (28.6%) of the 175 intervention group participants attended at least 18 of 24 sessions. Primary outcome analyses indicated a significant difference in the rate of improvement between randomization groups on all follow-up outcome measures. Specifically, the treatment group showed a greater weekly decrease in the ODI score compared to the control group (p < 0.001). Additionally, model-derived estimates demonstrated consistent improvement in the treatment group across all time points. Secondary outcome measures also showed significant improvements in the intervention group. The intervention group demonstrated significantly greater improvements in VAS (by 0.65, 0.93, and 1.22 points), PSQI (by 0.62, 0.82, and 1.02 points), and SF-36 (by 8.62, 11.74, and 14.86 points) compared to the control group at 8, 12, and 16 weeks, respectively. **Conclusions:** Among adults with CLBP, treatment with virtually-delivered HSSTQ resulted in greater improvement in physical function, pain, SQ, and QOL throughout the 12-week intervention compared with usual care. Improvements persisted one month after treatment concluded. These findings suggest that HSSTQ may be an effective treatment option for patients with CLBP. HSSTQ can be adapted for patients who have recently undergone spine surgery or other medical treatments.

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A218: Effect of anti-osteoporotic therapies on lumbar interbody fusion in postmenopausal osteoporotic females

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Introduction: There is a high rate of postoperative mechanical complications, which impairing the life quality of patients, and the resulting revision surgery also becomes a huge challenge to spinal surgeons. Among the reasons for mechanical complications, osteoporosis is an indispensable

factor, which is commonly seen in the elderly and post-menopausal females due to oestrogen deficiency, characterized by a decrease in bone mass and density. Therefore, it is extremely important to give anti-osteoporotic treatment for patients with osteoporosis who undergo lumbar fusion surgery. Recombinant human PTH (1-34), namely teriparatide, has already been approved as a treatment for severe osteoporosis, which results in the promotion of osteoblast differentiation, and has been reported to increasebone mineral density (BMD) in patients with osteoporosis. Denosumab, which suppresses osteoclast-mediated bone resorption as an inhibitor of RANKL, has been used to treat osteoporosis in recent years. However, the knowledge of the effects of denosumab, teriparatide, and combined therapy on lumbar fusion were inadequate in previous studies. This study aims to evaluate the effects of denosumab, teriparatide and their combination on the bone metabolism, BMD and fusion after transforaminal lumbar interbody fusion (TLIF) in postmenopausal females with osteoporosis. **Material and Methods:** Ninety-nine postmenopausal female with osteoporosis who underwent single-level TLIF with cement augmented pedicle screw fixation were included. Patients were categorized into teriparatide (T) group, denosumab (D) group, negative control (NC) group, and combination therapy (C) group. The age, menopause time, height, weight, body mass index, surgery segment were collected and compared between groups. The fusion rate, femoral neck T-scores, VAS, ODI scores were recorded at preoperation, 6, 12 months after surgery. The bone turnover markers (BTMs) of serum P1NP and CTX were recorded at preoperation, 3, 6, 12 months after surgery. **Results:** T-scores increased over 12 months in all three treatment groups but decreased in group NC, with the largest increases observed in the group C. Compared to the fusion rate of group NC, the fusion rate of the three treatment groups increased, with the fusion rate of group C being the highest. At 6 and 12 months after surgery, ODI and VAS scores were significantly lower than preoperative scores in all groups. In group D and T, BTM changes at 12 months after surgery (P1NP increases and CTX decreases, respectively) predict 12-month femoral neck T-score gains. In group C, more suppression in P1NP at 12 months after surgery predict 12-month femoral neck T-score gains. **Conclusion:** In comparison to individual therapies involving teriparatide or denosumab, the combined treatment of teriparatide and denosumab expedites spinal fusion subsequent to TLIF in postmenopausal women with osteoporosis. Among patients receiving either denosumab or teriparatide in isolation, alterations in BTMs at the 12-month post-surgery mark correlate with 12-month gains in femoral neck T-scores. For patients concurrently receiving both denosumab and teriparatide, although the trends in BTM changes align more with denosumab, greater suppression of P1NP at the 12-month post-surgery juncture is indicative of 12-month gains in femoral neck T-scores.

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A219: Nociceptive pain assessed by the PainDETECT Questionnaire may predict response to opioid treatment for chronic low back pain

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Introduction: The pharmacological management of chronic low back pain (LBP) is multifactorial and complex at an individual level. The PainDETECT questionnaire is a tool that distinguishes between neuropathic (NeP), nociceptive (NoP), and ambiguous pain. World Health Organisation (WHO) recommends a laddered approach to pain medication usage from first line to fourth line. By elucidating the difference in medication efficacy between these groups, clinicians can provide a tailored treatment plan to manage patient's individual pain profile and minimize the adverse effects of polypharmacy. This study aimed to investigate the relationship between different pharmacological treatments, pain categorizations as defined by the PainDETECT questionnaire and patient reported medication efficacy. **Material and Methods:** A secondary retrospective analysis of a prospectively collected database was conducted involving 318 consecutively recruited patients, aged 18 years and above, who completed PainDETECT, medication history and patient reported medication efficacy questionnaires. Medication history was categorised into four lines of treatment: first line (paracetamol $\pm$ non-prescribed anti-inflammatories), second line (prescribed anti-inflammatories), third line (anticonvulsants/neuromodulators) and fourth line (opioids). Medication efficacy was measured using a three-point Likert scale: effective (+2), somewhat effective (+1), no effect (0). **Results:** The study included 120, 50, 54 and 94 patients on first line, second line, third line and fourth line treatment, respectively. The NeP group had higher mean numerical rating scale (NRS) compared to NoP group in all four lines of treatment (8.10 ± 1.59 vs. $5.47 10 \pm 2.27$, $p < 0.001$, $8.64 10 \pm 1.43$ vs. $5.52 10 \pm 1.86$, $p < 0.001$, $8.00 10 \pm 1.07$ vs. $6.37 10 \pm 2.39$, $p < 0.01$, and $8.05 10 \pm 1.73$ vs. $7.2 10 \pm 1.29$, $p < 0.05$). When confounding for NRS, the distribution of medication efficacy significantly differed amongst the NeP, ambiguous and NoP groups in patients undergoing fourth line pharmacological treatment ($r^2 = 8.623$, $p < 0.05$). The NoP group exhibited significantly higher medication efficacy compared to the NeP group (U=14.038, $p < 0.05$). There was no significant difference in mediation efficacy across the pain classifications for first, second- and third-line treatment.

Conclusion: Opioids was the only line of treatment more effective in targeting NoP, as determined by the PainDETECT questionnaire compared to NeP. This pioneering study illustrates the complex nature of pharmacological management for chronic LBP. It underscores the importance of tailoring pharmacological treatment plans to fit individual pain profiles and expectations instead of adopting a blanket approach to pain management.

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A220: Effects of orthosis on conververive treatment of osteoporotic vertebral fractures - Propensity score matching test between orthotics and no orthotics groups

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Introduction: Orthotic treatment is a common option for osteoporotic vertebral fractures (OVF). However, there is insufficient evidence of its clinical efficacy. The aim of this study was to investigate the effectiveness of orthotic treatment for OVF. **Material and Methods:** A total of 194 patients with fresh OVF enrolled in the 2012 and 2020 prospective cohort studies were included. Those with poor prognostic factors on MRI (confined high intensity area in fractured vertebrae on T2-weighted images) were excluded. While all patients in 2012 cohort study were treated with soft brace, most of all patients in 2020 cohort study were treated without brace. The VAS for low back pain was used for clinical outcome, and X-rays parameters (at sitting and supine position) were used for radiographical evaluation to measure the compression rate of vertebral body and motion angular of vertebral wedging angle. Patients were divided into two groups: brace group and non-brace group. The patients matched by propensity score based on age, sex, compression rate of anterior wall at initial examination, and presence of old OVF, and we statistically compared between the matched groups. **Results:** (Matched brace group / matched non-brace group, respectively.) Propensity score matching revealed 61 cases in each group (mean age 76.6 ± 6.6 years / 76.9 ± 5.9 years (p = 0.84), 51 women / 53 women (p = 0.61)). The VAS for low back pain was 73.7 ± 16.5 mm / 77.5 ± 17.5 mm at the first examination and 24.0 ± 25.6 mm / 27.0 ± 25.3 mm at 6 months, with no significant difference in

improvement (p = 0.87, mixed effect models). In radiographical evaluation, the compression rate of anterior wall was 82.0 ± 15.6% / 79.5 ± 16.6% at the initial examination and 62.8 ± 21.9% / 62.8 ± 23.1% at 6 months (p = 0.39, mixed effect models), and the compression rate of posterior wall was 95.6 ± 5.8% / 96.8 ± 10.0% at the initial examination and 92.8 ± 8.3 % / 92.2 ± 13.5% at 6 months (p = 0.14, mixed effect models). The angular motion of fractured vertebrae was 4.3 ± 2.7° / 3.2 ± 3.1° at the initial examination and 1.2 ± 2.5° / 2.5 ± 2.7° at 6 months (p = 0.007, mixed effect models), showing a significant difference in the amount of change. The incidence of secondary vertebral fractures was 1.6% / 11.4% at 1 month (p = 0.028), and the hazard ratio for the cumulative incidence of secondary fractures due to orthotic treatment was 0.46 (95% confidence interval 0.20-1.09, generalized Wilcoxon test p = 0.054, Kaplan-Meier methods). **Conclusion:** Although orthotic treatment for fresh OVF did not show pain relief effects, it contributed to the stabilization of the fractured vertebra and may reduce the imminent fracture risk of secondary vertebral fracture, often seen immediately after fresh OVF.

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A221: Treatment satisfaction survey in patients treated with conservative therapy for osteoporotic vertebral fractures

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Introduction: We sometimes experience that when osteoporotic vertebral fractures (OVF) are treated with conservative therapy, those patients experience long-term pain, stress, and low treatment satisfaction. In this study, we examined the factors that influence treatment satisfaction one year after injury with conservative treatment for OVF. **Material and Methods:** Prospective cohort study. The study included 108 patients (mean age 76.1 years, 62 women) who received conservative treatment for fresh OVF at our hospital from March 2020 to August 2022 and were able to follow up for at least 1 year. The evaluation items were vertebral fracture height, the occurrence of secondary fractures, and a history of fragility fractures. The main imaging evaluation included radiographic dynamic imaging (sitting and supine lateral views) and whole spine radiographic parameters. Clinical assessments included back pain VAS, ODI, EQ-5D, and treatment satisfaction (on a 5-point scale from 0-4) at 1-year post-injury. The subjects were divided into two groups, one with a treatment satisfaction rating of 3 or higher (satisfied group) and the other with a treatment satisfaction rating of 2 or lower (unsatisfied group), and each evaluation item was analyzed using the Mann-Whitney U test and the Fisher exact test. **Results:** The satisfied group was 64.8% (70/108), and the unsatisfied group was 35.2% (38/108). Compared to the

satisfied group, the unsatisfied group had significantly more intravertebral cleft images in the supine lateral aspect at the time of injury (with cleft: 18.9% vs. 4.7%, p = 0.035) and significantly greater TK at the time of injury (39.6 vs. 32.9, p = 0.004). However, there were no group differences in fracture height or presence of adjacent fractures. At 1 year post-injury, there were significant differences in TLK (25.2° vs 15.5°, p = 0.025) and change in anterior vertebral wall height on dynamic imaging (1.7 mm vs 0.95 m, p = 0.019). In clinical evaluation, back pain VAS, ODI, and EQ-5D were all significantly higher in the unsatisfactory group (p = 0.005, p < 0.001, p < 0.001). **Conclusion:** In this study, patients who were less satisfied at 1-year post-injury had more thoracic kyphosis and vertebral cleft images at the time of injury. Furthermore, the patients had greater anterior wall height change of the fractured vertebral body on dynamic imaging at 1-year post-injury and stronger kyphosis deformity at the thoracolumbar transition area. It was suggested that poor spinal alignment at the time of injury and at 1-year post-injury had more influence on satisfaction at 1-year post-injury than secondary fractures that occurred during conservative treatment or fracture location.

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A222: Outcome and complications of pre-operative Halo traction in patients with severe spinal deformity: a systemic review and meta-analysis

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Introduction: The surgical management of patients with significant spinal deformities remains intricate and contentious. Despite great technical improvements that have been made in the surgical treatment of spinal deformities in patients, spinal reconstructive surgery for severe, rigid scoliosis with curves greater than 100° remains challenging because of the severity of the deformity, associated poor pulmonary function, potential for pseudarthrosis, and neurological complications. Since the concept of Halo traction was introduced in 1968, it has provided a practical alternative for treating individuals with severe spinal abnormalities prior to definitive curve correction surgery. It allows for a safe, gradual correction of spinal deformities in the frontal, sagittal, and axial planes, usually as a pre-surgical therapy. This paper reviewed online articles on the outcome and possible complications of applying halo traction prior to spinal deformity surgery. **Material and Methods:** The researchers conducted a systematic literature search in internet databases and utilized keywords related to the study. A systematic review and meta-analysis were done using Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA). **Results:** After thorough review of the significant articles and inclusion criteria, a total of 13 articles with 297

patients were included in the study. In terms of the clinical outcomes and complications attributed to the application of the halo traction, there were 40 patient who experienced (13.5% cases) pin tract infection or pin site loosening. Nine patients were observed to have neurological deficit, these were treated by reduction of the traction weight or temporary discontinuation of the traction. Pulmonary problems also existed in nine patients, comprising 3% of the total population in the study. Traction related complications were seen in almost all studies reviewed. The pin/traction complications rate was 21.5 and this complication proved to be the most common complication noted in this modality of treatment. Pre-traction and Post-traction Cobbs angle in both Sagittal and Coronal Plane were also evaluated. The results showed a reduction of 35.3+11.18 and 21.9+18.2 degrees in the Coronal (scoliosis) angle and Sagittal (kyphosis) angle, respectively. This corresponded to 32.2 % curve correction in the coronal plane and 23.2% in the sagittal plane, an indication that halo traction can contribute to pre-operative partial curve correction. The baseline pre-traction Functional Vital Capacity (FVC) % is 52.3%+19.1% and increased to 58.8%+19.1% post intervention. An increase of an average of FVC2%+8.1% was observed. **Conclusion:** Halo traction as a treatment modality for pre-operative preparation for patients undergoing deformity correction can achieve a decent degree of coronal and sagittal correction prior to surgery. Halo traction can avoid the perils of deformity surgery i.e. neurologic impairment, massive blood loss, lengthy surgery and prolonged anesthesia time. The complications of the halo traction device were present in almost all studies but are just trivial, therefore the benefits of applying traction outweigh the risk involved. Application of pre operative halo traction prior to spinal deformity correction surgery is a viable option.

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A223: The efficacy of gabapentin and pregabalin therapy for intermittent neurogenic claudication on lumbar spinal stenosis patients; a randomized controlled study

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Introduction: The common symptom in lumbar spinal stenosis (LSS) patients is neurologic intermittent claudication (NIC) that diminish the quality of life of patients. Initial treatment of LSS is conservative management including exercise, physiotherapy and medication. Previous studies reported that gabapentin increase in the walking distance, improve pain score in LSS patients. Pregabalin (PGB) is a newer generation gabapentinoid and commonly used as a first-line drug for neuropathic pain. Currently, there has no study compare the efficacy of gabapentin, pregabalin and placebo

in NIC improvement in LSS patients. **Material and Methods:** Adult patients aged > 18 years with lumbar spinal stenosis (LSS) with neurologic intermittent claudication (NIC) symptoms for at least one month were included. Patients were blind-randomized into three groups, which added gabapentin, pregabalin, and placebo, respectively, on the standard conservative treatment. The primary outcome is VAS. The other outcomes are Swiss Spinal Stenosis Score (SSS), Self-pace shuttle walk test (SPSWT), and EQ5D5L. **Results:** 68 LSS patients were enrolled and randomized. There has no statistical difference in baseline VAS score, SSS score, SPSWT and EQ5D5L. For the VAS, there has no statistical different in VAS reduction among three groups during the follow-up assessment over 4 months period (Placebo 3.44 ± 3.07, Gabapentin 4.19 ± 2.73 and Pregabalin 3.91 ± 3.22 (p = 0.064)). The symptom severity aspect of Swiss Spinal Stenosis Score (SSS) was the only outcome that significant decreased in patients who received pregabalin compared to placebo after 2 months of treatment (p = 0.042). The SPSWT and eQ5D5L during the follow-up period were not different among the three group (p > 0.05). **Conclusion:** The efficacy of gabapentin or pregabalin for lumbar spinal stenosis patient were not superior compared with that of the placebo in term of pain, disability and quality of life. Therefore, combined treatment with standard treatment and gabapentin of pregabalin does not provide additional relief in symptoms, functional improvement or increase quality of life in lumbar spinal stenosis patient compared with standard treatment alone.

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A224: The patient-reported outcomes of postoperative prostaglandin E1 derivative in lumbar spine surgery: a randomized, double-blind, controlled trial

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Introduction: Postoperative residual leg numbness is a problem in patients undergoing decompressive lumbar spine surgery. Prostaglandin E1 derivatives (PGE1D) are effective in reducing leg numbness in nonoperative patients. However, data about PGE1D efficacy after spine surgery is still limited. The purpose of this study was to compare patient-reported outcomes of postoperative PGE1D with placebo. **Material and Methods:** We conducted a randomized, double-blind, controlled trial with 60 patients with degenerative lumbar spine disease undergoing 1-2 levels of decompressive lumbar spine surgery. Thirty patients were randomized to PGE1D postoperatively for 6 months and 30 were randomized to placebo. The primary outcome was VAS leg numbness, and the secondary outcomes were VAS back pain and leg pain, ODI and EQ-5D which were all evaluated at 5 timepoints: preoperatively, immediately postoperative, and months 1, 3 and 6. Data were analyzed using a mixed model. **Results:** Demographic data and baseline patient-reported outcomes were

comparable between randomized groups. The mean (SD) age was 65 (9.3) years, and 45 (75%) participants were female. Both groups showed a significant reduction in numbness at all postoperative timepoints (all p < 0.001). The mean difference in numbness score in the PGE1D versus placebo groups was -0.2 (-0.7 to 0.4); p = 0.5. VAS back pain significantly decreased from baseline in both treatment groups at all postoperative timepoints (all p-values < 0.001). Compared to placebo participants, those randomized to PGE1D had significantly greater reductions in VAS back pain over all follow-up (mean difference = -1.1 (95% CI -1.7 to -0.5); p < 0.001). There were no clinically or statistically significant differences in other patient-reported outcomes between randomized groups. **Conclusion:** Postoperative PGE1D did not lead to a greater reduction in leg numbness compared to placebo. However, PGE1D may be a useful treatment for reducing back pain following decompressive lumbar spine surgery.

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A225: Cervical spine degenerative changes and neck pain related disability among professional porters and professional porters and white collar workers in Nepal

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Introduction: In the medical literature, neck pain is often linked to physical strain and degenerative changes in the cervical spine, even if the scientific evidence is weak. Nepalese professional porters are daily exposed to extreme cervical axial spinal loads, carrying goods using the traditional head strap ("namlo") around the forehead. This may put them at high risk of neck pain-related disability and degeneration. The aims of the study were to assess whether (1) professional porters have more neck pain-related disability and neck pain than white-collar workers; (2) porters have more cervical degeneration on magnetic resonance imaging (MRI) as compared

to white-collar workers and (3) whether the severity of cervical degeneration is associated with neck pain-related disability. **Material and Methods:** A cross-sectional, case-control study conducted at Dhulikhel Hospital in Nepal. The primary outcome was the neck disability index (NDI, range: 0 (no disability) to 100 (complete disability). The secondary outcome measures included the EuroQol five dimensions three levels (EQ-5D-3L) and numeric rating scales for neck pain (NRS-NP) and arm pain (NRS-AP). Two independent radiologists had assessed ten different findings of cervical degeneration (Pfirrmann grade, anterior osteophytes, posterior disc-osteophyte complex, neural foraminal stenosis, uncovertebral arthrosis, Schmorl's node, Modic changes, spinal canal stenosis, scoliosis, and kyphosis) on MRI with acceptable intra- and inter-rater reliability. The association between cervical degeneration and neck pain-related disability was analysed by multiple linear regression. **Results:** Of 126 presumably healthy males from urban areas evaluated for inclusion, 50 porters and 50 age matched white-collar workers were included. Mean age was 40 years in both groups (standard deviation (SD), ±37.9 - 42.7). Porters had on average worked 9.8 hours (SD ± 0.8), 6 days a week (SD ±0.44) for 15 years (SD ±7.1) carrying an average load of 83 kilograms (SD ± 14.3). Porters reported more neck pain-related disability (mean NDI 11.0, 95% confidence interval (CI) 9.4 - 12.5) compared to controls (mean NDI 5.6, 95% CI 3.6 - 7.7). This was in accordance with the results of the EQ-5D, NRS-NP and NRS-AP. The prevalence of cervical degeneration was similar between the groups. In the whole study population, none of these findings were associated with more disability related to neck pain. **Conclusion:** Compared to white-collar workers, porters reported slightly more neck pain-related disability, but had no more degenerative changes in the cervical spine. More severe cervical degeneration was not associated with increased neck pain-related disability among porters and controls.

OP26: Degenerative Cervical Myelopathy 2: Surgery

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A226: Anterior versus posterior surgery for patients with degenerative cervical myelopathy: an observational study from the Canadian Spine Outcomes and Research Network

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Introduction: For patients with progressive degenerative cervical myelopathy (DCM), the advantages and disadvantages of anterior versus posterior surgical approaches remain uncertain. Our primary objective was to evaluate differences in patient-reported disability after anterior versus posterior surgery for DCM according to the

Neck Disability Index (NDI). Our secondary objectives were to compare neurological function, neck and arm pain, health-related quality of life, adverse events, and rates of re-operations. **Material and Methods:** We analyzed data from patients with DCM who were enrolled in an ongoing multicenter prospective observational cohort study. We implemented Minimum Clinically Important Differences (MCID) to aid interpretation of treatment effects. We evaluated associations between surgical approach and achievement of the MCID for the NDI using multiple logistic regression. We performed pre-specified subgroup analyses according to baseline disease severity, number of levels operated on, and fusion versus non-fusion posterior procedures. We recorded adverse events (AEs) prospectively using the Spinal Adverse Events Severity (SAVES) protocol. **Results:** Among 559 patients, 261 (47%) underwent anterior surgery, while 298 (53%) underwent posterior surgery. Patients treated posteriorly were older, more comorbid, had worse DCM severity, and had a greater number of vertebral levels involved. After adjusting for potential confounders, there were no significant differences in the odds of achieving the MCID for the NDI (OR 1.23, 95% CI 0.82 to 1.86, p = 0.31). Among secondary outcomes, there were no significant differences for change in modified Japanese Orthopaedic Association (mJOA) scores, and differences in neck and arm pain and health-related quality of life did not exceed MCIDs. Anterior surgery was associated with greater rates of dysphagia (10% vs 2 %, p < 0.01), but only two cases were considered major. Posterior surgery was associated with greater rates of wound drainage (3% vs < 1%, p = 0.01), wound dehiscence (2% vs 0%, p = 0.01), wound infection (11% vs 1%, p < 0.01), neurological deterioration (8% vs 1%, p < 0.01), and all-cause reoperations within one year (8% vs 3%, p = 0.03). Posterior procedures also had significantly greater lengths of stay (6.4 (SD 6.4) vs 2.3 (SD 2.6) days, p < 0.01), operating room procedure time (163.8 (SD 61.5) vs 149.1 (SD 74.7) minutes, p = 0.01), and estimated blood loss (295.6 (SD 245.6) vs 104.6 (SD 105.8) mL, p < 0.01). **Conclusion:** Among patients undergoing surgery for DCM, anterior surgery was associated with similar improvements in neck-related disability, neurological function, pain, and health-related quality of life, with a more favorable profile of adverse events and shorter lengths of stay in comparison to posterior surgery. These findings suggest that anterior surgery might be considered a preferred option when feasible.

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A227: Quality assessment of degenerative cervical myelopathy information on the Internet

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Introduction: Patient education is a key element of spinal surgery informed consent. Patients frequently access health

information online, yet this information is unregulated and of variable quality. We aimed to assess the quality of information available on Degenerative Cervical Myelopathy (DCM) websites with a focus on identifying high-quality information websites. **Material and Methods:** We performed a Google search using keywords pertaining to DCM. The top 50 websites returned were classified based on their publication source, intended audience and country of origin. The quality of these websites was assessed using both DISCERN instrument and JAMA benchmark criteria. We also utilised a novel Myelopathy Information Scoring Tool (MIST) to assess the comprehensiveness, accuracy and detail of online DCM information. **Results:** Mean DISCERN score was 39.9 out of 80. Only one-quarter of these websites were rated 'good' or 'excellent' using DISCERN, the remaining were rated 'very poor', 'poor' and 'fair'. Mean JAMA benchmark score was 1.6 out of 4, with 23 out of 50 websites scoring 0. Evaluation using MIST found mean score of 25.6 out of 50. Using 30 points as satisfactory MIST cut-off, 72% of DCM websites were deemed critically deficient and unsatisfactory for comprehensive patient education. Both DISCERN and MIST indicated poorest information pertained to surgical risks and complications, as well as treatment outcomes. Websites such as Orthoinfo.aaos.org and Myelopathy.org provided reliable, trustworthy, and comprehensive patient education. **Conclusion:** Information available on almost three-quarters of DCM websites was of poor quality, with information regarding complications and treatment outcomes most deficient. Clinicians should be aware of quality sites that patient may be directed to, to augment patient education and surgical counselling.

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A228: Re-analysis of the CSM-PROTECT multicentre randomized controlled trial reveals a global treatment benefit of riluzole in patients undergoing surgery for degenerative cervical myelopathy

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Introduction: While the primary analysis of the CSM-PROTECT Trial did not demonstrate improved recovery with the adjunctive use of riluzole on the modified Japanese Orthopedic Association (mJOA) scale in patients with degenerative cervical myelopathy (DCM) undergoing surgical intervention, interesting observations emerged in secondary analyses, suggesting the possibility of other therapeutic benefits not captured by the mJOA scale. This study seeks to re-evaluate the efficacy of Riluzole through a global statistical analysis encompassing multiple outcomes, with the intent of providing a more comprehensive assessment of potential treatment efficacy. **Material and Methods:** In this re-analysis, we conducted a detailed examination of data from the multicenter, double-blind, placebo-controlled phase III CSM-PROTECT study. This trial included 290 patients who underwent decompressive surgery for DCM and were randomly allocated to receive either Riluzole or placebo. Our focus was to evaluate clinical improvement over one year using five distinct assessment scales: SF-36 Physical Component Summary (PCS), Numeric Rating Scale for Neck and Arm pain, ASIA motor score and Nurick grade. We employed a global statistical test (GST) that utilizes a nonparametric rank sum test to assess treatment efficacy. The resulting global treatment effect (GTE, ranging from -1 to 1) indicates the net gain in probabilities that one arm outperforms the other arm across multiple endpoints. A GTE greater than zero indicates a more favorable global treatment response with Riluzole compared to placebo. **Results:** A total of 290 patients in the original CSM-PROTECT trial were included in the analysis, with a mean (SD) age of 59 (10.1) years, including 129 (44%) females. In the trial, 141 patients received Riluzole, while 149 were administered placebo. There was a significantly higher probability of global improvement at 1-year among patients treated with Riluzole compared with the placebo group [GTE = 0.08 (SD 0.04), p = 0.02]. A similar trend of favorable global response with Riluzole was identified at 35 days and 6 months (GTE = 0.07), although the difference was not statistically significant (p = 0.04). Overall, Riluzole-treated patients had at least a 54% [=(1+GTE)/2] higher likelihood of achieving improved outcomes at 1 year compared to those receiving placebo. The triple combination of ASIA Motor score, Neck and Arm pain NRS at 1 year provided the best-fit parsimonious model for the detection of Riluzole's greatest overall benefit [GTE = 0.11 (SD 0.05), p = 0.007]. **Conclusion:** This re-analysis of the CSM-PROTECT trial demonstrates that perioperative administration of Riluzole leads to an overall improvement in clinical outcomes compared to placebo using global treatment effect. Based on these data, clinicians may wish to consider the option of using riluzole as an adjunctive treatment in patients with DCM undergoing surgical treatment.

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A229: Laminoplasty versus laminectomy and fusion for ossification of the posterior longitudinal ligament (OPLL) involving C2

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Introduction: This study compared the function and radiographical outcomes of the patients who underwent C2 dome-like expansive laminoplasty to those C2 laminectomy and posterior instrumented fusion for the treatment of OPLL with

C2 level and above. **Material and Methods:** This study performed a retrospective cohort analysis on 40 patients with compressive symptoms caused by OPLL up to C2 level. 21 patients underwent C2 dome-like expansive laminoplasty with C3-7 expansive open-door laminoplasty (Group C2-Dom) and 19 underwent C2-7 laminectomy and posterior instrumented fusion (Group C2-PS). The Japanese orthopedic association (JOA) score was divided into mild-moderate and severe (JOA < 9), and each group were compared. The types, longitudinal extent, K-line classification of OPLL, and the preoperative and postoperative differences in C2-7 angle on flexion, neutral, extension x-ray were analyzed to evaluate the radiological characteristics. JOA score, visual analog scale (VAS) score, and recovery rate (RR) were used to evaluate clinical outcomes and statistically analyzed. **Results:** The JOA score, VAS score and recovery rate were significantly improved at the final follow-up in both groups with no significant intergroup differences. At the final follow-up, ROM was significantly greater in the C2-Dom group than in the C2-PS group (1.11 vs 21.51, p < 0.05). There were no radiological or clinical differences between the two groups in mild-moderate JOA. In patients with severe JOA, pre- and postoperative ROM change was less in the C2-Dom group than in the C2-PS group (2.5 vs. 22.2, p = 0.01), and postoperative JOA (12.75 vs. 6.89, p < 0.01), change of VAS (19.42 vs. -14.44, p < 0.1), and recovery rate (49.95 vs. -2.46, p < 0.01) improved more in the C2-Dom group. **Conclusion:** The C2 dome-like expansive laminoplasty can preserve the patient's neck motion after surgery. When a patients with severe JOA, C2 dome-like expansive laminoplasty could achieve favorable clinical outcomes compared C2 laminectomy and posterior instrumented fusion. Further research and long-term clinical follow-up are needed to better appreciate the OPLL involving C2 level.

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A230: Laminoplasty vs. laminectomy and fusion: a comparison of radiographic and surgical outcomes

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Introduction: Cervical spondylotic myelopathy (CSM), the most common cause of spinal cord dysfunction in the elderly population, is a degenerative process resulting in cord compression and often leads to progressive deterioration of neurologic function. Currently, laminoplasty and laminectomy followed by fusion are two of the most utilized posterior techniques for patients with multilevel disease. While prior studies have attempted to compare laminectomy with fusion and laminoplasty, no consensus has been reached regarding superiority. Furthermore, few studies have analyzed sagittal balance between these procedures. Our study aimed to directly compare cervical laminoplasty and laminectomy with fusion for multilevel (≥ 3) CSM in non-kyphotic patients to determine the procedure associated with greater improvement in radiographic parameters. **Material and Methods:** Upon obtaining Institutional Review Board approval, patients older than or equal to 18 who underwent laminoplasty or laminectomy with fusion for cervical myelopathy from 2017-2020 were retrospectively identified. Preoperative and one-year postoperative radiographs were reviewed for each patient and C2-C7 cobb angle, C2-C7 SVA, C2 slope, and C2 tilt were measured. Patient data were collected through a Structured Query Language (SQL) search and manual chart review of the electronic medical records. Bivariate analyses were used to compare preoperative patient characteristics and postoperative outcomes. Multivariable linear regression models accounting for age, sex, BMI, CCI, and were developed to measure the effect of surgical technique on preoperative, postoperative, and delta radiographic measures. **Results:** Of 181 patients, 137 underwent laminectomy with fusion, while 54 underwent laminoplasty. Postoperatively, patients who underwent laminectomy and fusion had a greater SVA (42.3 ± 15.2 vs 37.5 ± 14.0, p = 0.034), C2 slope (29.9 ± 11.9 vs 24.3 ± 9.58, p < 0.001), and C2 tilt (18.4 ± 12.3 vs 14.6 ± 10.0, p = 0.029). Patients who underwent lamifusion also had greater changes in C2 slope (6.70 ± 10.0 vs 2.39 ± 6.76, p < 0.001) and C2 tilt (6.93 ± 11.7 vs 2.37 ± 8.32, p = 0.003). Lamifusion patients had greater rates of complications (11.7% vs 5.5%, p = 0.032). Undergoing a laminectomy with fusion procedure was not a significant predictor of any preoperative radiographic parameters but was found to be a significant predictor of postoperative C2 slope (estimate = 4.711, p = 0.006) and degree of change in C2 slope (estimate = 3.346, p = 0.025). Age, sex, BMI, and CCI were shown to be significantly impactful variables of several radiographic parameters pre- and postoperatively (p < 0.05). **Conclusion:** Our study established C2 slope and tilt as useful radiographic parameters in the evaluation of patients undergoing multilevel posterior laminoplasty vs. laminectomy and fusion. Lamifusion was associated with increased C2 slope and tilt, as well as increased C2-C7 SVA, and on multivariate analysis, lamifusion was independently predictive of increased C2 slope when compared to laminoplasty. We also found lamifusion was associated with a higher risk of complications, but more studies should be done to investigate what patient factors may also influence this increased risk. C2 slope may represent an effective and simple measurement to use in the future; however, longer follow-up of radiographic measurements should also be the focus of future research.

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A231: Does spinal cord drift predict functional recovery and C5 palsy in degenerative cervical myelopathy? A propensity-score matched comparative study of cervical laminoplasty versus laminectomy/fusion

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Introduction: This study elucidates surgical interventions for degenerative cervical myelopathy (DCM) by analyzing spinal cord drift's influence on recovery and C5 palsy occurrence after cervical laminoplasty (LP) and laminectomy with fusion(LF). It encompasses a propensity-score matched cohort DCM patients (LP vs. LF) with multidimensional assessment involving pre-operative alignment, postoperative cord drift, functional recovery (mJOA score, mJOA recovery rate), and C5 palsy incidents, supported by correlation analyses and robust statistical methods. **Study design:** Retrospective comparative study. **Objectives:** (i) to compare spinal cord drift between laminectomy and fusion (LF) and cervical laminoplasty (LP) for degenerative cervical myelopathy (DCM) treatment, (ii) to study relationship between preoperative cervical alignment, postoperative spinal cord drift, functional outcome, and C5 palsy. **Methods:** A cohort of 114 patients who underwent LP or LF for DCM were identified. After propensity-score matching, both groups included 30 patients each. Cobb angle(C2-C7) was used to assess pre-and postoperative cervical spine alignment (at 2-year follow-up). Based on preoperative alignment, there were lordotic(L) and straight(S) subgroups. Spinal cord position was measured on sagittal and axial-T2W MRI of cervical spine pre-and postoperatively at 2-year follow-up and spinal cord drift was measured by subtracting preoperative values from postoperative values. Functional recovery (mJOA score, mJOA recovery rate), and C5 palsy in patients were recorded and compared. **Results:** LF had higher mean spinal cord drift than LP group (2.66 ± 0.77 vs. 2.16 ± 0.80 mm, p = 0.049). Lordotic subgroups exhibited greater cord drift than straight subgroups within LP and LF groups (LP-L vs LP-S, p = 0.0001; LF-L vs LF-S, p = 0.0003 and LP-L vs LF-L, p = 0.006; LP-S vs LF-S, p = 0.03). Both groups significantly improved mJOA scores at two-year follow-up, with no LP-LF difference in mJOA recovery rate (mJOA-RR). Lordotic subgroups had significantly higher mJOA-RR (LP-L vs LP-S, p = 0.048; LF-L vs LF-S, p = 0.045). Preoperative cervical alignment, cord drift, and mJOA-RR correlated well (Spearman's ρ 0.7143 and 0.6053 respectively). Patients with > 2.5 mm cord drift (n = 24) had significantly higher mJOA-RR as compared to < 2.5 mm cord drift (n = 18). C5 palsy incidence did not significantly differ between LP-LF groups or subgroups.

Conclusion: Comparative data between both groups showed better spinal cord drift in the LF group, but failed to show any significant difference in the recovery rate and occurrence of C5 palsy. Preoperative lordotic cervical alignment in both groups correlated well with cord drift and cord drift with mJOA-RR. **Keywords:** Preoperative cervical alignment, Spinal cord drift, Laminoplasty, Laminectomy and fusion, C5 palsy, Propensity-score matching

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A232: Improving diagnosis and early detection of degenerative cervical myelopathy (DCM): a prospective cohort study

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Introduction: Degenerative cervical myelopathy (DCM) results from cervical spinal cord compression, with subtle, intermittent symptoms, often leading to delays in diagnosis and treatment that increase lifelong disability. Currently, there are no published diagnostic criteria, contributing to substantial variability in both clinical practice and inclusion criteria in research studies. In this study, we aimed to assess an array of clinical symptoms and signs for the purpose of informing the development of diagnostic criteria and identifying the most important symptoms and signs present in DCM. **Material and Methods:** A prospective cohort study was conducted with extensive data collection including demographics, medical history, symptom history, mJOA, NDI, QuickDASH, EQ-5D-5L, EQ-VAS, power testing in 22 myotomes, JAMAR grip dynamometer,1-2,1-5, and 2–3-digit pinch dynamometer, sensory testing, GRASSP-Myelopathy, and quantitative gait and balance testing using an electronic pressure mat. Sensitivity (SN) and specificity (SP) were calculated for all outcome variables including symptoms, signs, and quantitative measures of spinal cord function, and these were ranked by Youden's index (SN + SP − 1). 10 symptoms and 10 clinical signs were selected that best discriminate between healthy controls and DCM patients. **Results:** 130 DCM patients and 82 controls were enrolled. 216/281 (77%) outcome measures showed differences between DCM and healthy subjects (p < 0.05). The ten most discriminative clinical symptoms included: neck pain (SN 81%, SP 73%), hand incoordination (SN 52%, SP 92%), altered hand sensation (SN 76%, SP 90%), upper extremity weakness (SN 51%, SP 95%), autonomic dysfunction (urinary/bowel/sexual dysfunction) (SN 24%, SP 95%), gait imbalance (SN 63%, SP 95%), limitations in daily activities (SN 77%, SP 92%), difficulty lifting heavy objects (SN 75%, SP 87%), and exacerbation of neck pain during driving (SN 70%, SP 90%) or reading (SN 71%, SP 78%). Conversely, the 10 most discriminative clinical signs

included motor symptoms: weakness in thumb opposition (SN 32%, SP 97%), 1st dorsal interosseus (SN 35%, SP 97%), and intrinsic hand strength deficits (SN 25%, SP 98%). Reflex abnormalities including, hyper-reflexia of the biceps (SN 61%, SP 74%), triceps (SN 40%, SP 92%) and Hoffman reflex (SN 89%, SP 41%) or Tromners reflex (SN 97%, SP 35%) were also noted. Sensory assessments (pinprick, light touch, monofilament) showed low specificity (< 12%) but high sensitivity. Coordination testing, such as the presence of drops during the GRASSP-Myelopathy test, demonstrated SN 88% and SP 68%. Gait and balance measures included trunk deviations during tandem gait (SN 66%, SP 84%) and the ability to stand on one foot (SN 75%, SP 77%). **Conclusion:** This study identified a 10 clinical symptoms and signs that differentiate individuals with DCM from their healthy counterparts. These findings hold promise in contributing to the formulation of standardized diagnostic criteria for DCM. It is pertinent to acknowledge that the sensitivity of numerous assessment metrics employed in this investigation did not meet the optimal threshold, underscoring the persistent challenge confronting the AO Spinal Cord Injury Group as they work to establish diagnostic criteria for DCM.

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A233: Subsidence following anterior-only anterior cervical corpectomy fusion for cervical spondylotic myelopathy: systematic review and meta-analysis

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Introduction: Surgical interventions for cervical spondylotic myelopathy (CSM) frequently involve anterior approaches, such as anterior cervical discectomy/fusion (ACDF) or anterior cervical corpectomy/fusion (ACCF). Although graft subsidence is a well-established and described complication in ACDF procedures, much less has been published regarding factors related to subsidence in patients undergoing anterior-only ACCF for CSM. This systematic review aimed to address this gap by examining the occurrence and potential contributing factors of interbody subsidence following anterior-only ACCF performed for CSM. **Materials and Methods:** A systematic literature search was conducted using PubMed, Embase, and COCHRANE to gather English-language studies relevant to the subject. The study's inclusion criteria encompassed anterior-only anterior cervical corpectomy and fusion (ACCF), surgery for the primary diagnosis of cervical spondylotic

myelopathy (CSM), evaluation of subsidence and detailed descriptions of implant characteristics. Subsidence definition and published rates were collected and organized by the type of graft used. Qualitative analysis was performed for complications and revision rates. The data was subjected to meta-analysis to evaluate subsidence incidence rates, and meta-regression analysis was employed to assess variations between different graft types. **Results:** A total of 245 abstracts were evaluated, of which 34 papers met the inclusion criteria. In total, 2005 patients were evaluated over a mean period of 31 months (range 6-56 months). Pooled subsidence rates expressed as incidence per person-years based on graft type were as follows: 2% (carbon fiber), 27% (fibular strut allograft), 2% (nHAPA composite strut), 5% (PEEK), 10% (static titanium), and 2% (expandable titanium cages). The combined subsidence rate for all grafts was 7%. Notably, the expandable titanium cohort demonstrated a lower subsidence rate (2%) compared to the overall pooled cohort (7%), while other graft types showed no significant difference. **Conclusion:** In conclusion, subsidence occurred in approximately 7% of patients undergoing anterior-only ACCF procedures for CSM. Notably, the use of expandable metal cages resulted in a lower rate of subsidence compared with the broader cohort. The lower subsidence rates observed in ACCFs utilizing carbon fiber or expandable titanium interbody implants are consistent with those observed in anterior cervical discectomy and fusion (ACDF) procedures. This finding suggests that these implant options may be preferable to reduce the risk of subsidence when corpectomy is necessary for cervical spinal decompression without supplemental posterior fixation.

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A234: The effects of peri-operative adverse events on clinical and patient-reported outcomes after surgery for degenerative cervical myelopathy: an observational cohort study from the Canadian Spine Outcomes and Research Network

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Introduction: There is a lack of data examining the effects of peri-operative adverse events (AEs) on long-term outcomes for patients undergoing surgery for degenerative cervical myelopathy (DCM). We aimed to investigate associations between the occurrence of perioperative AEs and co-primary outcomes: 1) modified Japanese Orthopedic Association (mJOA) score and 2) neck disability index (NDI) score. **Material and Methods:** We analyzed data from 800 patients prospectively enrolled in the Canadian Spine Outcomes and Research Network multicenter observational study. The Spine AdVerse Events Severity system was used to collect intra- and post-operative AEs. Patients were assessed at up to 2 years post-surgery using the NDI and the mJOA scale. We used a linear mixed effect regression to assess the influence of AEs on longitudinal outcome measures as well as multivariable logistic regression to assess factors associated with meeting minimal clinically important difference (MCID) thresholds at 1 year. **Results:** There were 167 (20.9%) patients with minor AEs and 36 (4.5%) patients with major AEs. AEs were significantly associated with the number of levels operated, proportion of patients requiring future revision surgery, intra-operative blood loss, greater LOS and higher proportion of patients not discharged home. The occurrence of major AEs was associated with an average increase in NDI of 6.8 points (95% CI: $1.1 - 12.4$, p = 0.019) and reduction of 1.5 points for mJOA scores (95% CI: -2.3 to -0.8, p < 0.001) up to 2 years after surgery. Occurrence of a minor AE was not associated with differences in NDI scores (p = 0.64) but did significantly affect mJOA scores by an average 0.39 points (p = 0.039) relative to the no complication group. Interaction terms between complication subtypes and time were significant for major but not minor AEs, suggesting major AE occurrence significantly influenced the trajectory of NDI measures following surgery (p = 0.027 major AE; p = 0.13 minor AE). No time-complication interaction was observed for mJOA scores. Occurrence of major AEs reduced the odds of patients achieving MCID targets at 1-year post-surgery for both mJOA (OR 0.23, 95% CI: 0.086 - 0.53, p = 0.001) and for NDI (OR 0.34, 95% CI: $0.11 - 0.84$, p = 0.032). **Conclusion:** This study assessed the impact of AEs on neurological function and disability after surgery for patients with DCM. We found that major AEs detrimentally influenced the trajectories of NDI and mJOA outcomes at up to 12 months, and that occurrence of major AEs were associated with failure to achieve the MCID for mJOA and NDI at 1 year. Minor AEs were more common but not associated with significant effects on mJOA or NDI. Occurrence of both minor and major AEs impacted healthcare resource utilization by reducing the proportion of patients discharged directly to their home and prolonging LOS. These findings robustly demonstrate the natural history of PROs following intra-operative and peri-operative AEs. which have important implications for counselling patients and establishing post-surgical expectations.

OP27: Basic Science: Surgical Applications

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A235: Usage and complication rates of bone morphogenetic protein-2 for spine fusion

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Introduction: Bone Morphogenetic Protein-2 (BMP-2) is a popular adjunct for spine fusion. Although it has only been FDA-approved for select uses in the lumbar spine, it has been commonly used in off-label indications and locations. This study aimed to assess BMP-2 usage and complication rates at a high-volume tertiary orthopedic institute. **Material and Methods:** This retrospective study utilized a database generated through ICD-10 codes entered within our electronic medical records system. All fusion surgeries from 2/1/2016 - 1/31/22 were included. Surgeries defined by primary procedure name include anterior cervical fusion (ACF), posterior cervical and cervicothoracic fusion (PCF), anterior lumbar interbody and/or thoracic fusion (ALIF/ATF), posterior lumbar interbody and/or thoracic fusion (PLIF/PTF), lateral lumbar interbody fusion (LLIF), transforaminal lumbar interbody fusion (TLIF), and revision fusions. Chi-square for categorical variables and one-way ANOVA tests for continuous variables were used to analyze differences between demographic factors and operative characteristics. We assessed new complications within one year, including cancer, venous thromboembolism, cardiopulmonary complications, hematoma, dysphagia, wound dehiscence, infection, and pulmonary embolism. Radiculitis was assessed as either novel, such that the ICD-10 code was entered only after the surgical visit, or non-resolved, such that the patient had radiculitis at their initial visit and on subsequent visits. **Results:** A total of 9247 cases were included. The number of non-BMP-2 and BMP-2 cases for each surgery is as follows: 2865 and 33 ACF, 168 and 273 PCF, 43 and 1089 ALIF and ATF, 928 and 1597 PLIF and PTF, 37 and 1381 LLIF, 154 and 40 TLIF, 59 and 485 revision PLF and PTF, 33 and 4 revision ACF, and 6 and 43 revision PCF. Patients who underwent ACF and PCF with BMP-2 had higher rates of osteoporosis. (ACF: 24.2% vs 4.5%; PCF: 16.5% vs 8.9%) Patients who underwent ACF without BMP-2 had lower mean ASA class (2.1 vs 2.3), rates of complicating hypertension, (3.1% vs 12.1%) diabetes, (5.1% vs 15.2%) and age.

(56.4 vs 65.8). Conversely, patients who underwent PCF without BMP-2 had greater mean age (65.0 vs 62.2) and BMI. (29.1 vs 27.6) Patients who underwent ACF with BMP-2 use had greater rates of dysphagia, (3.0% vs 0.2%) seroma, (3.0% vs 0.1%) wound dehiscence, (3.0% vs 0.2%) and infection. (6.1% vs 0.8%). There were no demographic differences between patient who underwent lumbar fusion with our without use of BMP-2. Patients who underwent TLIF with use of BMP-2 had greater rates of novel (18.4% and 15.6%) and non-resolved (20.4% and 7.1%) radiculitis. PTF and PLIF patients with BMP-2 had lower rates of novel (10.2% vs 14.3%) but higher rates of non-resolved (9.5% vs 4.7%) radiculitis. ATF and ALIF patients with BMP-2 had lower rates of both novel (13.3% vs 16.3%) and non-resolved (12.8% vs 25.6%) radiculitis. There were no differences in other complication rates. **Conclusion:** This study report usage trends and complication rates for BMP-2 use. BMP-2 use was associated with greater rates of dysphagia in ACF, greater rates of post-operative radiculitis in TLIF, and lower rates of radiculitis in ATF and ALIF.

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A236: Abnormal ossification of the spine is regulated by the surrounding muscle: the role of troponin T1, slow skeletal type (TNNT1) in spine morphology

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Background: In recent decades, a multitude of research has portrayed how an array of possible congenital and acquired abnormalities of biomechanically-distinct elements such as bone and cartilage may affect the morphology and alignment of the entire skeleton, resulting in various disorders. Surprisingly, a possible regulatory role for the skeletal muscle, a key biomechanical factor, in skeletal morphogenesis or its association with common disorders has remained largely under-studied. Recently, several mutations involving the TNNT1 gene which encodes the Slow-twitch Troponin T (sTnT) protein, were shown to result in Nemaline Myopathy, a condition which in addition to muscle weakness, also results in scoliosis, suggesting a non-autonomous role for skeletal muscle function in the morphogenesis of specific skeletal elements. **Aim:** We hypothesize that skeletal muscle function regulates the morphogenesis of specific skeletal structures in general and that of the spine in particular and that its dysfunction may play a key role in the pathogenesis of various skeletal disorders. Specific aims included: To study the radiographic and histologic abnormalities in TNNT1-deficient mice and to study the temporal role of TNNT1 deficiency in skeletal morphology. **Methods:** For the localization and characterization of a possible phenotype, we first performed ex-vivo CT scan of the entire spine in skeletally mature TNNT1 deficient mice at post-natal day 90. Initial scan searching for gross deformities was then followed by focused higher resolution ex-vivo CT scans of distinct malformed

elements. We then performed sequential in-vivo CT scan of the affected spine segment in order to analyze the onset and progression of any spinal related phenotype. **Results:** Ex-vivo CT scan of TNNT1 deficient mature mice revealed several noticeable abnormalities. Spines of mutant animals revealed abnormal vertebral segmentation (i.e. fusion), most commonly involving the thoraco-lumbar junction as well as mild scoliosis. When applying in-vivo CT scan at various post-natal time points, we noticed that newborn TNNT1 knockout mice displayed no observable skeletal phenotype but that ossification of the thoraco-lumbar intervertebral disc gradually developed postnatally. **Summary:** Absence of TNNT1 resulted in developmental ossification in a unique and particular part of the spine. This suggests that certain components within the skeletal muscle are essential in the normal formation of the spine, indicating a robust non-autonomous effect of the surrounding muscle on the spine's morphology. These findings may shed important light on the pathogenesis of various idiopathic conditions in which abnormal ossification affects the spine.

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A237: ERAS for dorso-lumbar spine surgeries - A propensity score matched cohort study

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Introduction: This study was part of a quality improvement exercise in patients scheduled for dorso lumbar spine surgery with decrease in length of hospital stay as the primary aim. **Methods:** There were 172 patients included, with 86 cases each in ERAS group and pre-ERAS group. Sixteen interventions under three bundles- preoperative (6), intraoperative (2), and postoperative (8) were introduced in ERAS protocol. Data were collected prospectively in this group and compared with a retrospective patient cohort (pre-ERAS) which was propensity-matched for age, sex, and type of diagnosis. Both the groups were compared for length of stay (LOS), postoperative analgesic consumption, VAS scores, ODI index and complications. **Results:** In comparison to matched pre-ERAS cohort, ERAS cohort had significantly less LOS [2.36 (0.89) days versus 5.70 (1.73) days-p-value: < 0.001]. Pain scores at 6,12, 24, and 48 hours in ERAS group were 1.77 (0.52), 2.58 (1.48), 2.92 (1.13), 2.59 (1.15), which were significantly (p < 0.001) lesser than the pre-ERAS cohort; 6.19 (1.07), 6.45 (1.64), 4.70 (1.32), 3.49 (1.23) respectively. Disability index-(ODI) at 1-month after surgery was significantly lower in ERAS - 25.67 (6.25) versus 41.27 (7.37)- p-value < 0.001. Postoperative consumption of NSAIDS and opioids was significantly less in ERAS group. There was no significant difference in the complication rates (wound dehiscence, dural rupture, organ dysfunction, infection) in the immediate postoperative period and at 1-month.

Conclusion: ERAS in dorso-lumbar spine surgeries shortens LOS and postoperative analgesic consumption with no difference in the complication rates. There is improved functional outcome (measured using ODI) in the ERAS group at 1-month follow-up.

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A238: Larger deformations are experienced by vertebrae adjacent to degenerated intervertebral discs

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Introduction: Intervertebral discs (IVDs) degeneration involves changes in biomechanics, structure of the extracellular matrix, and cellular activities and can turn into a painful pathological condition [1]. How these changes can affect the load transfer through the vertebrae, and consequently the local mechanical behaviour and the risk of fracture of the vertebrae is still unclear. The effects of the IVDs degeneration on the adjacent vertebrae can be evaluated experimentally by combining biomechanical tests and Digital Image Correlation (DIC) to characterize, simultaneously, the external deformation of both vertebrae and IVDs. This study aims to evaluate the deformations on vertebrae adjacent to an intact and degenerated IVD. **Methods:** Seven T9-L1 spine segments from human donors (Ethical approval: Prot.n.113043) and imaged with a 3T Magnetic Resonance Imaging and a Computed Tomography to establish the degeneration of the IVDs (Pfirrmann grade = 2) [1] and exclude critical bone pathology. All soft tissues and the anterior ligament were removed without damaging the IVDs. A high-contrast white speckle pattern was prepared on the surface of each specimen. A four-cameras 3D-DIC system (Aramis Adjustable 12M, GOM) was used to measure the deformation on the surface of the specimens (measurement spatial resolution = 0.07mm). The spatial distribution of the deformation was evaluate through 3D deformation colour maps. The intact specimens were mechanically tested with a uniaxial testing machine (Instron 8500, 10kN load cell) to induce flexion, bending and compression loads in elastic regime, as defined by [2]. Artificial IVDs degeneration (nucleotomy) was mechanically induced [3] on the left side of the T11-T12 IVD to simulate a Pfirrmann grade 5 of degeneration [1]. Then, the degenerated specimens were tested again, following the same loading protocol. The compressive deformations were measured and compared before and after the IVD degeneration. **Results:** Random errors were smaller than 100me. The compressive deformations were larger after IVDs degeneration in the vertebrae adjacent to the degenerated IVD: +30% in flexion; +25% in left bending (side of mechanical degeneration); +10% in right bending; + 50% in pure compression. Regions with concentrations of deformation appeared after IVD degeneration close

to the endplate on the most stressed side: e.g. on the right side of the specimen during the right bending loading. **Conclusion:** IVD degeneration leads the vertebrae adjacent to the degenerated IVD to experience local larger deformations at the endplate. Moreover, in case of osteoporotic or metastatic vertebrae, the effects of the IVDs degeneration can be emphasized due to the internal alteration of the microstrcture. Indeed, in patients with degenerated IVDs and low bone mineral density, fractures can be expected [4]. Thus, further analyses are on going to: include a subregional analysis, on each vertebra and IVD, to identify the most deformed portion after the degeneration induced; to include the evaluation of the effects of the IVD degeneration on metastatic vertebrae.

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A239: Ligamentum flavum: analysis of vascularisation and micromechanical mapping

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Introduction: Lumbar spinal stenosis (LSS) is a serious and relatively common disease in the aging population. To the development of LSS significantly contribute degenerative changes of ligamentum flavum (LF). There is no prophylaxis of this disease in current knowledge yet. Previous studies have examined the pathophysiology and biochemical changes that cause the hypertrophy. Although it is natural to consider that the mechanical properties of ligamentum flavum can be altered due to ligamentous hypertrophy, only few studies have mentioned on this point. In our previous project, we found that vascularization of the LF is age-dependent, and the LF in patients with LSS has a significantly lower stiffness. However, to date, there are no reports describing local vascularisation and nanomechanical properties of ligamentum flavum depending on anatomical localization. The aim of our study is now (1) a detailed mapping of micromechanical properties (stiffness), vascularization, occurrence of inflammation and chondroid metaplasia of the ligament as a whole (comparison of its individual segments) and

comparison in individual levels L3-L5 and (2) comparison of these parameters in the ligaments of healthy patients and patients with LSS. **Design of Study:** Vascular density analysis of degenerated and healthy human ligamentum flavum combined with measurement of micromechanical properties. **Material and Methods:** The study involved patients who underwent surgery for lumbar spinal stenosis (LSS group) and for disc herniations without the presence of LSS (control group). We have examined 30 intraoperatively collected LF samples from 23 patients (14 LSS and 9 control group). Sample vascularization is characterized as microvascular density (L_v). Samples are also histologically examined for the presence of chondroid metaplasia and inflammation. Mechanical properties of native LF samples are analyzed using the Hysitron TI 950 TriboIndenter™ nanomechanical testing system. Quasi-static nanoindentation is performed to obtain loading curves and create maps of the local mechanical properties of each ligament. Each ligament is divided into nine segments. We perform a statistical analysis of the measured values depending on the observed parameters (age, presence of LSS, ligament segment, L3-S1 levels). **Results:** Within the individual segments of the ligament, there is significantly higher vascularization in its central part. Increased vascularization is significantly associated with the occurrence of chondroid metaplasia and inflammation. Average elastic moduli fluctuate between 3 kPa and 178 kPa. The ligament appears very inhomogeneous. But we found a gradient of ligament stiffness depending on its segments. **Conclusion:** This study shows that: (1) the vascularization of the central part of ligament is higher than the peripheral parts and the stiffness of this part is significantly higher than the stiffness of the peripheral parts. (2) Increased vascularization is significantly associated with the occurrence of inflammation and chondroid metaplasia.

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A240: Development of novel animal model for the study of scoliosis by non-invasive method and its validation through gene expression analysis

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Study Design: To induce scoliosis in young female wistar rats by Non-invasive method and validation of the model. **Purpose:** To induce scoliosis in a rat model through non-invasive method by bracing and to study the corresponding gene expression profile in the spine and different organs. **Overview of literature:** Scoliosis is an abnormal lateral curvature of the spine. The causes for scoliosis are still not clear. Literature suggests that scoliosis is

genetically heterogeneous, as there are multiple factors involved directly or indirectly in its pathogenesis. Clinical and experimental studies were done to understand the etiology of anatomical alterations in the spine and other internal organs, as the findings could help the clinicians in designing new ways of treatment. **Materials and Methods:** 12 female Wistar rats aged 21 days were chosen for the study, customized braces, RT-PCR primers. Radiological analysis (X-rays) Histopathology, SYBR green, Real time polymerase chain reaction (RT-PCR) analysis. **Results:** The spine of 6 rats was braced in deformed position which resulted in a permanent structural deformity and was confirmed by X-ray studies. The remaining rats were used as controls. The quantitative gene expression studies of the following genes (Osteocalcine, Pleiotrophins, MMPs, TIMP, interleukin 1 and 6, Tumor necrosis factor- alpha) showed differential and significant upregulation in different organs of scoliotic rats in comparison to the control rats. The results were statistically significant ($p < 0.05**$). Histopathological findings showed tissue necrosis and fibrosis in the brain, retina, pancreas, kidney, liver and disc of scoliosis rats. **Conclusions:** Bracing is a non-invasive method for inducing scoliosis in an animal model with 100% reliability with corresponding changes in the genetic expression. The scoliosis is not just a spine deformity but it can be termed as a systemic disease based on pathological changes observed in the various internal organs.

1829
A241: The potential of pre-conditioned human nasal chondrocytes for nucelus pulposus repair

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Introduction: The success of cell-based intervertebral disc (IVD) therapies is still limited, partly due to the degenerative environment that restricts the survival and function of therapeutic cells. Spheroids generated from human nasal chondrocytes (NCS) can survive in microenvironment simulating degenerative disc disease (DDD). However, the function of NCS for therapeutic use should still be enhanced. In order to optimize the therapeutic function of NCS, we have developed an ex-vivo pre-clinical model in order to mimic early-stage DDD. **Material and Methods:** Our ex vivo model is based on bovine IVD cultured under dynamic physiological loading in a bioreactor for 7 days. To mimic early-stage DDD, nucleus pulposus (NP) was digested with chondroitinase ABC (ChABC) and injected with IL1-b to induce inflammation. Additionally, the IVDs were cultured in hypoxia, low glucose, acidity, and low-grade inflammation (DDD condition),

recapitulating the low nutrient inflammatory environment of DDD. Pre-conditioned NCS were formed for 3 days and injected into the ChABC-DDD model for additional 7 days. Samples were analyzed by MRI, Immunofluorescence and ELISA. **Results:** Culturing bovine IVD under dynamic physiological loading in a bioreactor in DDD condition for 7 days is causing degradation of proteoglycan (Safranin-O) and the consequent loss of water content important for weight bearing capacity, as shown by MRI T2. Histological analyses revealed significantly higher number of apoptotic cells (Caspase-3) and a shift towards catabolic/pro-inflammatory state (MMP-13, IL-8) compared to control IVDs. Pre-conditioning NCS in Hypoxia together with IL1-Ra lead to increased survival in DDD environment (Caspase-3) and reduced inflammation (IL-8 release) in the disc. Pre-conditioned NCS are dissociating and engrafting into NP target tissue within 7 days. Mechanisms of survival and engraftment are currently being investigated. **Conclusion:** The ChABC-DDD ex vivo model mimics early-stage IVD disease. Furthermore, we demonstrated that NCS can be injected into this model and stay in the harsh DDD environment. Pre-conditioning in Hypoxia with IL1Ra increases NCS cell survival and engraftment. Safety and efficacy of NCS therapy will be evaluated in follow-up animal study.

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A242: Flexible materials maintain disc height and support the formation of hydrated tissue engineered intervertebral discs in vivo

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Introduction: A challenge in achieving optimal performance of tissue-engineered replacements for disc degeneration is maintaining disc height (DH) following implantation. One method for maintaining DH is mechanically augmenting tissue engineered intervertebral discs (TE-IVDs) with support cages. These cages must be able to support spinal loads without failing. As such, material selection is crucial for the long-term success of TE-IVDs. FPLA is a flexible filament that is amenable to the fabrication of TE-IVD support structures. Previously, FPLA cages withstood twice the deformation of polylactic acid (PLA) cages without detrimental changes in mechanics or fracture. However, no study has evaluated the difference between a rigid or a flexible material's ability to maintain DH or hydration in vivo, both which facilitate integration. In this study, we implanted empty cages and TE-IVDs cultured in FPLA, hypothesizing that FPLA implants would maintain DH and tissue hydration better than PLA for 6 weeks in the minipig spine. **Material and Methods:** Nucleus pulposus cells were encapsulated in 3% (wt./vol.) alginate at $10x10^6$ cells/mL. Annulus fibrosus cells were encapsulated in 10 mg/mL type I collagen at $10x10^6$ cells/mL

and pipetted around NP plugs. TE-IVDs were cultured in cages for 18 days. Empty cages and TE-IVDs were implanted at C3-4 or C5-6 following discectomy (DX) in Göttingen minipigs with additional levels as a DX control (n = 10 animals, n = 12 implants, n = 4 DX). Weekly x-rays were taken until endpoint or failure. Disc height indices (DHI) for PLA and FPLA cages were calculated and compared. T2 MRI scans of TE-IVDs cultured in FPLA (n = 4) were taken to quantify hydration. Analysis of cage DHIs and TE-IVD hydration were performed with a one-way ANOVA. DHIs of TE-IVDs were analyzed using a one-way nested ANOVA. **Results:** All implants remained in place following implantation. PLA cages failed within 2 weeks, with terminal DHIs that were similar to DX levels. Meanwhile, FPLA cages maintained native DH for 6 weeks, with DHIs twice as large as DX levels (p < 0.0001). Of the 4 TE-IVDs, 2 remained in place and 2 were displaced. Constructs that remained in place yielded DHIs that were similar to native and significantly greater than displaced and DX levels (p < 0.05). Displaced levels yielded DHIs that were significantly lower than levels that remained in place, but greater than DX (p < 0.05). Levels treated with TE-IVDs maintained hydration that was greater than cage or DX (p < 0.0001) and half the hydration of native disc. **Conclusion:** Flexible support materials led to superior DHI maintenance and tissue hydration when compared to rigid PLA. DHI maintenance by FPLA cages is consistent with its ability to conform to features of adjacent vertebrae without fracture. Although displacement led to a decrease in DHI, displaced levels had a greater DHI when compared to DX levels, implicating the therapeutic benefit of implanting support cages. TE-IVDs that remained in place maintained hydration for 6 weeks at half the T2 relaxation time of native disc. This relaxation time is consistent with findings in other large animals. Therefore, FPLA is more suitable than PLA for fabricating TE-IVD support structures.

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A243: Biomechanical limitations of partial pediculectomy in endoscopic spine surgery

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Background Context: Transforaminal endoscopic decompression is an emerging minimally invasive surgical technique in spine surgery. The biomechanical effects and limitations of resections associated with this technique are scarce. **Purpose:** The objective of this study was to analyze the effects of three different extents of reduction at the craniomedial pedicle (10%, 25%, and 50%) and to compare them with the intact native side. In addition, the influence of bone quality on the resistance of the pedicle after reduction was investigated. **Study Design:** Biomechanical cadaveric study.

Methods: Thirty lumbar vertebrae originating from six fresh frozen cadavers were tested under uniaxial compression load in a ramp-to-failure test: (1) the reduced pedicle on one side, and (2) the native pedicle on the other side. Of the 30 lumbar vertebrae, ten were assigned to each reduction group (10%, 25% and 50%). **Results:** On the intact side, the median axial compression force to failure was 593 N (442.4 - 785.8). A reduction of the pedicle by 10% of the cross-sectional area resulted in a decrease of the axial load resistance by 4-66% compared to the intact opposite side ($p = 0.046$). The median compression force to failure was 381.89 N (range: 336 - 662.1). A reduction by 25% resulted in a decrease of 7-71% ($p = 0.001$). The median compression force to failure was 333 N (265.1 - 397.3). A reduction by 50% resulted in a decrease of 39-90% ($p < 0.001$). The median compression force to failure was 200.9 N (192.3 - 283.9). At 10% pedicle reduction, the Hounsfield units (HU) value and the absolute force required to generate a pedicle fracture showed significant correlations ($\rho = 0.872$; $p = 0.001$). At 25%, a positive correlation between the two variables could still be identified ($\rho = 0.603$; $p = 0.065$). At 50%, no correlation was found ($\rho = -0.122$; $p = 0.738$). **Conclusion:** Resection of the inner, upper part of the pedicle significantly reduces the axial resistance force of the pedicle until a fracture occurs. **Clinical significance:** The extent of pedicle reduction itself plays only a limited role: once the cortical bone in the pedicle region is compromised, significant loss of resistance to loading must be anticipated.

Keywords: pedicle reduction; partial pediculectomy; foraminoplasty; transforaminal; endoscopic approach; endoscopy

OP28: Contemporary Topics in Lumbar Degenerative

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A244: The role of paraspinal muscles in outcomes after decompression and fusion surgery in patients with degenerative spondylolisthesis

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Introduction: Decompression and fusion surgery is a widely accepted treatment for symptomatic degenerative lumbar spinal stenosis (DLS). Atrophy of the paraspinal muscles (PM) has been linked to spinal conditions, such as lower back pain and sagittal malalignment. However, its association with outcomes after lumbar fusion surgery has yet to be investigated. This study aimed to examine the influence of fatty infiltration (FI) of the PM on the improvement in the Oswestry Disability Index (ODI) in patients undergoing decompression and fusion surgery for symptomatic DLS. **Material and Methods:** We retrospectively analyzed prospectively enrolled patients with symptomatic DLS undergoing decompression and fusion surgery. ODI was assessed preoperatively and two years postoperatively. A representative cross-sectional area of the PM was measured on a T2-weighted axial MRI sequence at the upper endplate of L4. The FI of the erector spinae, multifidus, and psoas muscles was determined using custom software (MuscleEval). Improvement in ODI was calculated as the difference between the pre-operative and follow-up ODI. Based on the literature, a 10-point improvement cut-off was defined as the minimum clinically important difference (MCID) for ODI. Patients with a baseline ODI below the MCID were excluded. Logistic regression was used to calculate the association between the PM and the odds ratio for an improvement in ODI $\geq$ MCID, adjusted for age, sex, and BMI. **Results:** 138 patients were included in the final analysis, with only two lost to follow-up. The median age was 68 years (IQR 62 – 73), the median BMI was 29 kg/m2 (IQR 26 - 33), 70.3% were female, 73.9% of patients had spondylolisthesis Grade 1, and the most common level of DLS was L4/5 (63.8%). The median preoperative ODI was 23 (IQR 17 - 28) with a median improvement of 13 (IQR 6 - 22), and 64.8% of patients had an MCID change in ODI. The median FI of the erector spinae was 40.0% (IQR 33.3% - 47.0%), of the multifidus 59.9% (IQR 50.4% - 70.1%), and for the psoas 6.0% (IQR 3.3% - 9.3%). Patients with a multifidus FI < 60% had a median ODI improvement of 17 points, while patients with a multifidus FI $\geq$ 60% had a median gain of 13 points ($p = 0.047$). With increased FI infiltration, the likelihood of clinically significant improvement (> 10 points) decreases significantly ($p = 0.004$). In the multivariable linear regression, the FI of the erector spinae and multifidus had a significant effect on the OR for the likelihood of MCID improvement in ODI (erector spinae: OR: 0.94, 95% CI: 0.90 - 0.99, $p = 0.010$; multifidus: OR: 0.93, 95% CI: 0.90 - 0.97, $p < 0.001$), while the psoas had no significant effect ($p = 0.469$). **Conclusion:** This study demonstrates that FI of the PM, specifically of the erector spinae and multifidus, is significantly associated with less likelihood of clinically relevant ODI improvement following decompression and fusion surgery. Further research is needed to assess the effect of interventions to strengthen the PM.

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A245: Step activity after spine surgery: which patients are slower to return to baseline?

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Introduction: There is limited evidence available that can help surgeons predict the time at which patient's return to their baseline level of activity after spine surgery. There has been an established association between daily step-count and all-cause mortality as well as overall cognitive function. The goal of the study was to determine if there was an association with the time at which patients returned to their baseline level of activity compared after having spine surgery with pre-operative activity levels as measured by a pedometer. **Methods:** Prospective data was collected for 49 patients who underwent either single or two-level anterior cervical discectomy and fusion (ACDF), lumbar laminectomy or laminotomy with or without fusion from 2019-2022 at a single academic institution. Pre-operative and post-operative step counts were measured using a pedometer. The primary outcome measure was the step counts recorded during the pre-operative and post-operative periods. Secondary outcomes were changes in the postoperative visual analog scale (VAS), Oswestry disability index (ODI), or patient-reported outcome measure (PROMIS) at the time of returning to or exceeding baseline step counts. Patients were divided into light, moderate or active and intense activity levels based on pre-operative step counts. An analysis of variance was performed to identify differences between activity level groups. Bivariate and multivariate linear regression models were used to determine the relationship between the primary outcome and key characteristics. A p-value < 0.05 was considered significant. **Results:** A total of 49 patients were included. The median pre-operative step count for all patients was 4380 and the average time at which patients surpassed their average pre-operative step count was 21.6 days. Moderate activity patients took about 1 day longer to return to their pre-operative step count compared with light activity groups at the 2-week post-operative period (p = 0.0256 95% CI 0.1054 - 1.9006). A multivariate linear regression showed that ACDF patients returned to pre-operative step count 0.9 days sooner than lumbar surgery patients (p = 0.0017). There was no significant difference in VAS, ODI and PROMIS results at the time which patients returned to or exceeded their baseline step activity. At 6 months post-op, mean VAS scores decreased from 4.06 to 2.67 (p-value = 0.14), ODI scores decreased from 44.75 to 29.71 (p-value = 0.12), PROMIS pain results decreased from 65.70 to 62.83 (p-value < 0.05) and PROMIS function results increased from 35.78 to 41.67 (p-value = 0.15). **Conclusion:** Patients who are considered moderate activity as measured by their pre-operative step counts take longer to return to their baseline activity than those who are considered light activity after spine surgery at the 2-week mark. Pre-operative step counts can be a useful indicator when discussing expectations after spine surgery. Patients can be expected to have similar patient reported outcomes regardless of the time at which they reach or exceed their pre-operative step counts. The evidence can be helpful when counseling patients who are having a delayed recovery and moderately active at baseline. The results also supported that appropriately indicated ACDF, lumbar laminectomy or laminotomy with or without fusion can improve patient pain reported outcomes.

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A246: Risk factors for patient nonsatisfaction after instrumented lumbar interbody fusion - A longitudinal dual-center study of 474 patients

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Introduction: Patients with severe axial low back pain remains a challenge for spine surgeons since it is still unclear when surgery is necessary. Instrumented interbody fusion is the main surgical therapy option. However, moderate to high patient nonsatisfaction rates were discovered in earlier investigations following instrumented lumbar fusion. As a result, it is important to identify possible non-responder patients in order to ensure patient satisfaction. **Material and Methods:** This was a longitudinal eight-year dual-center study on patients undergoing instrumented single-level fusion surgery, with either posterior- or transforaminal lumbar interbody fusion. Pre- and postoperative data were prospectively collected. We looked at the relationships between preoperative factors including pain severity, disability (measured by the Oswestry Disability Index (ODI)), preoperative duration of back pain, prior discectomy, and expectations for postoperative return to work. We also evaluated additional patient characteristics and pain profiles. **Results:** The cohort included 474 patients, of which 86 (18%) expressed nonsatisfaction at two-year follow-up. The nonsatisfaction group demonstrated significant higher preoperative VAS scores for leg pain (75 ± 19 vs. 68 ± 21, p = 0.006) and leg pain (65.3 ± 25 vs. 58 ± 28, p = 0.004). Patients with a preoperative VAS score of 0-40 experienced 13% treatment nonsatisfaction, 15% for VAS 41-79, and 25% for VAS 80-100. Preoperative ODI score, age, body mass index, length of back pain, walking distance, and frequency of preoperative sick leave did not significantly differ between the groups (p > 0.05). The preoperative job status of the patients and their expectations for their

postoperative return to work did not differ significantly (p > 0.05). **Conclusion:** Higher levels of preoperative back and leg pain were risk variables for post-lumbar instrumented fusion nonsatisfaction. Patients who reported experiencing severe preoperative pain (VAS 80-100) had a significant decline in surgery satisfaction rate. Patient-reported outcome analysis should be included in the preoperative patient selection.

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A247: Randomized controlled trial comparing the effects of pre-emptive single-dose ketorolac and dexamethasone on postoperative pain score and morphine consumption after lumbar laminectomy

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Introduction: Degenerative changes in the lumbar spine can lead to lumbar stenosis or nerve root compression, currently, there is no consensus on the optimal methods for postoperative pain management. This trial aimed to compare ketorolac and dexamethasone for postoperative pain and morphine use in lumbar laminectomy patients. **Material and Methods:** This study included 120 patients, ranging in age from 18 to 75 years old, who were undergoing lumbar laminectomy. The patients were randomly assigned to either the ketorolac (30 mg iv) group or the dexamethasone (8 mg iv) group. The study aimed to evaluate two main factors: the amount of morphine used, and the pain levels measured by the visual analog scale (VAS) at specific times after surgery, including the post-anesthetic care unit (PACU), as well as at 12, 24, and 48 hours following the procedure. Furthermore, any adverse events that occurred during the study were thoroughly recorded. **Results:** The group of patients who were given ketorolac required less morphine than those in the dexamethasone group after 48 hours (with a p-value of 0.01). However, patients in the dexamethasone group had lower VAS scores than those in the ketorolac group after 24 hours (with a p-value of 0.01). Importantly, no serious adverse events occurred, including respiratory depression and surgical site infections. **Conclusion:** After a lumbar laminectomy procedure, a single preemptive dose of ketorolac showed a slight decrease in postoperative morphine usage 48 hours later when compared to dexamethasone. However, there was no noticeable effect on the patient's pain scores.

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A248: Feasibility of the non-window type 3D-printed porous titanium cage in posterior lumbar interbody fusion: A randomized controlled multicenter trial

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Introduction: Since the majority of 3D-printed porous structured titanium (3D-Ti) cages are window type with a bone graft void, the question arises whether a non-window type cages without bone graft void might provide a broader contact surface for improved osteointegration. To date, a few comprehensive comparative studies has been conducted on the clinical and radiographic outcomes between window and non-window type 3D-Ti cages. This study conducted a multicenter, prospective randomized clinical trial to compare clinical and radiologic outcomes between window and non-window 3D-Ti cages in posterior lumbar interbody fusion (PLIF). **Methods:** Seventy patients planned for single-level PLIF were randomly assigned to either receive window type 3D-Ti cages (n = 37) or non-window type 3D-Ti cages (n = 33). Radiographic outcomes, including fusion rates, subsidence, and intra- and extra-cage osteointegration patterns, were assessed. The assessment of interbody fusion on the multiaxial CT scans was conducted using the following scoring systems. The new bone formation in the extra-cage space of both groups was evaluated using the Extra-Cage Bridging Bone (ExCBB) score, which ranges from 0 to 2, with grade 2 indicating successful fusion. Intra-cage osteointegration was assessed using the Intra-Cage Bridging Bone (InCBB) score for window type cages and a Surface Osteointegration Ratio (SOR) score for non-window type cages (both scores ranging from 0 to 2). Additionally, we examined the presence of the trabecular bone remodeling (TBR) sign on coronal CT images, which indicated the trabecular reaction between cage-endplate intersurface and vertebral body. Clinical outcomes were evaluated using the EuroQol-5-Dimensional questionnaire (EQ-5D), Oswestry Disability Index (ODI), and visual analog scale (VAS) for back and leg pain. **Results:** Out of the 61 patients, 58 achieved interbody fusion, resulting in a 95.1% fusion rate. There was no statistically significant difference in fusion rates between the window and non-window type 3D-Ti cages

(93.8% vs. 96.6%, respectively). While the subsidence rate was higher in the window type group compared to the non-window group, this difference was not statistically significant (15.6% vs. 3.6%, p = 0.262). The summation of ExCBB scores showed no significant difference between the two cage groups (5.7 ± 1.7 vs. 5.6 ± 1.3, p = 0.801). However, there was a significant difference in intra-cage osteointegration scores (p = 0.007), with the non-window cage group displaying a higher proportion of cases with a score of 4 compared to the window cage group. TBR was observed in 83.6% of patients with interbody fusion, with a slightly higher rate in the non-window cage group (89.7% vs. 78.1%, p = 0.385). Clinical outcomes, including ODI, EQ-5D, and back and leg VAS, improved significantly at the 12-month postoperative follow-up in both groups. **Conclusion:** This study demonstrates that non-window type 3D-Ti cages, which do not have a void for bone graft, can achieve an interbody fusion rate equivalent to that of window type cages, with a relatively low subsidence rate. These findings could provide valuable insights into the selection of appropriate cage designs for lumbar interbody fusion surgery and may inform future clinical practice.

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A249: Comparative study of posterior surgery for lumbar spine diseases with lateral listhesis and scoliotic disc wedging - Minimally invasive decompression vs. transforaminal lumbar interbody fusion

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Introduction: In recent years, minimally invasive posterior decompression has expanded its indications for lumbar spine disease, such as degenerative spondylolisthesis and degenerative lumbar scoliosis. However, there is no consensus regarding the indication of decompression for these lumbar spine diseases. The authors previously reported that lateral listhesis and scoliotic disc wedging are risk factors for reoperation in the posterior decompression for lumbar spine diseases. This study compares minimally invasive posterior decompression and posterior decompression/fusion on the clinical results and radiographic parameters of lumbar spine disease with lateral listhesis and scoliotic disc wedging. **Materials and Methods:** This study prospectively enrolled 110 consecutive patients who underwent posterior surgery for lumbar spine disease with lateral listhesis and scoliotic disc wedging in our hospital. Seventy-one patients in Group A (71 years old, 42 men and 29 women) performed microscopic bilateral decompression via unilateral approach (MBDU). Thirty-nine patients in Group B (73 years old, 15 men and 24 women) performed transforaminal lumbar interbody fusion (TLIF). We investigated clinical outcomes and reoperation rates 2 years after the operation between 2 groups. **Results:** Two years after the operation, the recovery rate of the JOA score was 52.9% in Group A and 57.4% in Group B. There was no significant difference in the rate between the 2 groups. The changes of VAS (low back pain/leg pain) were (-11/-42) mm in Group A and (-32/-46) mm in Group B, the change of SF-36 (PCS/MCS) were (13/1) points in Group A and (15/3) points in Group B. There was no significant difference in the changes in clinical scores between the 2 groups. There were 7 cases of reoperation in Group A and no case in Group B. The number of cases of reoperation was significantly higher in Group A. Regarding preoperative sagittal alignment parameters and the postoperative change of the parameters, there was no significant difference between the 2 groups. On the coronal parameters, intervertebral disc wedging in Group A changed from 5.1 degrees before surgery to 7.2 degrees 2 years after surgery. However, there was no significant difference between the 2 groups in changes in coronal parameters (scoliosis and intervertebral disc wedging). The 2 groups had no significant difference in the proportion of cases with lateral listhesis increasing. Evaluating reoperation cases in Group A, the recovery rate of the JOA score was 24%. The VAS changes (low back pain/leg pain) were (10/-39) mm. The changes of SF-36 (PCS/MCS) were (-2.7/-14.3) points. The clinical outcomes of the reoperation cases were significantly worse than those without a reoperation. **Conclusion:** Minimally invasive posterior decompression for lumbar spine disease patients with lateral listhesis and scoliotic disc wedging has a higher reoperation rate than transforaminal lumbar interbody fusion. The clinical outcomes of the reoperation cases were unfavorable. With these factors, we recommend that surgeons indicate fusion surgery for lumbar spine diseases.

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A250: Cascade links among paraspinal muscles degeneration, inflammatory process, and related back pain in patients with lumbar disc herniation

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Introduction: Recent studies have provided evidence that structural changes in paraspinal muscles are associated with intervertebral disc degeneration, ubiquitous with low back pain (LBP), and potentially thought to be regulated by inflammatory processes. However, the cascade links remain unclear. The aim of this prospective study was performed to determine the relationships between pain and structural changes in paraspinal muscles of 166 lumbar disc herniation (LDH) patients through comparisons with 80 healthy subjects. Moreover, a cohort study

was conducted to investigate structural changes that differed in LDH patients with and without LBP and the associations between the expression of inflammatory marker(s) and structural changes. **Material and Methods:** Cross-sectional areas (CSAs) and fatty degeneration of muscles were measured. Multifidus muscle (MM) tissue was procured from included individuals undergoing surgery. Gene expression was quantified using qPCR assays. Independent t-test, Chi-square, and Spearman correlation were used for data analysis. Functional CSA and fatty degeneration of MM were larger in healthy group than LDH group. **Results:** A significant increase in fat infiltration in MM in LBP group than in non-LBP group. TNF was 28-fold greater in high-fat infiltration group than low-fat infiltration group within MM. Expression of TNF and IL-1β in MM was moderately correlated with functional CSA and fatty degeneration of MM, which was moderately correlated with clinical outcomes. **Conclusion:** Results support the hypothesis that intervertebral disc degeneration is associated with dysregulation of the inflammatory state of local MM, which provides initial evidence that inflammatory dysregulation in paraspinal muscles has the potential for a broad impact on tissue health and LBP symptoms.

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A251: Evaluation of mRNA tumor necrosis factor alpha (TNF - a) level from nucleus pulposus, annulus fibrosus and facet joint tissue in degenerative lumbar canal stenosis patients

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Introduction: The etiology of pain that arises in the degenerative disease of lumbar canal stenosis is still a challenge to be analyzed based on specific involved structure that composing spine region. Two of the structure that presumably elicit the pain is intervertebral disc and facet joint. Increasing pain which experienced by the patient is strongly associated with an increasing of level specific inflammatory mediator Tumor Necrosis Factor-alpha (TNF- α**)**. The purpose of this study is to evaluate the level of mRNA specific for TNF-a which expressed in related structure of degenerative lumbal canal stenosis disease; nucleus pulposus, annulus fibrosus, and facet joint. Along with the evaluation of TNF-a expression, this study aimed to observe the correlation between level of mRNA TNF-a and subjective parameters such as VAS score for pain severity, pain characteristic and pre operative score Oswestry Disability Index (ODI). **Material and Methods:** This study used cross-sectional model involving ten patients with degenerative lumbar canal stenosis who had undergone surgery. Six male and 4 female subjects with an average age of 50 years. Soft tissue samples

from the nucleus pulposus, annulus fibrosus and facet joints were obtained during the surgery. Available samples then processed using conventional semi-quantitative reverse chain transcription polymerase reactions to determine level of specific mRNA expression of inflammatory mediator TNF-α. Collected data then analyzed using statistical program to compare level of mRNA TNF-a between each source and to observe its correlation with subjective parameters. **Results:** The level of mRNA TNF-α expression in facet joint groups were (4.13 ± 11.63) which significantly higher compared to the annulus fibrosus group (2.32 ± 6.01) and nucleus pulposus (-1.32 ± 6.5). There is a relationship between increased mRNA TNF-α expression in facet joints with an increase in pain levels with VAS (p < 0.001), assessment of preoperative clinical outcomes using the Oswestry Disability Index (IDO) (p < 0.001), axis pain type (p < 0.002). **Conclusion:** Increasing level of TNF-α involved in the progression of degenerative lumbar canal stenosis was observed. Expression of mRNA TNF-α from the facet joint observed to be higher than the other structure. It as well has a strong positive correlation with the subjective parameters (pain severity, pain characteristic and pre-operative condition,).
Keywords: mRNA; TNF-α; degenerative lumbar canal stenosis

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A252: Low Hounsfield Units on CT and risk of cage subsidence following oblique lumbar interbody fusion surgery

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Introduction: Subsidence of the cage following oblique lumbar discectomy and fusion (OLIF) reduces the expansion of the intervertebral foraminal height attained during surgery, can cause the recurrence of neurological symptoms that existed prior to surgery. Preoperative evaluation of the patient's bone quality is necessary to evaluate risk factors associated with cage subsidence. This study investigated the relationship between the Hounsfield Unit (HU) of the lumbar spine and cage subsidence. **Material and Methods:** This retrospective study included 77 segments on 43 patients with at least 2 years of follow-up after 1-2 segments of OLIF between 2016 and 2020. We analyzed cage subsidence, intervertebral disc height restoration amount, the HU of vertebral bodies above and below the surgical segment, and fusion status. On X-ray, cage subsidence was identified as endplate invasion of the vertebral body. **Results:** Within two years after surgery, cage subsidence was observed in 12.5% of the 77 segments. The average cage settlement was 4.3 millimeters (2.16 to 8.2 millimeters). The average HU of the entire lumbar spine (L1-L5 lumbar vertebrae) was considerably lower in the cage subsidence group (152,1 HU versus 112.7 HU).

Specifically, the HU of the lower lumbar spine following the surgical segment more accurately reflected the degree of subsidence than the HU of the upper lumbar spine. There was a tendency that the subsidence frequency of the cage increased when it was located in the middle rather than the anterior portion of the lumbar vertebrae. **Conclusion:** We determined the relationship between cage subsidence and HU on preoperative CT after OLIF through this study. Cage subsidence following surgery in patients with low HU necessitates appropriate evaluation prior to surgery and caution during surgery when the HU is low.

OP29: Novel Technologies: Navigation, AI, and Robotics

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A253: Simultaneous navigated posterior instrumentation and anterior exposure in lateral single position surgery improves operative efficiency and maintains safety

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Introduction: Computer-assisted navigation is increasingly being used for accurate placement of posterior instrumentation instead of fluoroscopy. While several studies have evaluated the accuracy of pedicle screw placement in the prone position with navigation, few have evaluation navigation in the context of lateral decubitus single position lumbar surgery (LSPS), and none have evaluated the efficacy of performing anterior exposure and posterior instrumentation simultaneously. **Materials and Methods:** Retrospective review of prospectively enrolled patients undergoing 1-4 level LSPS fusion involving anterior lumbar interbody fusion (ALIF) with or without additional LLIF, performed by 2 surgeons at 2 institutions in 2 countries were analyzed. Patients were divided according to the technique for placement of their pedicle screws. 'Nav' patients had simultaneous bilateral pedicle screw placement during anterior exposure performed by the access surgeon. The navigation was registered with intraoperative 3D fluoroscopy. 'Fluoro' patients had bilateral pedicle screw placement either before, or following anterior access, using fluoroscopic guidance. Patient demographics, operative metrics, length of stay, radiation dose, intraoperative and perioperative complications, reoperation at 90-days and radiological analysis were compared using independent samples t-tests and chi-squared analyses as appropriate with significance set at $p < 0.05$. **Results:** 92 patients underwent LSPS, 50 Nav and 42 Fluoro. Age, gender and BMI were similar between

groups. The mean levels fused (1.80 vs. 1.55, $p = 0.252$) and levels fused with ALIF (1.16 vs. 1.26, $p = 0.241$) were similar. A similar proportion of patients underwent LLIF in addition to LSPS (34.00% vs. 26.20%, $p = 0.417$). There were no significant differences in the proportion of procedures involving L4-5 ALIF (26.00% vs. 28.60%, $p = 0.782$) and L5-S1 ALIF (90.00% vs. 92.90%, $p = 0.628$). The Nav group had a 24% reduction in the mean operation time (123.86 vs. 162.64 mins, $p = 0.020$). Length of stay (2.31 vs. 2.52 days, $p = 0.628$) and fluoroscopic dose (58.77 vs. 46.42 mGy, $p = 0.232$) were similar, however operating room staff were not exposed to the majority of this radiation in the Nav group. Intraoperative complications were similar (6.00% vs. 9.50%, $p = 0.525$), vascular injury rates were similar (2.0% vs 2.4% $p = 0.901$), however postoperative complications (4.00% vs. 26.20%, $p = 0.002$) were lower in the Nav group. Reoperation at 90-days (4.00% vs. 7.10%, $p = 0.508$) were similar, with no instrumentation related revisions in the Nav group, compared to a 7.10% rate in the Fluoro group ($p = 0.055$). Radiographic alignment was similar between groups. **Conclusions:** Simultaneous navigated posterior instrumentation during anterior exposure in LSPS improves operative efficiency and may reduce instrumentation related complications without compromising safety.

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A254: Atlantoaxial screw placement in 54 patients with traumatic upper cervical spine injuries: comparison of 3D-controlled fluoroscopy-based and navigated techniques in terms of accuracy and safety

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Introduction: Instable injuries to the upper cervical spine can require surgical treatment. Depending on the pathology, stabilization can be achieved by ventral, dorsal, or combined treatment. In dorsal instrumentation, either lateral mass or pedicle screws are placed, with biomechanical studies showing greater stability for the latter. This makes it possible to reduce the number of instrumented segments, allowing for greater postoperative mobility than is possible with occipitocervical fusion. Because pedicle screw placement in the upper cervical spine is technically challenging due to anatomic proximity to neurovascular structures, 3D image-guided techniques, which include intraoperative computed tomography (iCT)-based navigation, are being used more frequently. The purpose of this study was to retrospectively compare iCT-based navigated and fluoroscopy-guided screw placement in patients with traumatic injuries in the atlantoaxial region in terms of safety and accuracy. **Material and Methods:** This study retrospectively analyzed 54 patients with traumatic atlantoaxial injuries who underwent dorsal stabilization in our hospital during the past

10 years. Two groups were formed based on the intraoperative imaging technique used. While the in the first group (3D-controlled) intraoperative fluoroscopy as well as intraoperative 3D imaging to control reduction and implant position was applied. The second group (navigation) was treated using iCT-based navigation for screw placement. The final screw position was analyzed on postoperative CT scans. Perforations in medial, lateral, inferior and superior direction were assessed and perforations > 1 mm were considered inaccurate and perforations > 2 mm or breach of the foramen with > 50% of screw diameter were considered critical. **Results:** A total of 216 screws from 54 patients were evaluated. In the 3D-controlled group, a total of 54 C1 mass screws and 12 C2 screws were placed using the Magerl technique, as well as 42 C2 pedicle screws. In the navigation group, 54 C1 mass screws, 52 C2 pedicle screws, and 2 C2 screws were placed using the Magerl technique. Analysis of screw position in the 3D controlled group showed five (4,6%) critical perforations, while one (0,9%) critical perforation was observed in the navigation group. Regarding accuracy 81.5% (n = 88) of screws in the 3D-controlled group were placed with a maximum perforation of < 1 mm, while 92.6% (n = 100) accurately placed screws were noted in the navigation group. Postoperative neurologic deficits or vascular complications were not observed in any of these patients. Statistical comparison of accuracy showed a significant difference between groups (p = 0.0245). The analysis of critical screws showed no significant difference (p = 0.2122). **Conclusion:** This retrospective study demonstrates that using iCT-based navigation, safe and effective screw placement is possible in patients with traumatic atlantoaxial injuries. Thus, this technique is a safe alternative to 3D-controlled fluoroscopy-based instrumentation in the treatment of the upper cervical spine.

2557
A255: Clinical and radiological results for cortical screw placement using patient specific templates

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Introduction: The cortical bone trajectory (CBT) for pedicle screw placement is believed to provide lower screw loosening-, and increased fusion rates, especially in osteoporotic patients. It is hypothesized to be a MIS procedure, although clinical studies to confirm this are missing. Cortical bone screw placement is technically demanding and navigation technology might be of added value. We investigated the immediate and late clinical and radiological results when using patient specific templates for CBT in lumbo-sacral screw placement. **Materials and Methods:** A cohort of 101 patients, operated with patient specific guides for CBT screw placement in two centers by 2 surgeons were included in a prospective study. Patients completed a VAS-B (Back) and VAS-L (Leg), HTS and ODI preoperatively, during the first 5 days after

surgery, at 6 weeks, 3- and 6 months and 1 year postop. Complications were recorded at same time intervals. Flex/Ext X-rays were taken at 3 months postop and a CT scan at 6 months. In case of non union at 6 months CT, CT was repeated 1 year after surgery. A level was considered to be fused if interspinous motion was < 5 degrees after 3 months with bridging bone on CT. Screws were divided into Group I (no cortical breach), Group II (0-2 mm breach) and Group III (> 2 mm breach). Screws were defined loose when osteolytic halo was present on CT. **Results:** 22 male and 79 female patients were included. 82 % of patients were operated at L45. Mean age was 62 years with a mean BMI of 27. 24% of patients were smokers. Mean OR time was 97 minutes, with a mean incision length of 6 cm and 105 ml of mean blood loss. We recorded 9 fluoroscopy shots per procedure on average. Preoperatively, mean VASB score was 7, and mean VASL was 5. From day 1 to day 5 postop, VASB dropped from 5 tot 3.1 and dropped further to 2.4 at 6 weeks. This decrease was maintained at one year FU. Mean VASL dropped to 1.4 immediately postop and remained stable till 1 year FU. Mean HTS went from 58 to 74 and ODI dropped from 44 to 17. No complications related to screw placement were recorded. 75% of the patients reached a solid fusion at 6 months and 95.6% at one year after surgery. Regarding screw placement, 97.3% of screws were in Group I, 1,7 % in Group II and 1% in Group III. Screw loosening rate after one year was 1.8%. There was no significant difference in terms of these results towards gender, age or smoking status. 93% of patients would do the surgery again if needed. **Conclusion:** Patient specific templates for CBT screw placement are clinically safe and radiologically accurate with excellent fusion rates regardless of age, gender and smoking status. Good to excellent clinical results are obtained immediately after surgery and sustainable after one year. The use of CBT screws by using patient specific guides can be seen as an effective and MIS procedure.

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A256: Implications of navigation in percutaneous thoracolumbar pedicle screw placement on accuracy, screw pedicle ratio, radiation dose and operating time: a consecutive case series with a matched control group

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Introduction: The placement of pedicle screws using 3D navigation is becoming increasingly common in spinal surgery. According to the literature, the higher accuracy of screw placement comes at the cost of longer operating times and higher exposure to radiation for the patient. The effect of using a navigated technique on the screw-to-pedicle size ratio has not yet been investigated, whereas a larger screw-to-pedicle ratio might have biomechanical advantages. The aim of this study was to investigate the

implications of the use of navigation on screw placement accuracy, screw-pedicle ratio and intraoperative patient radiation exposure as well as time needed for surgery. **Material and Methods:** The first 26 consecutive cases of 3D C-arm (Cios Spin, Siemens, Forchheim, Germany) based navigated (Pulse platform, NuVasive Inc., San Diego, CA, USA) thoracolumbar percutaneous pedicle screw placement performed in our institution by a single surgeon were included in the study. The accuracy of screw placement was evaluated using the Gertzbein-Robbins classification in intra- or postoperative 3D imaging, with pedicle perforations ≥ 4 mm (grades C to E) considered clinically relevant. In addition, the screw-pedicle ratio was documented for each screw placed. The surgical time, intraoperative radiation exposure (dose area product in mGycm^2), and fluoroscopy time (in seconds) were retrospectively compared with 26 cases of fluoroscopy-assisted pedicle screw placement. The cases were matched based on the spinal region, the number of screws placed as well as additional procedures performed (e.g., cement augmentation). **Results:** 91.9% of the screws placed using navigation showed no relevant pedicle perforation. 15 screws showed a breach of ≥ 4 mm, with 14 of the breaches being lateral. The accuracy of screw placement was significantly higher than in the fluoroscopy-assisted control group, where 84.9% of screws were accurately placed (p = 0.04). Nevertheless, the screw-pedicle ratio in the navigation group was significantly higher than in the control group (94 ± 24% vs. 88 ± 15%, p = 0.01). None of the patients included experienced neurological or vascular complications postoperatively. The operating time was slightly shorter in the navigated group (88.9 ± 20.8 minutes) compared to the fluoroscopy-assisted group (94.7 ± 35.1 minutes, p = 0.40). There was no significant difference in intraoperative patient radiation exposure (27.4 ± 15.0 Gycm2 vs. 25.9 ± 22.1 mGycm2, p = 0.50), while the fluoroscopy time was significantly shorter in the study group (95 ± 27s vs. 190 ± 83s, p < 0.001). Additional 3D scans for implant control were performed in 16 cases (23 scans) in the study group and in 14 cases (19 scans) in the control group. **Conclusion:** In conclusion, navigated percutaneous screw placement proved to be significantly more accurate than the fluoroscopy-assisted technique, despite the use of significantly larger screws in the study group. Neither did the use of 3D navigation increase the operating time nor the intraoperative radiation exposure of the patient, although 3D scans for control of screw placement were performed more frequently after navigation.

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A257: New Artificial Intelligence (AI) driven surface topography phone application help screen spinal deformity patients: early results from one institution

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Introduction: Radiation-free techniques such as scoliometers, spinal ultrasound and Moiré topography have had limited success in screening and monitoring patients with Adolescent Idiopathic Scoliosis (AIS). The purpose of such modalities was to decrease serial spinal x-rays. A new digital health application leverages advanced 3D surface topography technology coupled with artificial intelligence to predict scoliotic Cobb Angles. The objective of this study is to validate the accuracy and reliability of this technology. **Material and Methods:** A single-center observational study was conducted in the outpatient scoliosis clinic. One hundred and twenty-five patients were recruited with a confirmed diagnosis or suspicion of scoliosis. Once consented, two 3D surface topography scans (upright and bent forward positions) were performed on an Apple iPhone 12. Demographic and radiological parameters were collected to determine their influence on the validity of the automated measurement. Validity and reproducibility of the applications Cobb Angle predictions were compared to radiographic measurements. **Results:** Of the 125 patients recruited, 20 scans were discarded for poor quality, 69 were randomly assigned to the training set and 38 were used to validate the algorithm. To normalize the distribution of the training set, 12 additional control patients were added to the training set. The algorithm predicted the Cobb Angle (bellow 50) with an overall correlation of 0.89 and a mean average error of 6.2 degrees. Momentum Spine screened for AIS (10 degrees threshold) with a sensitivity of 0.92, specificity of 0.75, and area under the curve (AUC) of 0.94. At 25 degrees, the threshold for the initiation of brace interventions, a sensitivity of 0.71, specificity of 0.90 and AUC of 0.97 was noted and at 50 degrees (surgical threshold), 0.50, 1.00 and 0.94, respectively. **Conclusion:** The implementation of 3D topography combined with AI seems of improve the accuracy of the classic surface topography to predict scoliotic Cobb Angles. The applications' availability on smartphones facilitates frequent at-home remote monitoring of scoliotic deformities to avoid unnecessary hospital visits and spinal X-rays, potentially detecting early curve progression as well.

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A258: Robotic midline interbody fusion (MIDLIF): Initial experience and learning curve in the first 100 screws

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Introduction: There are a wide variety of techniques aimed to achieve lumbar fusion in degenerative pathology. The MidLIF is an alternative to the traditional pedicle screw-based trajectory lumbar fusion. Potential advantages such as a less invasive approach whereas maintaining a standard anatomic view have been advocated and reported elsewhere. On the other hand, the particular pedicle screw trajectory from medial to lateral may be more

technically demanding albeit having the assistance of intraoperative fluoroscopic or navigated guidance. We feel that robotics may play a key role in safely planning and executing the MidLIF screw trajectory. We report our initial experience on the first 100 robotic guided MidLIF screws. **Material and Methods:** From November 2021 to March 2023, the first 20 patients (100 screws) who underwent one to three level MIdLIF robot guided surgery were retrospectively revised. Different data such as: patient demographics, robotic workflow and general complication rate was prospectively collected and analysed for this study. **Results:** All the cases performed were lumbar fusions from L3 to S1 with a maximum of three levels (1 case). Age of the patients ranged from 50 to 76 years (mean 64) and weight ranged from 52 to 100 kg (mean 78.25). Robot's usage time ranged from 14 to 56 minutes (mean 27.1). Registration was performed with intraoperative X-ray in 19 cases whereas intraoperative CT was used in only one case. No registration issues were reported. 2 of the patients (10%) required intraoperative repositioning of the screw. Revision surgery was required in three patients (15%), two for screw malpositioning and one for insufficient decompression. **Conclusion:** The MidLIF is a technique that requires less muscle dissection although it may be more technically demanding due to unusual divergent and cranial trajectory of the screws. Robotic assistance may help us overcome this technical difficulty. Our first 20 cases demonstrate that robot screw guided placement could be safely performed.

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A259: Artificial intelligence-based analysis of associations between learning curve and clinical outcomes in endoscopic and microsurgical lumbar decompression surgery

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Purpose: A common spine surgery procedure involves decompression of the lumbar spine. The impact of the surgeon's learning curve on relevant clinical outcomes is currently not well examined in the literature. A variety of machine learning and deep learning algorithms have been investigated in this study to determine how a surgeon's learning curve and other clinical parameters will influence prolonged lengths of stay (LOS), extended operating times (OT), and complications, as well as whether these clinical parameters can be reliably predicted. **Methods:** A retrospective monocentric cohort study of patients with lumbar spinal stenosis treated with microsurgical (MSD) and full-endoscopic (FED) decompression was conducted. The study included 206 patients with lumbar spinal stenosis who underwent FED (63; 30.6%) and MSD (118; 57.3%). Prolonged LOS and OT were defined as those exceeding the 75th percentile of the cohort. Furthermore, complications were assessed as a dependent variable. Using unsupervised learning, clusters were identified in the data, which helped distinguish between the early learning curve (ELC) and the late learning curve (LLC). From 15 algorithms, the top five algorithms that best fit the data were selected for each prediction task. We calculated the accuracy of prediction (Acc) and the area under the curve (AUC). The most significant predictors were determined using a feature importance analysis. **Results:** For the FED group, the median number of surgeries with case surgery type at the time of surgery was 72 in the ELC group and 274 in the LLC group. FED patients did not significantly differ in outcome variables (LOS, OT, complication rate) between the ELC and LLC group. High Acc/AUCs for the testing dataset were achieved for OT (Acc: 78.27; AUC: 0.86; Model: C5.0), LOS (Acc: 84.68; AUC: 0.92), and complications (Acc: 88.05; AUC: 0.93) for the classification of the respective classes. Feature importance analysis indicated that LOS, OT, and complications were more significantly affected by patient characteristics than the surgical technique (FED versus MSD) or the surgeon's learning curve. **Conclusion:** A median of 72 cases of FED surgeries led to comparable clinical outcomes in the early learning curve phase compared to experience surgeons. These outcomes seem to be more significantly affected by patient characteristics than the learning curve or the surgical technique. Several study variables, including the learning curve, can be used to predict whether lumbar decompression surgery will result in an increased LOS, OT, or complications. To introduce the provided prediction tools into clinics, the algorithms need to be implemented into open-source software and externally validated through large-scale randomized controlled trials.

Keywords: length of stay; operation time; complications; spine surgery; artificial intelligence; prediction

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A260: Application of a novel spinal robot in autonomous laminectomy

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Introduction: The function of spinal robot in clinical application is only for assisting pedicle screw placement, and there is a lack of robot system for assisting laminectomy. Moreover, these existing robot systems only play an auxiliary role, but cannot perform the operation autonomally. Therefore, our team has developed a spinal robot system that can autonomously perform laminectomy.

The purpose of this study is to verify its accuracy and safety through animal experiments. **Material and Methods:** 16 pigs were equally divided into robot laminectomy (RL) group and manual laminectomy (ML) group. 6 thoracic and 12 lumbar total laminectomies were performed in each group. The operation time, bleeding volume, and operation safety were evaluated between the two groups. The deviation distance of the cutting plane of the robot group were evaluated. **Results:** The operation time was 129 ± 15.64 minutes in RL group and 82 ± 8.42 minutes in ML group (p < 0.001); The blood loss was 63.75 ± 34.62 ml in RL group and 85 ± 20 ml in ML group (p = 0.254). Unilateral laminectomy took 354.28 ± 46.74 seconds in RL group and 111.06 ± 28.71 seconds in ML group (p < 0.001); The single level total laminectomy took 822.39 ± 91.07 seconds in RL group and 236.17 ± 55.16 seconds in ML group (p < 0.001). There was no intraoperative neuro-electrophysiological monitoring abnormality and postoperative hind limb movement abnormality in the two groups. The average deviation of the cutting plane in the RL group was 0.73 ± 0.26 mm. **Conclusion:** The experimental results verified the accuracy and safety of this robot system and laid a foundation for subsequent clinical application.

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A261: Artificial intelligence classification for detecting and grading lumbar intervertebral disc degeneration

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Introduction: Intervertebral disc degeneration (IDD) is a common cause of symptomatic axial low back pain. Magnetic resonance imaging (MRI) is the standard for the investigation and diagnosis of IDD. Deep learning models of artificial intelligence are tools to detect visuals with significant speed and automatic tools. This study proposed artificial neural networks (ANN) for detecting, classifying and grading the IDD. **Material and Methods:** The sagittal images of IDD T2-weighted MRI of 500 levels from 100 adult patients with symptomatic low back pain were included and separated 400 MRI images for the training dataset (80%) and 100 MRI images of the test dataset (20%). Training datasets were cleaned, labeled and annotated by the radiologist. All lumbar discs were classified disc degeneration based on the Pfirrmann grading system. The deep learning method used the deep ANN model to train and detect and grading the IDD. The train ANN model was verified by testing dataset for graded under automatic model. **Results:** Sagittal intervertebral disc lumbar MRI images train dataset found 500 Grade I, 82 Grade II, 72 Grade III, 68 Grade IV, and 64 Grade V discs. The ANN model was able to detect lumbar IDD and classified having an accuracy more than of 95%. Training ANN model verified the test dataset that it found automatic classification and detection of

IDD with an accuracy more than of 95%. **Conclusion:** ANN model can be automatically graded reliably on routine T2-weighted MRI using the Pfirrmann grading system with an efficient method for lumbar IDD classification.

OP30: Tumors: Clinical Considerations

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A262: Is intraoperative cell salvage and autogenic transfusion a risk factor for distant metastases in spinal chordoma surgery

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Introduction: Surgical excision remains the treatment of choice for spinal chordomas. This is associated with significant intra-operative blood loss and high rates of allogenic blood transfusion. Intraoperative cell salvage with a leukocyte depletion filter (IOCS-LDF) is a well-recognised adjunct to high blood loss in oncological surgery. There remains controversy regarding the use of IOCS-LDF in sarcoma surgery due to concern about dissemination of chordoma cells potentially leading to distant metastases. **Material and Methods:** This is a retrospective review of surgically treated spinal chordoma patients treated between 2012-2021. Follow up was till time of death with a minimum of 1 year follow up. Data on demographics, histology, tumour location, history of previous local or systemic treatment, presence of local recurrence and metastases was collected. An EA margin was defined as one where final pathological margins and surgical impression matched the Enneking-recommended surgical margins. An EI margin was one where Enneking recommended surgical margins were not obtained intraoperatively, or in non-virgin patients where a previous intralesional procedure had been performed. Patient outcomes such as local recurrence, recurrence free survival in years, metastases, metastases free survival in years and overall survival was also recorded. All statistical analyses were performed using STATA Version 17.0 with statistical significance set at 2-sided p < 0.05. Descriptive statistics for numerical variables were presented as mean (range) & n (%) for categorical variables. Univariate predictors for time to local tumour recurrence and distal metastases were analysed using cox regression with death as competing. **Results:** A total of 31 patients were identified of which 1 patient was excluded due to intraoperative mortality. The mean age of the 30 patients included in the study was 61 (17-86). Most patients were male (19/30 (63.3%)), and most patients had symptoms of more then 3 months prior to diagnosis (70.0%). Most patients had normal performance

status (ECOG 0) (18/30 (60.0%)) and normal neurological status Asia E (28/30 (93.3%)). 20 (66.7%) patients had chordomas of the mobile spine, 10 (33.3%) of the sacrum. 17/30 (56.7%) patients had EA resections and 13/30 (43.3%) had EI resections. Overall local recurrence rate was 7/30 (23.3%) and metastases rate was 6/30 (20.0%). 5/6 of patients with metastases were EI patients of whom 4/5 (80%) had received autogenic blood. On univariate analysis EI status (p = 0.037) (4.75 (1.10-20.50)) was a significant risk factor for local recurrence. EI+ Autogenic blood transfusion was a significant risk factor for metastases (p = 0.034) (11.06 (1.20-101.78)) as was non-virgin (previous surgical treatment) status (p = 0.002) (6.70 (2.70-22.44) and history of previous radiotherapy (p = 0.004) (3.97 (1.57-10.04)). **Conclusion:** Our findings have resulted in a change in practice in our centre, and we believe them to be novel and important. IOCS-LDF is no longer used for non-virgin procedures; in virgin cases it is used during the surgical approach but stopped prior to any manipulation of the tumour where there may be the potential for capsular breach. We advocate further study into the potential mechanisms of metastatic spread of chordoma, and consideration of alternatives to IOCS for spinal tumour resection procedures with high expected blood loss.

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A263: Association between intratumoral flow void and intraoperative blood loss in palliative surgery for metastatic spinal surgery

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Introduction: Massive intraoperative blood loss (IBL) is one of the major complications in metastatic spinal tumor surgery. Pathological tumor type, surgical magnitude, operation time, and other factors have been reported as risk factors for massive IBL in metastatic spinal tumor surgery. In this study, we focused on intratumoral flow void on MRI, which is considered an indicator of tumor vascularity, similar to pathological tumor type. While intratumoral flow void in bone tumors of the extremities has been suggested to represent blood vessels, and an association between flow void and IBL has been reported in brain tumors, there has been no research regarding the association in metastatic spinal tumors. This study aimed to investigate the association between intratumoral flow void and IBL in palliative excisional surgery for metastatic spinal tumors. **Method:** We retrospectively investigated 78 cases of palliative excisional surgery for metastatic spinal tumors performed from January 2010 to March 2023 in our hospital. To identify factors associated with IBL, we analyzed the following clinical parameters; age, gender, body mass index, pathological tumor type, the presence and diameter of intratumoral flow void on

MRI, number of instrumented vertebrae, number of resected vertebrae, operation time, preoperative radiotherapy, and preoperative embolization. MRI images were obtained in three orthogonal planes and with T1-weighted, T2-weighted, and STIR sequences. The diameter of flow void was defined as the greatest vertical distance measured from the tubular structure of the flow void. **Result:** The average IBL was 376 ml. 58 cases (74.3%) showed intratumoral flow void, and the average diameter of flow void was 2.16 mm. We observed a positive correlation between diameter of flow void and IBL, with an average IBL of 795 ml when the diameter was ≥ 3 mm. In univariate analysis, factors related with IBL were the presence of flow void, diameter of flow void, pathological tumor type, number of instrumented vertebrae, number of resected vertebrae, and operation time. Notably, multivariate analysis revealed that the diameter of flow void had the strongest correlation (p < 0.01). **Conclusion:** This is the first report demonstrating the association between intratumoral flow void and IBL in palliative excisional surgery for metastatic spinal tumors. The results of this study indicate that metastatic spinal tumors with large diameter of flow void have intratumoral blood vessels that are challenging to control in bleeding. Therefore, in cases with large diameter of flow void, it's crucial to be aware of the potential for significant bleeding from intratumoral vessels during excision of metastatic spinal tumors.

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A264: EANS survey on preoperative tumor embolization for spinal metastasis

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Introduction: Embolization is a minimally invasive procedure, which can be used to treat spinal metastasis in conjunction with other treatment modalities to achieve the best possible outcome. The decision to perform embolization depends on interdisciplinary discussion and center-specific variables. We designed a survey to explore the treatment algorithm across centers of the European Association of Neurosurgical Societies (EANS). **Material and Methods:** We asked all specialists and residents in the EANS community to fill out an online questionnaire based on 13 questions from 7th February till 5th May 2023, which explored the frequency of tumor embolizations and the decision-making process as well as time interval between embolization and surgical treatment. Participants also stated how often they experienced complications with preoperative embolization and if they believed that embolization reduced the overall blood loss. **Results:** We achieved on total 115 of 117 complete responses with 82 % (n = 95) of all participants being male and 72% (n = 83) neurosurgical specialists. 75% (n = 87) of all responses came from university hospitals. Only 8% (n = 9) of all participants stated an average number > 30 spinal

stabilization procedures for vertebral metastasis per year and 39 % (n = 43) reported they do perform routinely preoperative embolizations. 25% (n = 28) indicated they only perform embolizations when vertebral body resection/replacement is necessary. 91% (n = 39) of all participants specified they perform embolizations only for hypervascularized tumors, e.g., renal cell carcinoma or thyroid carcinoma. Being asked why not routinely performing preoperative embolizations in patients with spinal metastases, 43% (n = 26) answered they usually operate on emergency cases, where there is no time for embolization. 46% (n = 45) made their decision for embolization based on tumor pathology and 37 % (n = 36) based on preoperative MRI and/or CT. 50 % (n = 34) of the colleagues performing embolizations declared they fulfill the procedure within 24 h before surgery in a separate anesthesia and 63% (n = 59) had the impression, or have evaluated, that intraoperative blood loss is lower after embolizations in their practice. 43% (n = 41) claimed that they have experienced procedure-related complications with neurologic deterioration due to spinal cord infarction being the most common one in 16% of cases. **Conclusion:** Preoperative embolizations for spinal metastasis appear to be rarely routinely performed for mainly hypervascularized tumors based on tumor pathology and preoperative MRI/CT imaging in a 24h interval before elective surgery. Most participants in our study stated a reduction of the blood loss, however also several procedure-related complications.

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A265: Circulating tumor DNA as a biomarker of radiation induced tumor killing in metastatic spine disease

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Introduction: Up to 40% of cancer patients will go on to develop spinal metastases. Radiation therapy continues to be a standard part of treatment. However, it is known that some tumors will respond better than others to this therapy, and certain patients may tolerate radiotherapy better than others. To date, there is no reliable method of predicting or measuring the effects of radiation therapy. Such a tool would be useful in monitoring tumor treatment in real time and could enable tailoring of treatment to individual patients. Circulating tumor DNA (ctDNA) is cell-free DNA shed by all tumors into the bloodstream. It has been shown that ctDNA is a more specific and sensitive biomarker than standard tumor biomarkers but its utility in radiation therapy in incompletely understood. Our study's aim is to determine if ctDNA can be used as a reliable biomarker for spinal metastases and thus used to tailor radiation therapy to individual tumor

response. **Material and Methods:** Athymic nude mice were implanted with $5x10^6$ LS174T human colorectal tumor cells in the flank. Mice were treated with 20 Gy stereotactic radiation in 5 fractions. Six mice per group were randomized based on pre-treatment tumor volume. To obtain enough blood to measure ctDNA, mice were anesthetized with isoflurane and a terminal blood draw via cardiac puncture was performed. Group 1 was sacrificed on day 1 (first dose) of radiation, group 2 on day 3 (middle dose) of radiation, group 3 on day 5 (last dose) of radiation, and group 4 was sacrificed in delayed fashion 10 days after last radiation dose. Because we used human tumors implanted in mice, we used the human LINE-1 retrotransposon as a tumor specific ctDNA and performed ddPCR with primers designed for this sequence. **Results:** Radiation decreased tumor size by 33% over the 5 days of treatment. During that time, the average percentage of positive ctDNA increased from 28.3% to 50.2%. Interestingly, on day 3 of treatment the average percentage of ctDNA was 70.8%. After 14 days post treatment, the average percentage of positive ctDNA was 53.1%. We also utilized linear and logistical modeling to measure the association of ctDNA and tumor size within groups. Within group 1 and group 4, logistic models measured a strong, positive association of $R^2 = 0.98$ and $R^2 = 0.98$ between tumor size and ctDNA, but this relationship was lost for group 2 ($R^2 = 0.33$) and group 3 ($R^2 = 0.43$). **Conclusion:** ctDNA of human tumors is measurable in a mouse model of metastasis and we demonstrate that ctDNA levels correlate with tumor volume; however, while radiation therapy appears to halt tumor growth, ctDNA levels seem to peak during radiation therapy, suggesting a radiation specific effect. Giving subtherapeutic dose of radiation seems to paradoxically increase amount of tumor DNA shed when receiving radiation. We also show that persistent tumor after radiation continues to shed ctDNA, which could be used to tailor treatment. Our preliminary results are promising and provide the framework to study further in human trials.

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A266: Externally validating twelve survival models for patients with metastatic spine disease: preliminary results from 953 patients

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Introduction: Survival prediction models for patients with metastatic spine disease aid spine surgeons, (radiation) oncologists, and patients in the shared decision-making

process to determine treatment strategies. To facilitate clinical use, survival models should be easily applied and reliable across the spectrum of oncologic disease. Additionally, given the continuous evolution of systemic treatment options, survival models should be externally validated using recent patient data. Therefore, we externally validated twelve survival prediction models with recent data from patients with metastatic spine disease irrespective of their received treatment. **Materials and Methods:** Validation was performed using survival data from patients with metastatic spine disease presented to a tertiary referral center in the Netherlands between 2016 and 2021. Eligible patients were identified through three existing prospective registries for patients with spinal/bone metastases (ClinicalTrials.gov identifiers: NCT02356497 and NCT02830451, and a third local registry). We externally validated 12 existing survival prediction models for patients with spinal metastases including three machine learning algorithms (PathFx, SORG, and GSTSG calculator) and nine scoring systems (Original Katagiri, Revised Katagiri, Original Tokuhashi, Revised Tokuhashi, Tomita, Bollen, Linden, OSRI, and Mizumoto). In total, the 12 models required 50 input variables, such as patient demographics, functional status, comorbidities, oncologic factors, previously received therapies, and laboratory values to predict 3, 6, and/or 12 month-survival. In total, only 17% of the patients (164/953) were included in the final validation set as they had all 50 input variables available for all 12 models. Laboratory values exhibited the highest prevalence of missing data, ranging from 26% to 59%, whereas all other variables had no more than 9% missing data. Received local treatment included radiotherapy in 50% (82/164), both radiotherapy and surgery in 28% (46/164), surgery in 17% (28/164), and no local treatment in 4% (7/164). Performance measures for the 164 patients across all 12 models included discrimination with area under the curve (AUC) and calibration. **Results:** Survival rate was 62% (118/164) at 3-months, 55% (90/164) at 6-months, and 43% (70/164) at 12-months. At 3-months, the SORG algorithm had the highest AUC (0.70 [95% confidence interval [CI] 0.60 – 0.78]). The Revised Katagiri score had the highest AUC at both 6-months (0.75 [95% CI 0.68 - 0.82]) and 12-months (0.76 [95% CI 0.69 - 0.83]). The SORG algorithm showed the best calibration at 3-months and 12-months, and the GSTSG calculator at 6-months. **Conclusion:** Preliminary results suggest that the SORG algorithm and the Katagiri score were the best-performing models for predicting survival in patients with metastatic spine disease. The sample size was limited due to missing data and further efforts are being made to retrieve the missing laboratory values. Of the 953 eligible patients, we expect to have obtained all variables for > 75% of patients in December 2023. Survival prediction models that utilize readily available clinical data will be the easiest to implement in daily practice.

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A267: Predicting quality of life of patients after treatment for metastatic spine disease: development and internal validation

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Introduction: Metastatic spine disease significantly impacts quality of life (QoL) in oncological patients. As most of these patients are treated in a palliative setting, maintaining or enhancing QoL emerges as the primary therapeutic objective. QoL can be enhanced by improving neurological impairment, preserving mobility, and ameliorating pain. Metastatic spine disease is unique in the spine subspecialty because treatment plans must consider QoL benefits in the context of expected survival. Many models have been developed to predict survival, but none to date predicts QoL. Therefore, we aim to develop a model that predicts patient-reported QoL at three months in patients with metastatic spine disease receiving radiotherapy and/or surgery. **Material and Methods:** We included 548 patients undergoing radiotherapy (324; 59%), surgery (129; 24%), both (38; 7%), or no treatment (57; 10%) through retrospective chart review at a tertiary spine center in the Netherlands, using data from three existing prospective registries (ClinicalTrials.gov identifiers: NCT02356497 and NCT02830451, and a third local registry) between January 2016 and December 2021. We assessed QoL using prospectively collected EQ-5D-3L questionnaires at baseline and follow-up three months post-treatment. From each EQ-5D-3L questionnaire, we calculated a health state index score ranging from less than 0 (where 0 is a health state equivalent to death; negative values are valued as worse than death) to 1 (perfect health). An improvement of 0.06 was considered the Minimal Clinical Important Difference (MCID) and was achieved in 255 (47%) patients. The 548 patients were divided into a training (80%) and testing cohort (20%), ensuring equal proportions of the MCID in each set. Five models - penalized logistic regression, random forest, stochastic gradient boosting, neural network, and support vector machine - predicted MCID. The variable selection, model building, and predictive performance assessment were conducted on the training set. The best-performing model in the training set was evaluated on the testing set for internal validation. **Results:** The majority

of patients were male (57%), with a median age of 67 years (interquartile range [IQR] 59 - 73). The three-month survival rate was 81%. On preliminary results, the penalized logistic regression algorithm had the best performance on the training data and achieved good calibration (intercept of -0.02, slope of 1.04), and acceptable discrimination (area under the receiver operating characteristic curve [AUC]: 0.77 [95% confidence interval [CI] 0.65 - 0.87]). On the independent test set, the model achieved excellent calibration (intercept of -0.002, slope of 1.02) and acceptable discrimination (AUC: 0.71 [95% CI 0.61 - 0.81]). On variable importance assessment, age, body mass index, Karnofsky Performance Scale, primary tumor histology group, and absolute white blood cell count were the five most important predictors. **Conclusion:** We developed and internally validated a model predicting post-treatment estimation of improvement of QoL using pro-spectively collected institutional data. The algorithm shows promise and requires further external validation before im-plementation in clinical practice. Adding more laboratory values such as albumin and lymphocytes as possible pre-dictors may improve algorithm performance. Integrating AI tools that predict outcomes such as survival and QoL into electronic health records may guide clinical decision-making.

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A268: Clinical outcomes and prognostic factors following the surgical resection of spinal metastases from renal cell carcinoma

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Introduction: Complete surgical metastasectomy (SM) of renal cell carcinoma (RCC) improves survival and the rate of this procedure has increased in the post-cytokine era with molecular-targeted therapy and/or treatment with immune checkpoint inhibitors. In the current guidelines, SM is rec-ommended for patients in whom complete surgical resection is technically feasible or can control symptoms locally. Bone metastases, especially in the spine, often compromise patient performance status. SM is indicated, if feasible, since it allows to achieve the best clinical outcomes possible compared with other treatments. This study examined the postoperative survival and prognostic factors in patients who underwent SM of spinal lesions. **Material and Methods:** Retrospective study of 65 consecutive patients with metastatic RCC who were operated using spinal SM between 1995 and 2017 at our institution. Patients in the cytokine group underwent SM in the spine before 2008, and those in the post-cytokine group, in 2008 or later. Cancer-specific survival (CSS) times from spinal surgery to death or last follow-up of at least 3 years were

determined using Kaplan-Meier analysis. A total of 23 po-tential factors associated with survival were analyzed using the log-rank test and Cox proportional hazard models. **Re-sults:** To achieve complete oncological resection of the spinal lesions, total en bloc spondylectomy was performed in 57 patients and hemivertebrectomy in 8 patients. Forty-eight patients underwent a single vertebral resection, 5 underwent two consecutive vertebral resections, and 12 three consecutive vertebral resections. Planed surgical resection of the entire spine tumor was achieved in all patients. Of these, 38 had complete SM of all visible metastases, including extra-spinal lesions. In all patients, the estimated median CSS time was 100 months. The 3-, 5-, and 10-year CSS rates were 77, 62, and 48%, respectively. These results are more favorable than those previously reported in large studies on patients with RCC-metastases. The survival times after spinal SM were similar in both cytokine and post-cytokine groups. The pa-tients with complete SM had better postoperative survival rates compared with those with incomplete SM (77 and 60% versus 42 and 32% for the 5- and 10-year CSS rates, re-spectively). In multivariate analyses, postoperative disability, the presence of liver metastases, multiple spinal metastases, and incomplete SM with other existing metastases, were significant risk factors associated with short-term survival. **Conclusion:** Complete SM, including extra-spinal metastases, was associated with improved CSS. Spinal SM with proper patient selection can potentially prolong survival in patients with spinal lesions from RCC.

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A269: Can a deep learning model lead to earlier diagnosis of high grade metastatic epidural spinal cord compression and reduction in treatment delay?

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Introduction: Delay in diagnosis and treatment has been found to be associated with poorer surgical and functional outcomes in patients with symptomatic metastatic epidural spinal cord compression (MESCC). Staging CT scans are performed rou-tinely in cancer patients and high grade MESCC is often un-derdiagnosed in these scans. We had previously developed and validated a deep learning model (DLM) to automate the detection of high grade (Bilsky 2/Bilsky 3) MESCC. In this study we aim to assess the utility of a DLM in detecting high grade MESCC and potential reduction in diagnostic delays. **Materials and**

Methods: This is a retrospective review of 140 patients who had underwent surgical decompression and stabilization for MESCC between Jan 2015 to Jan 2022. All patients had high grade MESCC (Bilsky 2-3) between C7 to L2. Prior staging CT Thorax Abdomen and Pelvis up to 4 months prior to diagnostic MRI was reviewed by a consultant musculoskeletal radiologist (JH) and consultant spinal surgeon (JT) and classified into cases with and without high grade MESCC. A previously validated deep learning model (DLM)was then used to classify these scans. Their findings were then compared to the original radiologist (OR) reports. Inter-rater agreement was assessed. Potential decrease in diagnostic delay was calculated in days from screening CT to first MRI scan diagnosing high grade MESCC. **Results:** 95/140 (67.8%) of patients had available pre-operative CT scans. High grade MESCC was identified in 84/95 (88.4%) of the pre-operative CT scans by both JH and JT. High grade MESCC was reported in only 32/95 (33.7%) of pre-operative scans by the OR. There was almost perfect agreement between JH vs JT kappa = 0.947 (CI 0.893-1.000) (p < 0.001), JH vs DLM kappa = 0.891 (0.816-0.967) (p < 0.001) and JT vs DLM kappa = 0.891 (0.816-0.067) (p < 0.001). There was poor interobserver agreement between the OR and all other readers (kappa between 0.021 to 0.125). There was a mean potential reduction in diagnostic delay of 19 days. **Conclusion:** There was a high incidence of undiagnosed high grade MESCC in the OR reports. The DLM had an almost perfect interobserver agreement with both reviewers and this is the first clinical study to demonstrate its potential for reducing diagnostic delays. There is a need for further prospective studies to characterize its role in the early diagnosis and treatment of MESCC.

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A270: Survival analysis of patients with metastatic osteosarcoma: a surveillance, epidemiology, and end results population-based study

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Purpose: The present study is aimed at investigating whether (1) primary tumour surgery confers an improved survival on patients with metastatic osteosarcoma and (2) primary tumour surgery influences survival of patients with metastatic osteosarcoma differently according to primary tumour site. **Methods:** We retrospectively identified 517 patients with high-grade, metastatic osteosarcoma in the Surveillance, Epidemiology, and End Results (SEER) database between 1994 and 2013. The effect of primary tumour surgery on survival was assessed using Kaplan-Meier

analyses, log-rank tests, and multivariate Cox proportional hazard regression modeling. **Results:** Of those 517 patients with metastatic osteosarcoma in the cohort, 351 patients (68%) underwent primary surgery, and 166 patients (32%) did not undergo surgery. Primary tumour surgery was associated with increased overall survival (hazard ratio (HR) = 0.457, 95% CI 0.354-0.590, p < 0.001) and cancer-specific survival (HR = 0.422, 95% CI 0.325-0.550, p < 0.001). When we focused on different primary tumour sites, receipt of primary tumour surgery significantly prolonged the survival of patients with extremity osteosarcoma (p < 0.05 for overall and cancer-specific survival). However, for patients with pelvis/spine osteosarcoma, both univariate and multivariate analyses indicated that primary tumour surgery might not be associated with improved survival (p > 0.05 for overall and cancer-specific survival). **Conclusions:** Our study is the first population-based analysis to provide evidence of a favourable prognostic impact of primary tumour surgery on metastatic extremity osteosarcoma patients but not metastatic axial (pelvis/spine) osteosarcoma patients. Moreover, we found that surgery type (resection of the primary tumor without amputation vs. amputation) did not influence survival in patients with metastatic osteosarcoma.

OP31: Cervical & Novel Technologies

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A271: Myth or fact: 3D-printed off-the-shelf prosthesis is superior than Titanium mesh cage in anterior cervical corpectomy and fusion

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Introduction: The anterior cervical corpectomy and fusion (ACCF) has been one of the recognized surgical approaches for treating degenerative cervical spondylotic myelopathy (DCSM) since the 1950s. However, the optimal implant to fill the gap after decompression has been debated, for implants used nowadays are still associated with complications of subsidence or non-union. With the rapid development of the Three-dimensional printing (3DP) technique, the 3DP trabecular structured prosthesis claimed to promote bone ingrowth and reduce stress shielding effect with proper trabecular space, thus providing more reliable initial stability. Anterior cervical spinal surgery has been an innovative adopter of 3DP technology for both patient-specific (PS) and market-available "Off-The-Shelf" (OTS) implants. Nevertheless, there is a paucity of clinical studies to verify the efficacy of 3DP OTS prosthesis in ACCF. This study aims to find out whether 3DP O TS prosthesis is superior than Titanium mesh cage (TMC)

in ACCF when treating single-segment DCSM. **Material and Methods:** The medical records of the DCSM patients who had undergone ACCF from January 2016 to January 2019 in a single center were abstracted. Patients were divided into the 3DP group (28 patients) and TMC group (23 patients) according to the implant type. The hospital stays, operation time, and intra-operative blood loss were compared between the two groups. The modified Japanese Orthopedic Association (mJOA) scores and neck disability index (NDI) were recorded pre-operatively, 2 weeks postoperatively, 3 months post-operatively, 6 months post-operatively, 12 months post-operatively, and 24 months post-operatively for both groups. Radiological data was measured at each follow-up time point to evaluate fusion, subsidence rate, cervical lordosis (CL), fused segment angel (FSA), and mean vertebral height (MVH). **Results:** The differences between the two groups in operative time, intraoperative blood loss, and the hospital stay were not statistically significant (p > 0.05). There were five cases of postoperative dysphagia (2 cases in the 3DP group, and 3 cases in the TMC group), symptoms relieved one week later. No screw loosening, plate breakage was found in either group, and all cases achieved bony fusion at the 24-month follow-up. The difference in improvement rate of JOA and NDI between the two groups was not statistically significant (p > 0.05). The number of cases with subsidence in the 3DP group in post-operative 3 months, 6 months, 12 months, and 24 months follow-up was 7 (25.0%), 9 (32.1%), 10 (35.7%), and 10 (35.7%), respectively; while the one in TMC group was 6 (28.6%), 7 (33.3%), 8 (38.1%), and 8 (38.1%), respectively. The difference in subsidence rates between the two groups at each follow-up time point were not statistically significant (p > 0.05). The postoperative CL improved in both groups when compared with their pre-operative ones (p < 0.05), but the difference of improvement in CL, FSA, MVH at 24 month follow-up between the two groups was not statistically significant (p > 0.05). **Conclusion:** In treating single-segment DCSM with ACCF, both 3DP OTS prosthesis and TMC achieved similar satisfactory clinical outcomes. However, the 3DP OTS prosthesis was not able to reduce subsidence as it claimed.

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A272: Facet joint loading after one, two and three-level keeled cervical disc arthroplasty

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Introduction: Cervical Disc Replacement (CDR) can reduce compensatory Range of Motion (ROM) at adjacent levels, and increase/restore intervertebral disc height resulting in reduced facet joint loading. Despite CDR in improving ROM, reports of facet degeneration have emerged. ROM and associated facet forces can be influenced by prosthesis design, implant height and positioning. It is recognized that increased ROM at the expense of detrimental facet loading can be a precursor to facet pathology and result in adverse biomechanical loading that may exacerbate adjacent segment pathologies. The purpose of this study was to evaluate effects of multi-level CDR on corresponding facet forces. **Material and Methods:** Seven human cervical spines (C2-C7, age range: 38 to 66 years) were inserted with thin film sensors (0.2 mm thick) into one facet joint at (C4-C5), (C5-C6) and (C6-C7) and secured on the exterior of the facet capsule. Specimens were inserted into a testing fixture permitting flexion, extension, and lateral bending without disruption of specimen orientation and were subjected to cyclic loading by applying a 3 mm deflection to the central (index) vertebra at a rate of 0.1 Hz for 20 cycles in each loading mode with data collection at 40 Hz. Testing conditions included the intact specimen followed by se-quential CDR with a keeled baseplate at the index (C5-C6), inferior (C6-C7), and superior (C4-C5) levels with repetition of the loading regimen between implantations. For each condition/loading mode, facet forces were reported as the (Max/Min) force ratio and compared using a 1-way ANOVA with Dunnett's post-hoc tests for comparison to intact con-dition. **Results:** In flexion, compared to the intact specimens, all three vertebral levels displayed a non-significant but re-duced (Max/Min) force ratio following a one-level implan-tation at (C5-C6). In extension, the (Max/Min) force ratios across all levels and surgical conditions were not statistically different from the corresponding intact conditions and loca-tions (P>0.66). Loading in lateral bending resulted in reduced, though not statistically different force ratios across implan-tation sites. Sequential implantations inferior and superior to the index level displayed comparable or non-significant re-ductions of the facet ratios regardless of implantation level or loading mode (P>0.6508 for all). Implantation of this keeled total disc replacement device at the index level does not statistically alter contact in the facet joints regardless of one-, two- or three-levels of implantations. The (Max/Min) force ratios at all levels under all implantation conditions and loading modes were comparable to or reduced (though not statistically) as compared to the intact condition. Implantation of this keeled disc replacement device at the index, inferior and superior levels does not statistically alter contact in the facet joints up to three-levels of implantations. **Conclusion:** Clin-ically, one may be able to perform multiple level implantations without unduly overloading the facet joints proximal or distal to the central index level. The hypothesis that multi-level CDR does not unduly alter facet force ratios was substantiated. The secondary aspect of increased compensatory facet forces due to additional insertions was not evident.

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A273: Risk factors of bone loss after cervical disc arthroplasty and hybrid surgery

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Introduction: Cervical disc arthroplasty (CDA) is a potentially feasible alternative surgical technique for patients with cervical disc degeneration disease (CDDD). Periprosthetic bone loss (BL) is a radiological phenomenon which was proposed in recent years. The impact on surgical outcome and inner mechanism of BL are still unclear. This study aims to the study aims to comprehensively explore the risk factors of BL and attempted to furtherly reveal its underlying mechanism. **Material and Methods:** A retrospective and comparative study was conducted of consecutive patients who had undergone one-level CDA, two-level CDA or two-level hybrid surgery (HS) at our institution to treat CDDD. Demographic and perioperative data, including age, gender, body mass index, bone mineral density, operation duration, blood loss, follow-up time, surgery type, arthroplasty level, preoperative and postoperative serum levels of calcium and phosphate were routinely recorded. The radiological images of all patients at pre-operation, 1-week post-operation and last follow-up were collected, to evaluate the following radiological parameters: BL, Hounsfield Unit value, anterior milling ratio, endplate-cover ratio, cervical lordosis, C2-C7 range of motion, disc angle (DA), disc ROM, sagittal vertical axis (SVA), T1 slope. Patients were divided into different groups in reference to existence and degree of BL, following with inter-group comparisons. **Results:** A total of 324 patients were enrolled in this study, among whom 170 underwent one-level CDA, 120 underwent two-level CDA and 94 underwent two-level HS, with 384 arthroplasty segments involved in total. BL was detected in 57.72% (187/324) patients and 53.91% (207/384) arthroplasty segments during the whole follow-ups. Univariate logistic regression analysis indicated that age ≥ 45 years was associated with lower risk of BL compared to age < 45 years (OR = 0.524, 95%CI = 0.348-0.789, p = 0.002, ref: age < 45 years); two-level HS led to a lower BL risk (OR = 0.412, 95%CI = 0.246-0.690, p = 0.001, ref: one-level CDA); a greater postoperative SVA was correlated with an increased risk of BL (OR = 1.270, 95%CI = 1.009-1.598, p = 0.042). The final multivariate regression model shows that age ≥ 45 years risk (OR = 0.608, 95%CI = 0.398-0.929, p = 0.022, ref: age < 45 years) and two-level HS risk (OR = 0.431, 95%CI = 0.251-0.740, p = 0.002, ref: one-level CDA) were independently associated with a higher risk of BL. Besides, a greater ΔDA was a independent risk factor of BL (OR = 1.048, 95%CI = 1.005-1.094, p = 0.029). The results further indicated an association between two-level HS and lower severity of BL (OR = 0.445, 95%CI = 0.273-0.724, p = 0.001, ref: one-level CDA). Severe BL was demonstrated to lead to a higher rate of endplate subsidence and collapse. **Conclusion:** Younger age and greater ΔDA were independent risk factors of BL, while HS potentially exerted preventative effect. Bone remodeling and micromotion may potentially initiate the BL process. Simultaneously, intraoperative procedures may also influence the occurrence of BL. Subsequent research should focus on elucidating the mechanisms and preventive measures for severe BL.

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A274: A novel application of tumor treating fields for the management of spinal metastases

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Introduction: Spine metastases can result in severe neurologic compromise and decreased overall survival. Despite treatment advances, patients frequently develop local disease progression, highlighting the need for novel therapies. Tumor treating fields (TTFields) impair tumor cell replication and are influenced by surrounding tissue. We hypothesize that the deposition of TTFields is increased in bone due to its non-conductive properties and this results in suppression of cell growth in spinal metastasis models. **Material and Methods:** Computational modeling of TTField treatment intensity was performed using simulated spine resection cavity. Luciferase tagged KRIB osteosarcoma and A549 lung adenocarcinoma cell lines were cultured in demineralized human bone graft. Cultures were treated with TTFields using the inovitro system and cell viability quantified. In vivo assays were performed after murine orthotopic tumor cell implantation. Using the inovivo system for TTField application, cell growth was monitored using bioluminescence and MRI. Functional impact of tumor growth was recorded and tissue collected for histologic analysis. **Results:** Simulation study demonstrated enhanced electrical field intensity within the tumor-bone interface of the resected vertebral body. In vitro analyses demonstrated TTFields suppressed tumor cell growth. Similarly, using orthotopic in vivo models, TTFields prevented tumor cell proliferation from the vertebral body into the spinal canal, resulting in significant improvement of multiple functional milestones that correspond with the degree of spinal cord compression. **Conclusion:** We report the first study demonstrating that TTFields achieve enhanced treatment intensity in bone, resulting in inhibition of tumor growth in 3-dimensional cultures and orthoptic murine models of spinal metastases.

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A275: Uncovertebral joint fusion versus endplate space fusion in anterior cervical spine surgery: a prospective randomized controlled trial

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Introduction: The uncovertebral joint is a potential region for anterior cervical fusion. The effect of the uncovertebral joint fusion has been confirmed in goat model. However, there are no clinical trials on human uncovertebral joint fusion (UJF). This study aimed to compare the fusion speed and clinical efficacy of UJF and traditional endplate space fusion (ESF) in anterior cervical surgery. **Methods:** Patients with single-level cervical spondylosis were recruited and admitted between February 2021 and October 2022 and randomly divided into the UJF and ESF groups. The primary outcome was the early fusion rate 3 months postoperatively. Secondary outcomes included the incidence of complications and patient-reported outcome measures (PROMs). **Results:** A total of 74 (92.5%) patients completed the trial and were included in the analysis, with an average age of 54.8 (26-65) years. The operation duration (131.3 ± 29.4 min vs. 123.6 ± 26.0 min, p = 0.237) and intraoperative blood loss (70.6 ± 50.0 ml vs. 79.2 ± 49.0 ml, p = 0.454) were comparable between the two groups. The fusion rate in the UJF group was significantly higher than that in the ESF group at 3 and 6 months after operation (3 months after operation: 66.7% vs. 13.2%, p < 0.0001; 6 months after operation: 94.1% vs. 66.7%, p = 0.006). No significant difference was found in the fusion rate between the two groups 12 months postoperatively. The JOA, NDI, and VAS scores for the arm and neck significantly improved after surgery in both groups. **Conclusions:** In anterior cervical fusion surgery, the early fusion rate in UJF is significantly higher than that in ESF.

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A276: Predictors of ligamentum flavum buckling in patients with congenital cervical spinal stenosis

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Introduction: Congenital cervical stenosis (CCS) is an abnormal narrowing of the cervical spinal canal present at birth that can predispose to cervical cord compression. Ligamentum flavum buckling can further contribute to preexisting cervical stenosis, placing CCS patients at additional risk for cervical myelopathy. Prior research has demonstrated that positional changes may exacerbate LF buckling. This study uses kinetic magnetic resonance imaging (kMRI) to evaluate structural and kinetic parameters of the cervical spine as independent predictors of ligamentum flavum buckling in patients with CCS. **Material and Methods:** A retrospective review of 113 consecutive cervical spine kMRI images from patients who met inclusion criteria. CCS was defined as a pedicular spinal canal diameter under 13mm. Using the MRAnalyzer automated imaging analysis software, T2-weighted mid-sagittal slices across cervical levels C2-T1 were analyzed for various structural parameters including T1 slope, sagittal spinal canal diameter, cervical lordosis, disc bulge, posterior disc height, LF thickness, and LF buckling in the neutral position. If present, the degree of ligamentum flavum buckling was measured in extension. Dynamic-based measurements such as translational and angular motion were assessed as anteroposterior translation of adjacent vertebra relative to one another and intervertebral angular variation respectively, both which were calculated as differences in motion parameters between flexion and extension imaging. Statistical analysis included stepwise logistic regression to identify independent predictors of LF buckling using age and sex as covariates. The model with the best fit was selected to identify the most predictive variables for LF buckling. **Results:** Overall, 113 patients (49% male) with a mean age of 44.83 + 11.73 were included in our study. Ligamentum flavum buckling most commonly occurred at the C4/C5 disc level (43/113). The highest incidence of congenital cervical spinal stenosis was at the C5/C6 disc level (29/113). At C3/C4, translational motion at the index level was predictive of LF buckling (p = 0.037; OR:8.16, 95%CI:1.13 to 58.86). LF thickness was predictive of LF buckling at C4/C5 (p =.047; OR:6.68, 95%CI:1.02 to 43.68). Translational motion at C6C7 was protective against LF buckling at C5C6 (p =.042; OR:0.06, 95%CI:.004 to.902). Angular motion at C5/C6 level when analyzing the C6C7 level approached significance (p =.08; OR:0.513, 95%CI: 0.243 to 1.083). **Conclusion:** LF buckling is a dynamic phenomenon associated with cervical spine instability. Standard radiography cannot detect buckling due to the radiolucent nature of the structure, whereas kMRI allows the characterization of dynamic-based pathologies such as LF buckling. Kinetic and structural parameters at the index level are predictors of LF buckling. Kinetic parameters at adjacent levels are protective factors, decreasing the incidence of LF buckling. Used in conjunction with static radiography, these parameters may assist surgeons in predicting a dynamic pathology from static imagery.

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A277: Smart fusion spine: a novel method to in-vivo measure spinal implant loads for the assessment of posterolateral fusion - Proof of concept in an in-vivo sheep model

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Introduction: Reliable and timely assessment of bone union between vertebrae is considered one of the key challenges after spinal fusion surgery. In a single-case ovine feasibility study a novel sensor concept demonstrated the ability to objectively assess posterolateral fusion based on continuous implant load monitoring. In this follow-up study, the influence of mono-segmental fusion on the measured implant loads was systematically investigated in a larger sample size using an updated sensor system. **Material and Methods:** Three Swiss white alpine sheep underwent bilateral facetectomy at level L2-L3 and L4-L5. The segments were stabilized using two pedicle-screw-rod constructs per level. Between each pedicle screw-pair a sensing device was attached to the rod resulting in four implanted sensors per animal. Rod loads were continuously monitored over 16 weeks through wireless data transmission. After euthanasia, the spines were tested for range of motion about the three major axes of loading. A high-resolution CT scan was performed to confirm the fusion success. **Results:** After an initial increase in implant load until reaching a maximum at approximately week 4, eleven out of twelve sensors measured a constant decrease in implant load over 16 weeks to on average 52% (SD ±9%) of the maximum. One sensor measurement was compromised by newly forming bone growing against the sensor housing. In agreement, in vitro residual motion of all segments was less than 1°. Bridging bone at each facet as visible on CT confirmed the fusion of all motion segments. **Conclusion:** Data obtained by continuous measurement of implant loading of spinal screw-rod constructs may enable objective and radiation-free monitoring of spinal fusion progression. However, the sensitivity along with the design of the current sensor concept needs to be tailored to and validated at the human spine.

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A278: Digital preoperative huddle platform use leads to decreased surgical cost

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Introduction: We evaluated the effect of multidisciplinary preoperative team communication through a structured mobile app on supply-related operating room costs, length of stay, and case length. **Material and Methods:** We implemented utilization of a digital huddle software as a service (SaaS) platform from March 2022 to June 2023 for neurological surgeries performed at a single tertiary care center. The platform supports the preoperative huddle between attending surgeons, residents, anesthesiologists, nurse anesthetists, operating room nurses and technicians and facilitates communication regarding surgical plan, room setup, patient positioning, medications, and surgical equipment. Surgeons were encouraged, but not required, to participate. Surgeons were grouped as "participants" and "nonparticipants" based on usage. We analyzed the association between huddle participation and differences in length of stay, supply-related cost, and case length, using group comparison and historical controls. Statistical analysis utilized general linear models. **Results:** A total of 97 surgeons and 29626 cases were included from March 2021 until June 2023. We included participating neurosurgery cases (12 surgeons, 4064 cases) which were compared with non-participating neurosurgical cases (6 surgeons, 2452 cases), orthopedic spine cases (20 surgeons, 6073 cases), and surgeries performed on a different operating room floor (59 surgeons, 21996 cases). Across all surgeons, cost increased by 7.3% (95% CI: 0.9-14.1, $p = 0.025$) in the post-intervention period. However, among participating surgeons after the implementation of the application, there was a supply-related cost decrease of 16.3% (95% CI: 8.3-23.6%, $p < 0.001$) and average net savings of $747 per surgical case. Restricting the analysis to neurosurgeons on our operative floor, participation was associated with a supply-related cost decrease of 17.5 % (95% CI: 6.0-27.5%, $p = 0.0037$). Restricting analysis to neurosurgeons and orthopedic surgeons on our operative floor, the cost decrease was 16.6% (95% CI: 5.2-26.6%, $p = 0.0055$). There was no change in case length, (median case length 171 minutes, change: + 2.7% increase, 95% CI: -2.2% - 7.9%, $p = 0.28$). **Conclusion:** The implementation of digital huddle SaaS resulted in a 16.3%

decrease in supply-related OR costs among participating surgeons during a period when the overall cohort experienced a 7.3% cost increase. These pilot data support wider implementation of digital huddle SaaS and further large-scale value analysis.

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A279: Study on the relationship between 3D configuration of vertebral and axis vertebrae

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Introduction: To better observe the relationship between the vertebral artery and the axis vertebrae through 3D software combined with imaging examinations. **Material and Methods:** Two hundred patients who underwent CT angiography of the head and neck at Honghui Hospital from 2018 to 2023 were selected. The data were imported into Mimics 21.0 software to measure the parameters of the axis vertebrae, including the diameter of the pedicle, the height of the pedicle isthmus, and the thickness of the pedicle isthmus. On the coronal view of the CT scan, a vertical line passing through the center of the C3 transverse process was used as a reference line to define the deviation direction of the vertebral artery, which was classified as lateral deviation (A), vertical entry (B), and medial deviation (C). Using the horizontal line passing through the exit of the C2 transverse process for reference, the degree of vertebral artery transverse course was defined and classified as below the transverse process (1), between the two (2), and above (3). The vertebral artery and cervical vertebrae were individually labeled and differentiated by different colors to establish a 3D model. **Results:** The incidence of narrow pedicles in the axis vertebrae was 30%, and the incidence of high transverse course of the vertebral artery was 35%. Based on the deviation direction and transverse course, they were classified into nine types: A-1, A-2, A-3, B-1, B-2, B-3, C-1, C-2, and C-3. Among them, A-1, B-2, and C-3 were the most common types, accounting for 70% of the nine types. These three types corresponded to lateral deviation with low angulation, vertical entry, and medial deviation with high transverse course, respectively. Among them, A-1 and B-2 types can be treated with pedicle screw fixation, while C-3 type is not recommended for pedicle screw fixation. **Conclusion:** 3D anatomical studies can provide more intuitive assistance for doctors to understand the relationship between the vertebral artery and the axis vertebrae, facilitating the safe placement of pedicle screws during surgery.

OP32: Surgical Complications: Implant and Technique-Related Complications

1763
A280: Comprehensive analysis of peri-operative complications in patients undergoing trans-oral release for irreducible atlantoaxial dislocation: a single-center 21-year experience of 537 patients

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Introduction: Irreducible atlantoaxial dislocation (IAAD) is most commonly defined as AAD that can not be reduced with cranial traction using up to 1/5 of body weight under general anesthesia. Currently, surgical intervention is the only effective treatment for IAAD. We previously described a technique of one-stage anterior transoral soft tissue release followed by posterior fixation and fusion for the management of IAAD. Although anatomical reduction was achieved in most cases, these procedures were associated with complications that were concerning for spine surgeons. We herein reported a comprehensive analysis on the profile of peri-operative complications associated with this technique. **Material and Methods:** This was a retrospective study on patients of IAAD receiving transoral soft-tissue release for reduction of the atlantoaxial joint followed by posterior atlantoaxial instrumentation and fusion during the past 22 years at our institution. Patients were excluded if there was tumor, tuberculosis, or other infectious processes involving the craniovertebral junction, if odontoidectomy was performed, if anterior internal fixation was used, if any other concurrent surgery was performed, or if there was incomplete clinical or imaging data. Electronic medical records, lab results, imaging studies were reviewed for each patient with particular attention paid to their clinical and surgical characteristics and intra-operative and post-operative complications. Data on patient demographics, diagnoses, surgical procedure performed, and the management and outcome of complications were collected. In order to provide a comprehensive analyses, we included all complications suffered by enrolled patients in the current study, including those directly related to the trans-oral procedure, those associated with the posterior internal fixation procedures, and those pertaining to airway issues as well as general complications. **Results:** Out of 585 patients who received the trans-oral soft-tissue release procedure for IAAD at our institution since 2000, 537 met the inclusion criteria.

The average age was 36.9 years (range 4-73 years). There were 261 male and 276 female patients. The trans-oral procedure was the index surgery in 516 patients and a revision procedure in 21 patients. A total of 134 incidences of complication were identified in 97 patients (18.1%), of whom the average age was 37.9 years (range 7-69 years), the gender ratio was 1.37 (56 male and 41 female). Infection (8.6%) and neurological deterioration (6.0%) were considered as common complications with occurrence rate greater than 5%. Implant-related issues and airway issues were found in 3.9% and 3.0% of patients, respectively. Less common complications including oropharyngeal dysfunction (6 cases) and vascular injury (2 cases) were also reported. Revision surgery was performed in 5.8% of patients due to either infection, neurological deterioration, or implant failure. Patients with superficial and even deep wound infection would eventually recover, as long as there was no intracranial infection, which was associated with a high rate (80%) of debilitating neurological sequalae. **Conclusion:** There is a relatively high overall rate of complications (26.0%) associated with transoral release for IAAD, with some complications causing significant morbidity or even mortality. Therefore, experience on peri-operative management and patient optimization is of paramount importance in ensuring surgical success in these challenging cases.

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A281: Risk factors for instrumentation failure after total en bloc lumbar spondylectomy in patients with spine tumors: a systematic review

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Introduction: Total en bloc spondylectomy (TES) poses unique biomechanical challenges when attempting to reconstruct the spinal column. In the lumbar spine, this is even more challenging given the unique anatomy of this region and the high rate of instrumentation failure. The purpose of our study was to conduct a systematic review of the incidence and risk factors of instrumentation failure after lumbar TES. **Material and Methods:** We conducted a systematic review using the PRISMA guidelines and screened for studies between April 2000 and August 2023 that reported individual patient data on lumbar spondylectomy. Our primary endpoint was instrumentation failure (IF). The data was pooled and provided an overall instrumentation failure rate. The timing of instrumentation failure and risk factors were ascertained from individual studies. Levels of evidence were also reported. **Results:** A total of 16 studies conducted between April 2000 and August 2023 that met our eligibility criteria were included in our study, with a total of 153 patients undergoing lumbar TES. The mean patient age was 42 years (standard deviation 16), and the mean follow-up time was 52 months. Out of 153 patients, 129 included data on IF, with 36% (46 of 129) having metastatic tumors, 64% (82 of 129) having primary tumors, and one case (0.8%) where the origin of the tumor was unclear. The total reported failure rate was 21% (27 of 129), with 63% (17 of 27) experiencing late failure (> 12 months after surgery), 4% (1 of 27) experiencing early failure (< 12 months after surgery), and 33% (9 of 27) at an unspecified time. There was a statistically significant correlation between radiotherapy and IF (p < 0.001). The posterior surgical approach was associated with a reduced incidence of IF (p = 0.011). The use of autografts and the use of a titanium cage were significantly associated with a greater incidence of IF (p < 0.001 and p < 0.001, respectively). Instrumentation failure was not correlated with age (p = 0.686), gender (p = 0.739) or multilevel surgery (p = 0.963). **Conclusion:** Our data indicates that the posterior approach in patients with TES is associated with a lower incidence of instrumentation failure, whereas identified risk factors for instrumentation failure were autografts, titanium cages, and radiotherapy. In regards to the high rate of IF, continued research on more robust construction designs is needed.

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A282: Correlation between sagittal balance and distal junctional failure in degenerative spine pathology: a retrospective analysis

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Introduction: Mechanical failure of spinal posterior instrumented arthrodesis in the lumbar region is suspected to occur more frequently when sagittal balance is not adequately restored [1]. While failures at the proximal instrumented extremity have been well described, the lumbar distal junctional pathology has received less attention in literature [2] and is not clear if targeting spinopelvic parameters is suitable to prevent failure. This study aimed to investigate the failure of the caudal end of lumbar posterior fixation in terms of pre-operative and post-operative spinopelvic parameters, correction performed, demographics and clinical data. **Material and Methods:** The lumbar, thoraco-lumbar, and lumbo-sacral

posterior fixations performed with pedicle screws and rods in 2017-2019 at Rizzoli Orthopaedic Institute were retrospectively analysed. The revision surgeries were collected in the junctional group if the failure in the caudal end was caused by (i) pullout of the screws and/or (ii) breakage of rods or screws and/or (iii) vertebral fracture and/or (iv) degenerative disc disease. Fixations which have not failed were gathered in the control group. As 81% failures occurred within 4 years, an observational period of 4 years was chosen. The main spinopelvic parameters (sagittal vertical axis (SVA), pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS), thoracic kyphosis (TK), lumbar lordosis (LL), PI-LL, T1 pelvic angle (TPA) and T1 spinopelvic inclination (T1SPi)) were measured for each patient on standing lateral radiographs with Surgimap (Nemaris). Demographic and clinical data were extracted for both groups. **Results:** Among the 457 patients who met the inclusion criteria, the junctional group included 101 patients, who required a revision surgery. The control group collected 356 primary fixations which had not failed within 4 years. The two most common causes of revision surgery were screws pullout (57 cases) and rod breakage (53 cases). The multivariate logistic regression model showed that patients older than 40 years had a high probability of developing distal junctional pathology. SVA, PT, LL, PI-LL and TPA differed significantly between the two groups (p = 0.021 for LL, p < 0.0001 for the other parameters, repeated-measures mixed effect models). The correlation between the two groups and the pre-operative and post-operative conditions was significant for PT, SS, LL, TK, PI-LL and TPA (p < 0.005, repeated-measures mixed effect models). Both the long and short thoraco-lumbar fixation showed a higher probability of requiring a revision, compared to the only lumbar fixation. Sex and BMI and number of cages did not affect the risk of failure. **Conclusion:** Mechanical failure is more likely to occur in patients older than 40 years with a thoraco-lumbar fixation where PT, PI-LL and TPA were not properly restored. In addition, to assess the sagittal balance the SVA alone should be carefully evaluated in relation to the PT and TPA, so as to take into account the pelvis compensatory mechanisms.

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1202

A283: Personalized surgical strategies and clinical outcomes for severe ossification of the posterior longitudinal ligament in the cervical spine

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Purpose: This study aimed to implement a personalized surgical plan for the treatment of severe ossification of the posterior longitudinal ligament (OPLL) and to compare the clinical efficacy of various surgical approaches. **Methods:** We conducted a retrospective analysis from patients with severe cervical OPLL who underwent surgery following a personalized surgical strategy from January 2014 to May 2021. The study included 130 patients, comprising 71 males and 59 females, with an average age of 59.1 ± 9.6 years. All patients exhibited rapidly progressing symptoms of spinal cord compression with continuous deterioration. Conservative treatment lasting 2 to 4 months was ineffective. MRI scans showed a mean spinal cord compression ≥ 50%, with the maximum spinal cord compression (MSCC) exceeding 95%. Among these cases, MSCC was located in the upper cervical spine in 10 instances and extended from the cervical thoracic segment to the upper thoracic spine in 5 instances. Based on the personalized surgical strategy, anterior surgery (ACCF+ACDF) was performed on 58 patients, posterior surgery (laminectomy or/and laminoplasty) on 67 patients, and combined anterior and posterior surgery on 5 patients. Three cases required revision after posterior laminoplasty due to sagittal imbalance leading to aggravated neurological symptoms during the follow-up. The JOA and NDI score were used to evaluate surgical efficacy. **Results:** No significant differences were observed in gender, age, BMI, disease course, surgical segment, MSCC, and follow-up time among three groups. There were no significant differences in JOA score, NDI index among three groups at preoperative and 2 months postoperative follow-up (p > 0.05). At the final follow-up, no significant difference was noted in NDI index among the three groups (p = 0.22), but a significant difference was present in JOA score among the three groups (p = 0.039). The JOA scores for upper extremity function, lower extremity function, trunk and bladder function were compared separately among the three groups. A significant difference was found in the upper extremity function score (p = 0.045), but no significant differences were observed in the lower extremity function score (p = 0.64), trunk and bladder function score (p = 0.22) among three groups. No significant difference was found in the incidence of incisional infection, dysphagia, and dysphonia between two groups (p > 0.05). A higher incidence of CSF leakage was observed in anterior surgery (p = 0.040), and a higher incidence of axial pain was noted in posterior surgery (p = 0.039). In 3 patients who underwent laminectomy and fusion, neurological symptoms gradually worsened 12 months after surgery. **Conclusion:** Anterior surgery facilitates a more effective postoperative recovery of upper limb neurological function in patients. When the MSCC is located in the upper cervical spine and extends to the upper thoracic spine, anterior surgery presents greater challenges. However, by adhering to the operational principles outlined in this paper, it is still possible to perform direct anterior removal surgery. Sagittal imbalance after laminoplasty may lead to a recurrence of neurological symptoms, which can be addressed by anterior revision surgery."
Keywords: OPLL; personalized surgical strategies; myelopathy

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A284: Lessons learned from 20 years of history using vertical expandable prosthetic titanium rib in early onset scoliosis patients

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Introduction: The use of Vertical Expandable Prosthetic Titanium Rib (VEPTR) has shown a marked decline for early onset scoliosis (EOS) treatment. At the verge of VEPTR era, a global assessment of twenty years of this device's outcomes encompassing coronal correction, spine growth height, pulmonary function, complication rates, and the impact on health-related quality of life (HRQoL) was performed. The aim of this study was to analyze all EOS patient data from Pediatric Spine Study Group (PSSG) registry that were treated initially with VEPTR instrumentation surgery and followed up for at least five-years. **Methods:** We reviewed all patients from PSSG database that underwent traditional VEPTR instrumentation with a minimum of five-years of follow-up without any prior spine surgery. Demographic variables, radiographic parameters, pulmonary function test (minimum of two-years between studies), 24–Items Early Onset Scoliosis Questionnaire (EOSQ-24) findings (minimum two-years between questionnaires) and complications were examined. **Results:** A total of 447 patients with a mean age of 4.24+2.62 years; 51.0% male were included. Fifty percent had congenital scoliosis, followed by neuromuscular (27.5%), syndromic (11.9%), and idiopathic etiologies (10.3%). Two hundred and thirteen patients had at least one comorbidity. Thoracic insufficiency syndrome was the most common comorbidity reported. At five-year follow-up evaluation after initial index surgery, 237 patients continued with VEPTR, 186 were converted to fusion, and 24 required hardware removal without further surgery. Initial mean body mass index was 16.40+2.68 Kg/m2, and most recent was 17.42+4.08 kg/m^2 (p < 0.001). Preoperative coronal Cobb angle was 66.94+23.59°, and most recent was 56.71+18.85°

(p < 0.001). Preoperative sagittal Cobb angle was 46.73+7.62°, and most recent was 53.95+22.85° (p < 0.001). The T1-S1 Spine height increased from 232.99+47.93 mm to 297.54+63.47 mm (p < 0.001); while T1-T12 height changed from 141.63+33.87 mm to 188.33+43.35 mm (p < 0.001). The L1-S1 height increased from 90.56+20.19 mm to 109.63+24.47 mm (p < 0.001). During five-year follow-up period, 82 patients underwent pulmonary function testing, with at least two years between tests. Forced vital capacity (FVC) diminished from 61.92+31.58% to 46.84+20.18% (p < 0.001), as well as the forced expiratory volume in one second (FEV1) from 85.53+148.22 to 47.98+22.12 (p = 0.004). In those patients (N = 238) with a minimum of two years between the initial and the last EOSQ-24 questionnaire administration, the score changed from 71.92+18.95 to 73.17+19.24 (p = 0.328). Seventy-two percent of patients had post-operative complications (336/447); hardware migration and failure being the most common. Evaluation between all EOS categories showed better results in congenital scoliosis. **Conclusion:** This study presents the most extensive sample of VEPTR utilization in the EOS literature, with a minimum of five-years of follow-up. The principal objectives of VEPTR devices were to improve coronal deformity, stimulate spine growth, and hold respiratory function deterioration. Our results indicate that the first two objectives were achieved. However, VEPTR technique could not prevent worsening of respiratory function as initially proposed. Our data did not demonstrate a significant improvement in HRQoL parameters. Although we acknowledge the limitations of analyzing limited PFT/EOSQ data, it is important to highlight the trend observed in both topics. Due to high complication rates, the medical community should continue to seek alternative approaches to treat EOS.

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A285: Classification on morphological changes of the overload vertebra after two-level zero profile anterior cervical discectomy and fusion

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Introduction: In the two-level anterior cervical discectomy and fusion (ACDF) with Zero-P implant system, we found the collapse often occurred on the intermediate surgical vertebra. We definite the vertebra between the implants as overload vertebra (OV). The present study was to explore and classify the morphological changes of the overload vertebra after two-level ACDF. **Methods:** Between May 2012 and May 2020, patients underwent two-level ACDF were reviewed. Clinical outcomes were evaluated according to the VAS scores of the neck and arm, the JOA scores and the NDI scores.

Radiological evaluation was conducted via lateral radiographs for flexion, extension, and neutral positions. Cervical lordosis (CL), segmental lordosis of the functional spinal unit (FSU), range of motion (ROM) of the surgical segments, the height and the anteroposterior diameter of the surgical vertebral bodies, the area of the surgical vertebral bodies and the fusion rate were recorded. All data were collected preoperatively and at 3 days, 3 months, 12 months postoperatively, and the final follow-up. **Results:** 155 patients were involved with 85 males and 70 females. The VAS of neck, VAS of arm, JOA score and NDI were all improved after surgery (p < 0.05). The Cobb of the total cervical spine and the FSU were significantly improved at 3 days after surgery (p < 0.05). The cobb of the total cervical spine and the FSU were decreased at 3, 12 months and the final follow-up. At 3 months after surgery, the area of OV was significantly decreased compared with that at 3 days postoperatively (p < 0.05). The loss of area on overload vertebral body was significantly larger compared with the upper and lower vertebral body (p < 0.05). The anterior height of OV was significantly decreased at 3 months after surgery compared with that at 3 days postoperatively (p < 0.05). The anteroposterior diameter of OV was also significantly decreased at 3 and 12 months and the final follow-up after surgery compared with that at 3 days postoperatively (p < 0.05). Then, we divided the morphological change of overload vertebral body into four types. They were Type I (the unchanged group), Type II (the bone loss group), Type III (the height loss group) and Type IV (the kyphosis group). In the sub-group analysis, the VAS score of neck was significantly higher in Type IV group at 3 and 12 months after surgery compared with that in Type I group (p < 0.05). The cobb of the total cervical spine and FSU were significantly decreased in Type IV group compared with those in Type I group (p < 0.05). **Conclusion:** The OV is a special vertebra in two-level ACDF. The overload vertebral body may suffer a more obvious morphological change after surgery. The anterior vertebral body collapse may result in cervical spine kyphosis which may decrease the clinical outcomes.

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A286: Comparison of patient-reported postoperative dysphagia in patients undergoing one-level versus two-level anterior cervical discectomy and fusion with the Zero-P Implant System

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Introduction: We hypothesize that a greater number of surgical levels may result in a higher incidence of dysphagia due to more dissection of soft tissue, although whether the incidence of postoperative dysphagia differs between these procedures in anterior cervical discectomy and fusion (ACDF) with the Zero Profile (Zero-P) Implant System is unknown. Thus, the purpose of this retrospective study was (1) to investigate whether the incidence of postoperative dysphagia differs between one-level and two-level ACDF with the Zero-P and (2) to examine patient characteristics that may be associated with the occurrence of dysphagia after ACDF with the Zero-P. **Material and Methods:** A retrospective analysis of 208 patients who underwent ACDF with the Zero-P Implant System and had at least one year of follow-up was performed from January 2013 to December 2018. The patients were divided into two groups based on the number of operated levels (one-level group, N = 86; two-level group, N = 122). Dysphagia was assessed based on the Bazaz grading system. The incidence of dysphagia and the severity of dysphagia at each follow-up were compared between the two groups. The patients were divided into two groups (nondysphagia group, N = 160; dysphagia group, N = 48), and covariates were obtained for multivariate analysis, including demographic parameters, surgical parameters, and radiographic parameters. **Results:** The results showed that the incidence and severity of postoperative dysphagia in the two-level group were significantly greater at 1 week, 1 month and 3 months postoperatively than those in the one-level group. The results of ordinal logistic regression showed that older age, two-level surgery, greater prevertebral soft tissue swelling (PSTS) and the difference between the postoperative and preoperative C2-7 angle (dC2-7A) were significantly associated with a higher incidence of dysphagia after ACDF with the Zero-P. **Conclusion:** Two-level ACDF with the Zero-P can result in a significantly greater incidence and severity of transient postoperative dysphagia. Older age, greater PSTS and the dC2-7A were also associated with postoperative dysphagia after ACDF with the Zero-P.

Keywords: ACDF; Zero-P; cervical degenerative disc disease; dysphagia

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A287: A prediction nomogram for fractured vertebra re-collapse after posterior reduction and pedicle screw fixtion in thoracolumbar fractures

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Introduction: The postoperative re-collapse of fractured vertebra is one of the common complications after posterior reduction and pedicle screw fixation for thoracolumbar fractures (TLFs). This study aimed to establish a predictive nomogram model for fractured vertebra re-collapse after posterior reduction and pedicle screw fixation for TLFs. **Material and Methods:** Patients undergoing posterior reduction and pedicle screw

fixation surgery for TLFs at our hospital between January 2016 and December 2021 were retrospectively reviewed. According to the re-collapse of the fractured vertebra at the final follow-up, patients were divided into collapse and non-collapse groups. The predictors for fractured vertebra re-collapse were identified by univariate and multivariable logistic regression analysis, and a nomogram model was developed. The prediction performance and internal validation were established. **Results:** A total of 224 patients were included in this study. Of these, 46 (20.5%) patients developed re-collapse of the fractured vertebra. Age, AO fracture classification, screw distribution in the fractured vertebra, anterior vertebral height compression ratio (AVHC) and preoperative vertebral wedge angle (pre-VWA) were associated with fractured vertebra re-collapse. Then, these predictors were used to construct a predictive nomogram. The AUC of the nomogram model was 0.882. The C-index was 0.873 (0.845-0.900), and it was 0.845 with bootstrapping validation. The calibration curves and DCA also suggested that the nomogram model had excellent predictive performances for fractured vertebra re-collapse. **Conclusion:** A clinical nomogram incorporating five variables was constructed to predict the fractured vertebra re-collapse after posterior reduction and pedicle screw fixation for TLFs. The nomogram demonstrated good calibration and discriminative abilities, which may help clinicians to make better treatment decisions.

180
A288: Analysis of relationship between subaxial pedicle screw malposition and vertebral artery injury on cadaver

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Introduction: The aim of our study is to test the safety margin hypothesis for prevent vertebral artery injury which one of the most serious consequences of screw malposition, investigating the sensitivity of existing classifications of cervical pedicle screw malposition in detecting vertebral artery damage, as well as determining the threshold value at which screw malposition causes vertebral artery injury on cadaver. **Material and Methods:** In our study, anatomical measurements were taken using preoperative CT scans on five human cadavers. Transpedicular screws were placed to create lateral pedicle violation. Postoperative measurements were taken using CT scans and then vertebral arteries were dissected to macroscopically and histopathologically assess damage. **Results:** Our findings revealed a significant correlation between the safety margin, consisting of combined distance of the vertebral artery from the lateral and medial walls, and the area occupied by screws within the foramen for causing vertebral artery damage. The classifications described in the

literature did not show a statistically significant relationship with vertebral artery damage. Critical threshold for causing vertebral artery damage is exceeding the safety margin. **Conclusion:** By experimentally validating the safety margin, which has been defined in various ways in the literature, our study has confirmed its presence and effectiveness. It has demonstrated the lack of a significant relationship between classifications of cervical pedicle screw malposition in the literature and vertebral artery damage. New classification was made with the cadaveric results from study. Our study contribute to the literature as the first experimental study highlighting the importance of considering the safety margin and position of the vertebral artery, increased vertebral artery injury risk at dominant side because of smaller safety margin and importance of preoperative examination of vertebral artery on both sides although the artery is pushed laterally during screw malposition.

OP33: MIS Thoracolumbar Surgery

1263
A289: Prediction of the lumbar spine instability in relation to lumbar decompression surgery by using finite element analysis

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Introduction: Human aging often leads to chronic modifications in intervertebral discs, leading to conditions like lumbar foraminal stenosis, characterized by herniated nucleus pulposus, osteoarthritis, and ligament hypertrophy. These can result in neural ischemia and faulty nerve conduction, causing symptoms from radiating pain to intermittent neurogenic claudication. Initial treatments usually recommend conservative measures to minimize surgical damage and slow spinal degeneration. However, when ineffective, they can worsen the patient's condition, making comprehensive decompression through laminectomy or facetectomy necessary. These techniques may alleviate symptoms but can cause long-term complications like accelerated disc degeneration due to altered spinal alignment. Recent focus is on minimally invasive techniques and targeted therapies to treat the lesion without aggravating spinal

degeneration. Given that low-grade static spondylolisthesis may not require instrumentation or fusion, endoscopic surgery presents a promising alternative. To aid this, we developed a finite element model for biomechanical analysis of endoscopic treatment, aiming to determine optimal facet joint resection that targets the lesion without compromising spinal stability. **Material and Methods:** Our model was constructed using high-resolution computed tomography images from a volunteer with no known spinal diseases. From these, a three-dimensional reconstruction of the L1-S1 region was created. Various simulated postoperative models were generated. These models represented varying subtypes from foramen and lamina related decompression surgery. To reflect real-world surgeries, we also simulated two endoscopic surgery finite element (FE) Models. The "endoscopic foraminotomy" involved the removal of the cranial side superior articular process to mimic percutaneous endoscopic lumbar decompression of the exiting nerve root. The "extend foraminotomy" involved the removal of the cranial and ventral side of the superior articular. Simulations involved a physiological load and a pure moment of 10nm to mimic the state of the articular process and intervertebral disc activities under four different loading conditions. The resulting range of motion (ROM) and Peak von Mises stress (PVMS) in the annulus were then measured and analyzed. **Results:** Distinct ROM variations were observed across different surgical levels, with the highest discrepancy noted during left lateral bending and right axial rotation for models simulating the most extensive decompression procedures. In terms of PVMS, significant variations were observed during flexion, particularly in models simulating laminectomy. Despite these variations at individual levels, no significant differences in overall ROM or PVMS were noted when considering the whole lumbar spine, except for during flexion. **Conclusion:** Endoscopic foraminotomy and extended foraminotomy were found to maintain better equilibrium distribution of load and spinal stability compared to total foraminotomy, potentially improving patient outcomes.

1539
A290: Effectiveness of quad-cortical thoracic missile screw for the upper instrumented vertebrae allowing minimally invasive selective anterior thoracic fusion for scoliosis

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Introduction: It is established that Anterior Spinal Fusion for adolescent idiopathic scoliosis (AIS) may result in shorter fusion levels. Cephalad angled insertion allows through two vertebrae as fixation through the main mini open wound or a laparoscopic portal. Analysis consisted of a single centre cohort of Selective Anterior Thoracic Fusion (SATF) utilising a quad cortical double vertebral missile screw for the Upper Instrumented Vertebrae (UIV) to minimize soft tissue dissection. **Material and Methods:** A retrospective analysis between 2017-2023 of patients undergoing SATF was performed. Data was collected from British Spine Registry (BSR) and local records for a 1 year minimum follow up. Cobb angles for standing and fulcrum bending radiographs (FBXR) pre-operatively and post-operatively were measured. Patient satisfaction reported via SRS22 questionnaires. **Results:** There were 21 patients undergoing SATF with a mean age of 16.5 y, F:M ratio of 20:1. There were 19 single major curves. Preoperative cobb angle 54.2°. Fulcrum Bending XR (FBXR) was 23.0°. The last postoperative Cobb was 22.7°. The Correction Rate (CR) was 58.1% and the Fulcrum Bending Correction Index (FBCI) was 100.9%. SRS22 was 3.44 (pre-op), 3.77 (1-year postop) and 4.08 (2 years). Return to surgery within 30 days 4.8% (n = 1) for screw adjustment. Reinsertion of chest drain 4.8% (n = 1). Overall mean blood loss 426 ml, mean operation length 360 minutes and mean length of stay 5.8 days. There were no revisions of the UIV Missile screw nor intra-operative monitoring events. **Conclusion:** MIS Selective Anterior Thoracic spinal fusion is found to be an effective and safe approach to the management of AIS. We report a short fusion length of 7.1 levels. The FBXR is predictive of final Cobb angle and therefore we recommend reserving this procedure for flexible curves with a FBXR < 25°. The quad cortical double vertebral missile screw has aided in minimizing surgical exposure yet achieving satisfactory and reliable correction at 1 year.

1290
A291: Promising feasibility of saphenous nerve somatosensory - Evoked potential intraoperative monitoring during lumbar spine surgery

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Introduction: Saphenous nerve somatosensory evoked potentials (SN-SSEPs) have been proposed to detect lumbar plexus and femoral nerve injury during lateral lumbar surgery, as tibial nerve somatosensory evoked potentials (TN-SSEPs) alone are insufficient. SN-SSEPs may prove to be useful in various types of lumbar surgery since stimulation of the saphenous nerve below the knee derives solely from the L4 root, providing means of L4 monitoring. The feasibility of routine SN-SSEPs for lumbar monitoring has yet to be established. This study aims to determine the feasibility of monitoring SN-SSEPs in lumbar surgery without special modification of the anesthetic technique. **Material and**

Methods: At a single center, 563 cases of lumbar surgery were monitored using both SN-SSEPs and TN-SSEPs. Baseline monitorability parameters and baseline amplitude of SN-SSEPs and TN-SSEPs were recorded, as well as stimulation parameters. Anesthesia management was at the discretion of the attending anesthesiologist. Saphenous nerve stimulation was performed using 13mm needle electrodes placed below the knee. Using the same needle electrodes, tibial nerve stimulation was performed at the ankle. Recorded data were retrospectively graded for monitorability, and two independent reviewers measured SN-SSEPs and TN-SSEPs cortical amplitudes. **Results:** In 563 cases, 92.2% of SN-SSEPs and 97.9% of TN-SSEPs were monitorable. In general, SN-SSEPs required greater stimulation intensities and longer pulse durations than those required by TN-SSEPs. In addition, the stimulus repetition rate was less than the standard of 4.79 Hz in 25% of SN-SSEPs and 14% of TN-SSEPs (p < 0.05). Pulse train stimulation was employed in 29% of SN-SSEPs and 8% of TN-SSEPs (p < 0.05). Mean amplitudes were 0.8 mV for SN-SSEPs and 1.4 mV for TN-SSEPs (p < 0.05). Reviewer classification of SSEP monitorability correlated with an amplitude threshold of 0.27 mV and an AUC (area under the curve) of 0.993. Furthermore, BMI did not affect the individual monitorability of SNSSEPs or TNSSEPs (both p > 0.05). Out of 20 SSEP alerts due to unexplained anesthetic changes, eight involved both nerves, eleven involved only the saphenous nerve, and only one involved the tibial nerve. **Conclusion:** Based on the results of this study, it is feasible to utilize SN-SSEP monitoring during lumbar surgery while using an anesthetic regimen of a halogenated inhalational agent. SN-SSEP monitoring may expand the role of neuromonitoring in detecting root injuries during lumbar surgery.

550

A292: Comparison of clinical and radiologic outcomes between oblique lumbar interbody fusion and minimal invasive transforaminal lumbar interbody fusion in spondylolisthesis, a randomized controlled trial

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Introduction: Minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) and Oblique lumbar interbody fusion (OLIF) are widely used for treating spondylolisthesis. These procedures minimize damage to the surrounding muscle and improve outcomes compared to traditional open procedures. No study has directly compared OLIF and MIS-TLIF in a prospective trial. This study aim to compare clinical and radiologic outcomes between MIS-TLIF and OLIF in grade I-II spondylolisthesis patients. **Material and Methods:** 60 patients who underwent single-level surgery were randomly allocated to the MIS-TLIF or OLIF group. Clinical outcomes were assessed using visual analogue scale(VAS) for back and leg pain, Oswestry Disability Index(ODI), EQ-5D-5L, and satisfaction score. Data were collected pre-operatively, post-operatively and at months, 1, 3, 6 and 12. Radiologic outcomes included measurements of disc height (DH), foraminal height (FH), foraminal area (FA), cross-sectional area of spinal canal (CSA), spinal canal diameter (SD) and fusion status. Intraoperative parameters, including operative time and blood loss. Mixed effects or panel regression models were used to calculate parameter changes from baseline to subsequent timepoints. **Results:** Demographic and disease characteristics at baseline were comparable between groups. Clinical outcomes in both groups all showed clinically and statistically significant improvements from baseline to each subsequent time point (all p < 0.001). Predicted mean change (95%CI) in VAS back was -3.9 (-4.6 to-3.1), VAS leg was -5.6 (-6.2 to-5.1), ODI was -15.7 (-19.0 to -12.5) and EQ5D5L was 25.4 (21.3–29.6). The differences in TLIF vs OLIF group over total follow up were not statistically significant: VAS back -0.3 (-0.8 to 0.2); p = 0.18, VAS leg: -0.4 (-0.8 – 0.04); p = 0.08, ODI: 0.4 (-1.9 to 2.8); p = 0.7 and EQ5D5L: 0.1 (-1.9 to 2.2); p = 0.9. Radiological parameters significantly improved post-baseline in all patients (p < 0.001). The changes in DH (-0.4 (-0.7 to -0.1) mm; p = 0.008), FH -1(-1.4 to -0.6) mm; p < 0.001 and FA -6.1 (-10 to -2.2) mm^3; p = 0.002 were lower in TLIF vs OLIF group. CSA was higher in TLIF compared to OLIF group 19 (10-29) mm^3; p < 0.001, and SD change was not different between groups 0.3 (-0.2 to 0.7) mm; p = 0.3. Blood loss was significantly lower in OLIF group (97 vs 141mL; p = 0.013). Operative time and length of stay were similar (120 vs 114 min, 2.5 vs 2.4 day; p > 0.05). **Conclusion:** In patient with grade 1-2 spondylolisthesis, patient reported outcomes improved in both MIS-TLIF and OLIF groups: between group differences were minimal and not significantly different. OLIF demonstrated advantages in restoration of DH, FH and FA, lower intraoperative blood loss compared to MIS-TLIF.

2257

A293: A cadaver study: the relationship of vital organs of the thoracolumbar junction during a far lateral approach using a t-12 corpectomy model

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Introduction: In recent years, minimally invasive surgery (MIS) has gained an important role in spine surgery.

Postoperative complications, duration of hospital stay and rehabilitation time may be significantly improved by adopting these new procedure techniques. More extensive surgeries such as a complete corpectomy with cage-implantation are not only feasible, but use of MIS may have become the standard for these procedures in many facilities. Although these new techniques have become well-established, there have been only few studies investigating vital structures at risk during the procedures. The thoracolumbar junction is a critical junction area for spinal disorders /diseases with the juxta position of the diaphragm and its attachments and the proximity of various vital structures to the surgical access. Today, only few studies have qualitatively assessed which structures are at risk and none has provided a quantitative evaluation by demonstrating measurements of the proximity of structures involved and assessed injuries. **Material and Methods:** Six fresh-frozen adult cadaveric specimens (torsos) were dissected according to standardized protocol. All specimens had no prior spine or torso surgeries. A formal left-sided far lateral T12 corpectomy was carried out by senior spine fellows under submission, using dedicated surgical tools and after having received focused training. Upon completion of the procedure, which involved a full T12 corpectomy, a cage was placed between T11 and L1 agents and the procedure was being completed. We then turned the patient supine and performed a formal celiotomy and sternotomy to allow for an open anterior inspection of all structures concerned. Vital structures as in vessels, diaphragm, pleural membranes, psoas and neural elements, important foramina of the diaphragm (Bochdalek, Morgagni) as well as the thoracic duct were identified. Any injuries to these structures were recorded and proximity to key relevant structures to this exposure were measured. Pictures were taken on every important step during the whole procedure. Access equipment and surgical implants are provided by commercial vendor (Globus Med Inc). **Results:** We were able to quantify the actual diaphragm excursions and describe its origins to the spine. Surprisingly, there was no actual diaphragm injury in any of the cadavers. Despite the junior nature of our surgeons, there were no injuries to the neurovascular structures: We found expected parietal but no visceral pleural injuries. Formal measurements of anatomic correlations were provided to all vital structures. Safe satisfactory cage placement using far lateral access instrumentation and simple fluoroscopy could be confirmed in all cadavers. **Conclusion:** Our cadaver study identified the feasibility of performing a T12-corpectomy through a far lateral approach with no violation of the actual diaphragm and expected limited injuries to the parietal pleura only. Formal measurements of distances to the vital structures were obtained, are listed, and will be formally presented together with a novel graphic depiction. This cadaveric study did support the fact that one can perform a T12 corpectomy without a diaphragm injury. In fact, we could have concluded a L1 corpectomy without diaphragm injuries since the diaphragm was found to originate at the L2 vertebra.

1907
A294: Use of internal fixation in thoracolumbar fractures: open versus minimally invasive technique

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Introduction: Thoracolumbar fractures are injuries that can have significant consequences on the quality of life. Its treatment is controversial and there is no consensus in the literature on the matter. The open fixation and arthrodesis technique is the most widely used, however, recent publications demonstrate equivalent radiographic results with minimally invasive surgeries (MIS) without arthrodesis, with the advantage of shorter surgical time, bleeding, local complications and hospital stay. In this paper we will compare thoracolumbar fractures operated with the MIS and the open technique, analyzing in both cases their radiological results and complications. **Material and Methods:** Analytical design of retrospective cohorts. 72 patients were evaluated, 34 patients with minimally invasive technique and 38 patients with open technique, between the years 2011 and 2022. Inclusion criteria: patients older than 18 years old, spinal injury between T11-L2, complete imaging study and postoperative follow-up of at least 3 months. Exclusion criteria: history of previous spinal surgeries and osteoporotic or pathological bone fractures. A descriptive analysis of demographic variables, type of fracture, intraoperative information, early and late radiological evolution and complications was performed. In addition, a maximum likelihood test is performed to search for differences in the dichotomous variables and a student's t test to search for differences in the continuous variables, with a significant p value of less than 0.05. **Results:** The mean follow up was 16.1 months (max. 89.7) in the MIS group and 21.4 months (max. 118.6) in the open group. There were no significant differences in demographic characteristics between the two groups. Postoperative hospital stay was 7.97 days for the minimally invasive technique and 16.63 for the open technique (p = 0.05). The delta mean difference between early and late regional kyphosis correction was 5.59° in MIS and 8.31° in open surgeries (p = 0.07). There were no intraoperative complications in both groups. We identified misplaced screws in 1 patient in each group (MIS 2.94%; Open 2.63%) of whom none required revision. Loss of late correction was observed in 8.82% in fractures treated with the MIS and 20.05% in the open technique (RR: 0.41, p = 0.16). Operative wound complications were 0% for MIS and 10.52% for the open technique (p = 0.15), of which 5.26% correspond to deep infection (p = 0.52). **Conclusion:** Both the open technique and MIS are alternatives for the treatment of

thoracolumbar fractures. MIS technique shows advantages like fewer days of hospital stay, less loss of correction and complications of surgical wound.

1880

A295: Radiation exposure and surgeon safety during minimally invasive spine surgery in the lack of neuronavigation: a UK single centre retrospective study

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Introduction: Spinal surgery has evolved significantly during the past decades, however use of fluoroscopy is still widespread with substantial radiation exposure to the patient and surgeon. The aim of this study is assess whether there is a radiation exposure shortfall of MIS surgery in a large UK centre without the use of NN and identify risk factors that increase radiation exposure, as well as the barriers to wider adoption of NN technology. **Methods:** We retrospectively analysed all spinal instrumented cases performed in Queen Elizabeth Birmingham Hospital Neurosurgery and Spine Unit between April 2021 and March 2022. A questionnaire regarding use of protective equipment was answered by the consultant surgeons and trainees. **Results:** In a 12-month period, 122 instrumented thoracolumbar spinal cases were recorded that fitted our inclusion criteria, 66 open and 56 MIS, with a mean patient age of 56.8 years and mean BMI of 27.8. For MIS cases, a mean of 194 x-rays were performed for each case, compared to 99 for open cases, while the dose calculated was 0.97mGym2 for MIS, compared to 0.45 mGym2 for MIS. **Conclusion:** MIS procedures without the use of neuronavigation carries a high risk of radiation exposure to the surgeon.

1174

A296: Endoscopic spine surgery for metastatic lesion with radicular pain

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Introduction: Medical advancements have extended the survival time for various cancers. However, they have also brought about an increasing concern regarding spinal metastases, especially those leading to nerve compression and spinal instability. These factors significantly affect the quality of life. Dealing with these challenges requires a multidisciplinary approach. This report showcases five cases in which endoscopic surgery was utilized to alleviate neurological symptoms. This, in turn, facilitated the prompt initiation of radiation therapy to attain local control. **Material and Methods:** Five patients with various primary malignancies (hepatoma, breast cancer, multiple myeloma, lung adenocarcinoma, and prostate cancer) experienced radiculopathy and neuropathic pain resulting from tumor metastasis causing root compression. Despite receiving adequate analgesics, the pain persisted, prompting a consultation with a spine surgeon. Endoscopic surgery for nerve decompression was performed to provide pain relief and enable these patients to attain local control within a short period of time. **Results:** All patients underwent the endoscopic decompression surgery smoothly, achieved pain relief, and regained mobility post-operatively. Four lesions located in lumbar region and one in cervical. Bleeding did not appear to be a significant issue during the procedure, even in cases involving tumors. **Conclusion:** In selected cases, endoscopic surgery offers a superior approach for achieving direct nerve decompression. Because it is a minimally invasive procedure, it does not disrupt the scheduled treatment protocol, such as radiotherapy or chemotherapy. We believe that this procedure serves as a valuable option for enhancing the quality of life for cancer patients.

77

A297: Full endoscopic unilateral laminotomy for bilateral decompression in patient with cervical spine stenosis: surgical technique and early experience

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Background: Full-endoscopic decompression surgery has been shown to be safe and efficacious in the lumbar spine, while its role remains to be determined in the cervical spine. We describe the utility of full endoscopic cervical unilateral laminotomy for bilateral decompression (CE-ULBD) in a series of elderly patients with severe central stenosis, significant medical comorbidity, and existing cervical deformity. **Methods:** A collected cervical spine surgery was retrospectively queried for patients with cervical spondylotic myelopathy receiving CE-ULBD. Demographic data, operative details, imaging, and patient reported outcomes, including visual analogue scale (VAS) for neck and upper extremity pain, Nurick grade, and the modified Japanese Orthopedic Association (mJOA) score, were reviewed. Description of the surgical technique is provided. Descriptive statistics were

calculated. **Results:** From 2021 through 2022, 15 patients with an average age of 60.5 ± 5.0 years underwent CE-ULBD for symptomatic upper cervical stenosis due to ligamentum flavum buckling. All patients had one stenotic segment. The most commonly affected segment was C4/5 (7/15 patients). Average length of surgery was 139 ± 16.4 minutes. Average length of stay was 3.3 ± 0.2 days. Average clinical follow-up time was 12.0 ± 4.7 months; clinical outcomes at most recent follow-up were improved via both the Nurick grade (1.2 ± 0.4, $p < 0.01$) and modified Japanese Orthopedic Association (14.6 ± 1.0, $p < 0.001$) compared with pre-operative values. One patient experienced a transient loss of motor function improved during OPD visit, one case of respiratory failure due to pneumonia. **Conclusions:** Severe central cervical stenosis is a safe and viable target for full-endoscopic decompression via an interlaminar approach.

OP34: Spine Trauma

1096
A298: The surgical algorithm for the AO Spine Sacral Injury Classification System

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Introduction: Although many sacral classification systems have been previously proposed, none have been adopted as a universal standard. Previous studies have validated the AO Spine Sacral Injury Classification, demonstrating that the classification is a reliable and reproducible system across an international audience of spine and trauma surgeons. After the reliability of the classification was established, a numerical value was then applied to each injury subtype to create the Sacral AO Spine Injury Score (Sacral AOSIS), which organized the classification into hierarchical order. The current study now aims to provide an international consensus on surgical management for sacral fracture in order to establish a surgical algorithm for sacral fractures based on the AO Spine Sacral Injury Classification System. **Material and Methods:** A survey was sent to general orthopedic surgeons, orthopedic spine surgeons, and neurosurgeons across the five AO Spine regions of the world. Descriptions of controversial sacral injuries based on different fracture subtypes were given and surgeons were asked whether the patient should undergo operative or non-operative management. The results of the survey were used to create a surgical algorithm based on each subtypes' Sacral AO Spine Injury Score (AOSIS). **Results:** International agreement of 70% was decided on by the AO Spine Knowledge Forum Trauma experts to indicate a recommendation of initial operative intervention. Using this, sacral fracture subtypes of AOSIS 5 or greater were considered operative while those with AOSIS 4 or less were generally non-operative. For subtypes with an AOSIS of 3 or 4, if the sacral fracture was associated with an anterior pelvic ring injury (M3 case-specific modifier), intervention should be left to the surgeons' discretion. **Conclusion:** The AO Spine Sacral Injury Classification System offers a validated hierarchical system to approach sacral injuries. Through multi-specialty and global surgeon input, a surgical algorithm was developed to determine appropriate operative indications for sacral trauma. Further validation is required, but this algorithm provides surgeons across the world with the basis for discussion and the development of standard of care treatment.

1707
A299: Cross-cultural adaptation, reliability, and validity assessment of the Swahili (Tanzania) version of the AO Spine Patient Reported Outcome Spine Trauma (PROST): a single-center cross-sectional validation study

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Introduction: Traumatic spinal injuries (TSI) present a significant global health challenge, particularly in low and middle-income countries, where limited resources, such as implants and technology, often result in less favorable outcomes. A dedicated outcome measurement tool is essential to effectively assess and determine appropriate treatment

strategies for TSI patients. The AO Spine Patient Reported Outcome Spine Trauma (AO Spine PROST) tool, designed to evaluate individuals' functioning and health status following spinal trauma, has been successfully validated in English and Dutch. However, a validated Swahili version of the tool is currently unavailable. This study aimed to bridge this gap by translating the AO Spine Patient Reported Outcome Spine Trauma tool into Swahili, the most spoken African language with over 200 million speakers, ensuring cross-cultural adaptation in accordance with established guidelines and evaluating its psychometric properties among Swahili-speaking patients with spinal trauma. **Methods:** This cross-sectional validation study was conducted at Muhimbili Orthopedic Institute (MOI) in Dar es Salaam, Tanzania, a prominent referral hospital specializing in spinal injuries. The English version of the AO Spine Patient Reported Outcome Spine Trauma tool was meticulously translated and culturally adapted into Swahili following internationally recognized guidelines. Patients were administered the AO Spine (PROST) instrument, with a one-week retest period for assessing test-retest reliability. Interviews were conducted either in person or via telephone. To assess concurrent validity, patients also completed the EQ-5D-5L questionnaire. Descriptive statistics were employed to analyze patient characteristics, while measurement properties were evaluated based on content validity (floor and ceiling effects), internal consistency (Cronbach's α and item total-correlation coefficients), and test-retest reliability via Intraclass Correlation Coefficients. Spearman correlation tests were conducted within the PROST items and with EQ-5D-5L. Statistical significance was set at p < 0.05, and data analysis was performed using R version 4.1.2. **Results:** The study included 73 patients, with a median age of 33 years at the time of injury, who were predominantly male (83.6%). The median follow-up time-period duration was 11 months, and it took an average of 9 minutes to complete the questionnaire. The translated version exhibited robust content validity, with no observed floor or ceiling effects. Internal consistency was excellent (Cronbach α = 0.93), with all items above the reliability standard (α > 0.70). Item-total correlation coefficients were deemed acceptable, ranging from 0.25 to 0.82. Test-retest reliability was excellent for the total score (intraclass correlation coefficient = 0.96). Individual AO Spine PROST items displayed moderate to excellent reliability, with intraclass correlation coefficients ranging from 0.59 to 0.97. Construct validity revealed excellent correlations between the PROST summary score and EQ-5D (ρ = .83, p < 0.001) and a very good correlation with EQ VAS (ρ = .74, p < 0.001). Individual PROST items also exhibited significant correlations with EQ-5D-5L and EQ-VAS. **Conclusions:** The new Swahili version of the AO Spine PROST demonstrated very favorable reliability and validity for outcomes. This validated tool is recommended for use by treating surgeons in the East African region, both in clinical practice and research, to facilitate evidence-based and patient-centered care outcomes.

1034
A300: Mortality in patients admitted to the Acute Spinal Cord Injury Unit, Cape Town, South Africa

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Introduction: Rising healthcare costs and an ever-increasing trauma burden have a significant impact on the management of spinal cord injuries, especially in developing nations. Scarce resources need efficient allocation amid rising demands and potential futility of care. The Cape Town Acute Spinal Cord Injury (ASCI) Unit represents the sole dedicated facility for acute SCI management in Africa, delivering contemporary critical care in accordance with international standards. This stands in stark contrast to the impoverished living conditions patients encounter upon reintegration into their communities. Survival rates of tetraplegic patients in Africa remain inadequately documented, and our study constitutes the largest single-centre investigation of long-term mortality outcomes for SCI. Our objective was to identify predisposing factors linked to early mortality in ASCI patients and stratify them by risk, thereby facilitating improved resource allocation in the face of scarcity. **Methods:** We conducted a retrospective analysis of data from the prospectively maintained database of patients admitted to the Cape Town Acute Spinal Cord Injury Unit between 2003 and 2022. A total of 81 database variables, encompassing ASIA scores, ventilation support, complications, and survival time, were collected. To validate the survival status of patients, we cross-referenced national identity numbers with the National Department of Home Affairs database, resulting in the verification of 2,214 out of 3,223 patients. **Results:** Among the patient cohort, 683 (31%) were confirmed as deceased. Of all quadriplegic patients, 59% survived, with 29% succumbing within five years and 17% within the first-year post-injury. Factors contributing to early post-injury mortality included age > 60 (odds ratio [OR] 4.2), need for ventilation (OR 2.6), high quadriplegia in terms of neurological level (OR 2.3), and the presence of a complete spinal cord injury (OR 1.8). Mortality rates were notably elevated in individuals with neurological levels above C4, with 66% experiencing overall mortality and 35.4% dying within the first year (OR 2.7). The occurrence of complications significantly correlated with early mortality, with cardiovascular complications having an OR of 7.9, respiratory complications such as broncho-pneumonia an OR of 2.6, and gastrointestinal or heamatological complications having ORs of 3.3 and 3.2, respectively. Combinations of these adverse factors substantially escalated the risk of early mortality. For patients with high complete spinal cord injuries requiring ventilatory support, the OR for death within the first year was

4.8, which increased to 19.8 when age exceeded 60. **Conclusion:** Our study revealed that at least 30% of the 2,214 patients in our cohort were deceased at the conclusion of the study period. Complete tetraplegic patients had the highest overall mortality rate, with early death being significantly associated with high complete spinal cord injuries, ventilation requirements, increasing age, and the presence of complications. Resource allocation needs to be strategized in SCI patients with varying prognosis and this study will aid early decision making and rationalization of critical care.

1510
A301: AO Spine PROST (Patient Reported Outcome Spine Trauma): development of version 1.1

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Introduction: Various outcome measures are available to evaluate the function and health of people with spinal cord injury (SCI). However, none cover the whole spectrum of functional status, secondary problems, mood and social consequences with a single scale. The AO Spine Knowledge Forum Trauma initiated a project to develop such instrument for the spine trauma population: the Patient Reported Outcome Spine Trauma (AO Spine PROST). This tool was developed for people with spine trauma and minor or no neurological impairment. To the best of authors' knowledge, it is adopted worldwide with currently being translated into 17 languages. In the current study, the applicability of the AO Spine PROST for people with motor-complete SCI was examined from the perspective of the healthcare professionals. Also, recommendations were made for adjustments of the tool. **Material and Methods:** A discussion meeting with SCI rehabilitation physicians in the Netherlands was performed, followed by an international online survey among healthcare professionals involved in the care of people with SCI. Participants rated the comprehensibility, relevance, acceptability, feasibility and completeness of the AO Spine PROST on a 1-5 point scale (5 most positive). Comments could be provided per question. The discussion meeting was audio taped, meaningful phrases transcribed, and analyzed thematically. The results of the international survey was compared with the results of the discussion meeting using descriptive statistics. The comprehensibility, relevance, acceptability, feasibility, and completeness of the tool were analyzed by calculating frequency tables using SPSS. **Results:** A total of 13 physicians attended the discussion meeting. The survey was completed by 196 participants worldwide. Comparable results were obtained from the discussion meeting and the international survey. Comprehensibility (mean 4.1 ± 0.8), acceptability (4.0 ± 0.8), relevance (3.9 ± 0.8), completeness (3.9 ± 0.8), and feasibility (4.1 ± 0.7) were rated positively for use in people with motor-complete traumatic or non-traumatic SCI. A few participants questioned the relevance of items about the lower extremities (e.g. Walking) or indicated the lack of questions about respiration/breathing and complications. **Conclusion:** The AO Spine PROST was found to be applicable for people with motor-complete traumatic or non-traumatic SCI. This study formed the basis for recommendations in adapting the tool (version 1.1) in order to make it applicable to the entire spine trauma patient population, including patients with (severe) SCI. Currently, this modified version of the tool is being validated among SCI patients. It is expected to be even more useful in the clinics and research, contributing to the comparison of spine trauma outcomes in a valid and reliable fashion.

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A302: The impact of concomitant spinal cord injury on postoperative health-related quality of life after traumatic subaxial cervical spine injuries, a nationwide registry study

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Introduction: The agreement between objective neurological outcomes and health-related quality of life (HRQoL) or disability measures has yet to be investigated in the context of traumatic subaxial spine injuries with concomitant spinal cord injury (SCI). **Purpose:** To evaluate the impact of SCI on the HRQoL in patients surgically treated for traumatic subaxial cervical spine injuries. **Study Design/Setting:** Observational study on prospectively collected registry data. **Patient Sample:** Patients who underwent surgery for subaxial cervical spine injuries between 2006 and 2016 identified in the Swedish spine registry (SWESPINE). **Outcome Measures:** Patient reported outcome measures (PROMs) consisting of EQ-5D-3L$_{index}$ and NDI. **Material and Methods:** The nationwide Swedish Spine registry (Swespine) was queried for patients treated for subaxial cervical spine fractures. Patient reported outcome measures (PROMs) consisting of EQ-5D-3L$_{index}$ and NDI were available for 418

patients. Statistical analysis was conducted in SPSS. **Results:** Among the 418 identified patients, 93 (22%) had a concomitant SCI. In this group, 30 (32%) had a complete SCI (Frankel A), and the remainder had incomplete SCIs (16 (17%) Frankel B; 25 (27%) Frankel C; 22 (24%) Frankel D). PROMs significantly correlated with the Frankel grade (p < 0.001). However, post-hoc analysis revealed that the differences between adjacent Frankel grades failed to reach both statistical and clinical significance. On univariable linear regression, the Frankel grade was a significant predictor of EQ-5D-3L$_{index}$ at 1, 2, and 5 years postoperatively as well as the NDI at 1 and 2 years postoperatively (p < 0.001). Changes of PROMs along time from 1, to 2, and 5 years postoperatively did not reach statistical significance, regardless of the presence and degree of SCI (p > 0.05). **Conclusion:** Overall, the Frankel grade significantly correlated with the EQ5D-3L$_{index}$ and NDI and was a significant predictor of PROMs at 1, 2 and 5 years. PROMs were stable beyond 1 year postoperatively regardless of the severity of the SCI.

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A303: The impact of the type of posterior fusion assembly on return to work in patients with thoracolumbar junction fractures

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Introduction: Traumatic fractures of the spinal column are frequent with extended work absences resulting in significant social and economic implications for both the individuals and the society as a whole. The aim of our study is to evaluate the time to return to work (TRW) in patients treated for traumatic thoraco lumbar spine junction fractures (TLSJF) according the type of fixation. **Material and Methods:** A monocentrique study was conducted in an Orthopedics and Traumatology department in a tertiary hospital between 2010 and 2020 including patients with TLSJF treated by posterior instrumented fusion. We divided our patients into 3 groups:

- Group A (GA) including 65 patients treated with a short assembly (one level above the fracture and one level below)
- Group B (GB) including 33 patients treated with a mixed assembly (two levels above the fracture and one level below)
- Group C (GC) including 22 patients treated with a long assembly (two levels above the fracture and two levels below)

The Oswestry score and the Dallas self-questionnaire were used to assess the functional results. We noted the TRW and the number of patients who returned to work. **Results:** We enrolled 102 patients with a mean age of 48.39 ± 14 years. The gender ratio was 1.2. Fourty-three percent were unemployed and 33.1% had manual work. Twenty-one patients had diabetes. TLSJF was caused by road traffic accidents in 25%, work accidents in 19,2 % and domestic falls in 50.8% of the cases. The mean hospital stay was 21 days [6-64]. The mean Oswestry score was 33.5 in GA, 22.84 in GB and in 22.78 GC. Dallas self-questionnaire was the worst in the GA (25) with a significant difference (p = 0.02). There were no significant differences between the three groups for Oswestry score. 64.61% of patients in GA, 75.75% in GB and 28% in GC returned to work. We noted a significant difference between the groups (p = 0.03). The mean TRW was 157 days [90-420]. In GA, the mean TRW was 136.67, in GB 166.36, and 155 days in GC. The differences were not statistically significant in TRW between GA and GB (p = 0.7) nor between GB and GC (p = 0.44). This duration can be explained by some risk factors as the transfer to other hospitals, delays in obtaining osteosynthesis materials, or, in some cases, by the management of associated injuries. **Conclusion:** Our study found a statistically significant difference between the type of fixation and the TRW in patients with TLSJF. However, short fusion assembly had the worst functional outcomes. This underscores the importance of considering other factors beyond the fixation method when planning treatment and recovery strategies.

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A304: Short-term radiological outcomes of percutaneous fixation using the ES2 system in thoracolumbar spine fracture without neurological deficit

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Introduction: Fractures of the thoracolumbar spine represent the most frequent fractures of the axial skeleton. Percutaneous fixation of these fractures in the absence of associated neurological deficit has become a reliable alternative to conventional open surgery. However in the context of trauma, most of the data the literature regarding loss of correction and sagittal balance is based on open surgery when instrumentation might be associated to intervertebral bony fusion, which is not the case with percutaneous procedure, that on the other hand, respects the musculo-ligamentous structures. The purpose of our retrospective study was to assess the loss of sagittal correction after percutaneous fixation as a function of the fracture level and the type of construct. **Material and Methods:**

The records of 91 consecutive patients operated for one level thoracic or lumbar fractures using percutaneous pedicular fixation were retrospectively reviewed. There were 54 men and 37 women aged 45 ± 18 years-old. The average BMI was 26.1 ± 5.6. 68 fractures were Magerl type A and 23 type B. There were 8 thoracic (T11 and above), 53 thoracolumbar (T12 - L1), and 30 lumbar (L2 and below) fractures. The fixation was purely in the thoracic region in 6 cases, purely lumbar in 62 cases, and thoraco-lumbar in 23 cases. 54 patients had a short "1+1" construct, 28 had a long "2+2" construct, and 8 had an asymmetrical fixation. The level of fracture was taken (i.e. pedicular screws placement) in 54 cases. The stability of the construct was radiologically assessed: vertebral height (VH) in mm (X-rays adjusted to the exact measurements on the CT scans), regional kyphosis (RK) in degrees, and failure of the material (tearing). Repeated measurements were done preop; in the immediate postoperative status (ventral decubitus on logs), at 6 weeks, at 6 months, and at 1 year. The radiological outcomes were correlated with the type of fracture, the level of fracture, the extent of the construct, and the taking of the fractured level. **Results:** The average loss of correction overall was -4.77 mm in height and -12.49° in kyphosis at the last follow-up. There were 16 cases of mechanical tearing most distal (11/16). 3/16 required a revision procedure for extension or simple removal. There was no significant difference depending on the type of fracture (type A: VH = -5mm ± 3.7; RK = -12° ± 7.9° / type B VH = -3.7 mm ± 2.6; RK = -14.1° ± 10.6°) with pVH = 0.14 and pRK = 0.38 respectively. There was no significant difference according to the level of fracture (pVH = 0.45 and pRK = 0.74). Regarding the extent of the construct, there was a significant difference in vertebral height loss -5.4+3.4 mm (long) vs -4.4+3.8 mm (short) (pVH = 0.05) and no significant loss in kyphosis (pRK = 0.21). In the thoracolumbar group, higher tearing rates were noted for short constructs without (75%) or with (25%) screws in the fractured level versus long constructs (respectively, 9% and 0%). **Conclusion:** The study demonstrates that a strategy favoring long constructs in the thoracolumbar hinge zone and short constructs with taking the fractured level in the lumbar region would ensure a reliable and stable correction at one year.

1256

A305: Safety of minimally invasive fixation in the management of low energy spine fractures in octogenarians: a single centre retrospective cohort study

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Background: Fractures involving the spinal column in the ageing population associated with a ground level fall mechanism are an increasing challenge commonly due to patient's fragility, comorbidities and poor bone mineral density. In addition, the incidence of inflammatory back conditions such as Ankylosing spondylitis (AS) and diffused skeletal hyperostosis (DISH) is also on the rise, resulting in an increasing challenge in the surgical management of ankylosed spine fractures in the elderly. The use of minimally-invasive placed pedicle screws, augmented with cement has been suggested as a mean to stabilize an unstable spinal fracture. However, reports on the safety of applying MIS with cement in octogenarians and especially those with ankylosed spine is relatively lacking. **Objective:** To assess intra- and post operative complications associated with minimally invasive-placed pedicle screws with or without cement augmentation in the treatment of spinal fractures and compare outcomes in octogenarians versus younger patients with focus on Ankylosed spine as possible risk factor. **Methods:** Retrospective cohort analysis in a single institution was performed by retrieving records of patients who presented with unstable spinal fractures caused by a low energy impact and were surgically treated by two fellowship trained surgeons. Inclusion criteria included patients 55 years or older and low energy mechanism. Exclusion criteria included any suspicion of other etiologies such as malignancy or infection, patient younger than 55 or any prior existing adjacent spinal surgery. Major complications were defined as those that were life-threatening, required re-operation within 90 days or resulted in substantial impairment. **Results:** From 2018 to 2022, we identified 44 patients aged 55 or older (mean age 75.4, 26 females) who were surgically treated for unstable spinal fractures with minimally-invasive placed pedicle screws with or without cement augmentation. Of those, 20 patients were 80 or older (mean age 84.95, 22 females) with the majority diagnosed with ankylosed spine (n = 12; 11 with AS, 1 with DISH; 60%), compared to 8 patients in the 55-80 age group (n = 8, all with AS; 33%). No significant difference was found in terms of length of stay (LOS) in octogenarians compared to younger patients (4.33 vs. 3.45 days, p = 0.23). In terms of major complications, no significant difference was noted intra-operatively (1 complication in each group) or post-operatively (5/24 (20%) of the younger age group versus 3/20 (15%) in the octogenarian group. **Discussion:** Our data suggests that minimally invasive placed pedicle screws can serve as a safe mean to stabilize an unstable fracture in the octogenarian population. Furthermore, the presence of ankylosed spine in the form of AS or DISH does not seem to increase the rates of intra- or post-operative major complications. Other aspects of surgical treatment of fractures in the ankylosed spine in octogenarians will be discussed.

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A306: Avulsion fractures of the occipital condyle: are they truly unstable?

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Introduction: Avulsion fractures of the occipital condyles are rare, potentially unstable injuries that, according to current

literature, may be associated with other high-mortality injuries in the context of trauma [1]. The Anderson-Montesano classification is currently used to classify these injuries, with type III being associated with greater severity [2]. Our objective is to retrospectively identify patients diagnosed with avulsion fractures of the occipital condyles treated conservatively in our center and to describe associated injuries, treatment received, and follow-up. **Materials and Methods:** Patients diagnosed with avulsion fractures of the occipital condyles managed conservatively in our center between January 2017 and December 2022 were retrospectively identified and included in an anonymized database. CT and MRI reports confirming the diagnosis of the injury and other associated injuries were retrieved from the electronic medical records. Demographic data, mechanism of injury, and patient follow-up were also analyzed. **Results:** Twelve patients diagnosed with occipital condyle avulsion fracture were identified. Eleven patients (92%) underwent MRI during admission, which did not show significant ligamentous injury at the craniovertebral junction. One patient with an associated Gehweiler 5 atlas fracture evolved with an ipsilateral V3 segment vertebral artery dissection without associated infarction. Another patient with an additional lateral mass fracture of the axis developed a stroke secondary to an ipsilateral vertebral artery injury. All patients were managed conservatively, one with a halo vest and the others with a rigid cervical collar. All patients progressed favorably with bone consolidation in subsequent follow-ups without residual instability. **Conclusion:** In our case series, occipital condyle avulsion fractures behaved as stable injuries and achieved adequate consolidation in follow-up. This suggests that these isolated injuries can be treated conservatively with excellent clinical and imaging outcomes, as seen in other observational studies [3,4]. Prospective studies and more significant evidence are needed to confirm this observation.

Keywords: occipital condyle avulsion fracture; craniovertebral junction; cervical trauma

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OP35: AIS Deformity

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A307: Open-label randomized controlled trial for gradual or immediate brace weaning for adolescent idiopathic scoliosis

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Introduction: It is unclear whether reduced hours of brace-wear or immediate brace removal results in better outcomes. A randomized controlled trial (RCT) is conducted to compare resultant Cobb angle changes, truncal balance, and HRQoL between immediate and gradual brace weaning protocols. We hypothesize that gradual brace weaning results in better maintenance of Cobb angle and truncal balance, and superior health-related quality of life (HRQoL) as compared with immediate brace weaning for adolescent idiopathic scoliosis (AIS). **Material and Methods:** An open-label randomized controlled trial was conducted. AIS patients with full-time underarm bracing and indicated for weaning (Risser ≥ 4, > 2 years post-menarche, and no bodily growth between 2 visits) were randomly allocated into two groups: gradual weaning (nocturnal brace-wear for 6 months), and immediate weaning. Primary outcome was major curve Cobb angle and whether there was curve progression (major Cobb increase $> 5^{\circ}$), static curve (change of major Cobb between 5° to -5°) or curve regression (reduction of major Cobb $> 5^{\circ}$). Secondary outcomes were truncal balance (trunk shift, C7-CSVL deviation) and HRQoL scores (SRS-22r, EQ-5D-5L). Parameters were studied at post-weaning 6-months, 1-year and 2-year follow-up. One-way ANCOVA evaluated the effect of weaning protocols on Cobb angle, truncal balance and HRQoL changes whilst controlling for curve type, weaning Cobb and maturity status. **Results:** 369 patients (82.4% girls) were randomized to immediate (n = 155) and gradual weaning (n = 151). There were no intergroup differences of patient demographics at baseline (p > 0.05). Adjusted mean difference of changes of major Cobb angle between gradual and immediate weaning at post-weaning 6-months, 1-year and 2-years were 1.7° (95%CI: 0.5-2.9°, p = 0.006), 1.3° (95%CI:-0.1-2.6°, p =0.064), 0.6° (95%CI:-0.1-2.3°, p = 0.463) respectively. At post-weaning 2-years, there were no significant differences between groups for change in truncal shift (2.6 vs 2.4 mm, p = 0.897) and change in C7-CSVL deviation (2.3 vs 1.7 mm, p = 0.695). Comparing immediate and gradual weaning, there were minimal differences in SRS-22r total score (0.22 (95%CI:0.15-0.30) vs 0.27 (95%CI:0.18-0.37), p = 0.407), EQ-5D utility score (0.016 (95%CI:0.007-0.024) vs 0.023 (95%CI:0.010-0.036), p = 0.360) and EQ-VAS (2.1 (95%CI:-0.6-4.7) vs 1.4 (95%CI:-1.2-4.0), p = 0.730). **Conclusion:** Gradual weaning appears to

have no obvious benefits over immediate weaning in terms of post-weaning curve magnitude and truncal balance maintenance, and HRQoL changes. Standardization of immediate weaning allows for earlier return to normalcy without risks.

A308 (993, FYI: This abstract is in the program but due to copyright issue, cannot be published)

1087
A309: Dystrophinopathy in paravertebral muscle of adolescent idiopathic scoliosis: a prospective cohort study

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Introduction: Adolescent Idiopathic Scoliosis (AIS) is commonly associated with muscle pathology based on previous studies, but the patients did not show typical symptoms of decreased limb muscle strength and respiratory muscle function limitation. So AIS may be a particular kind of core myopathy, and we infer that the pathological changes of paravertebral muscles are involved in the development and evolution of AIS, especially the proteins therein. Based on the hypothesis that the onset and clinical progression of AIS may be associated with certain neuromuscular diseases, we used pathological methods to further analyze paraspinal muscle changes in AIS patients and introduced immunohistochemical antibody markers used in neuromuscular disease diagnosis through routine morphology. And we are particularly interested in the Dystrophin protein which is the pathogenic factors of Duchenne muscular dystrophy. **Material and Methods:** A total of 40 AIS patients were included in the case series, all of whom received posterior scoliosis correction surgery. Neurological, muscular, neuromuscular, and rheumatologic illnesses, malignancies, surgical correction history, and exercise therapy treatment were excluded. None of the patients in this series underwent preoperative physiotherapy or wore braces. The patients were also separated into mild (Nash-Moe 0 and I) and severe (Nash-Moe II and III) Nash-Moe groups to determine if dystrophin protein deficiency increased with vertebral rotation. Controls were 20 Congenital Scoliosis (CS) and 20 Spinal Degenerative Disease (SDD) patients. The biopsy of the muscle should be slightly away from the tendon tissue to avoid non-specific pathological morphology. The biopsy tissue was wrapped in a semi-humid saline gauze and immediately transferred to the laboratory, where it was drained with blotting

paper and was consecutively embedded in tragacanth and OCT compound (Tissue-Tek) and finally frozen in isopentane precooled in liquid nitrogen. This process avoids autolytic or irreversible artificial artifacts in muscle tissue within half an hour. Cryostat slices were 7-10μm thick. Conventional H&E staining, histochemical staining (NADH-TR), and EnVision two-step immunohistochemical staining were performed under standard techniques that used the following primary antibodies: Dystrophin-1 (Anti-dystrophin rod domain), Dystrophin-2 (Anti-dystrophin C-terminal), Dystrophin-3 (Anti-dystrophin N-terminal), Myosin. **Results:** There were significant deletions of dystrophin-1 (p < 0.001), dystrophin-2 (p < 0.001) and dystrophin-3 (p < 0.001) in AIS group compared with both CS group and SDD group. The higher the Nash-Moe classification in the AIS group, the more significant the loss of dystrophin-2 (p = 0.042) in the convex paraspinal muscles. In addition, there was a negative correlation between the dystrophin-1 and 2 on the concave side of AIS group and Cobb Angle, and there was a significant correlation between dystrophin-2 and Cobb Angle (p = 0.011). **Conclusion:** Dystrophin protein deletion of paraspinal muscles plays an important role in the formation and development of AIS. The severity of scoliosis is correlated with the degree of dystrophin deletion in paravertebral muscle of AIS patients. Therefore, dystrophin dysfunction may cause the occurrence and development of AIS.

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A310: Development of stigma assessment scale for adolescent idiopathic scoliosis: AIS-SAS

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Hypothesis: It is possible to assess stigmatization with a valid and reliable scale in adolescent idiopathic scoliosis (AIS) patients. **Introduction:** Stigma is the negative feeling, behavior, and attitudes that individuals or society might hold as a result of an illness or perceived difference. Patients with AIS may experience fear, shame, guilt, anxiety, and low self-esteem due to a deformed spine, wearing a brace, and/or having a surgical scar. Stigma associated with AIS has the potential to negatively impact treatment compliance as well as emotional and social health. We aimed to develop the AIS Stigma Assessment Scale (AIS-SAS) to assess stigmatization in AIS patients. **Material and Methods:** During AIS-SAS development steps, we used literature review and expert opinion for item generation (1), assessed content

validity (2), and conducted a field test for construct validity and reliability (3). Six experts on our team created 38 items across three subscales: Disease, Brace, and Surgery-related stigma. We sent a draft of AIS-SAS to eight AIS specialists for content validation. Exploratory factor analysis (EFA) and convergent validity were examined for construct validity. We checked convergent validity using correlations between AIS-SAS, Rosenberg Self-Esteem Scale (RSES), SRS-22 and Spinal Appearance Questionnaire (SAQ). Reliability was gauged via internal consistency and test-retest methods. AIS-SAS scores, based on a 5-point Likert scale from 1 (never) to 5 (always), are tallied by item summation; higher scores signify more stigma. **Results:** Sixty-seven adolescents with AIS were included in the study. The content validity of AIS-SAS ranged from 0.9 to 1 for each item. EFA results showed each subscale as one-dimensional, with factor loadings ranging from 0.51 to 0.96 for the 3 stigma scales. Eight items with loadings under 0.3 were removed from the scales. The final version of AIS-SAS consisted of 3 scales: disease-related (18 items), brace-related (5 items), and surgery-related (7 items) stigma. Regarding convergent validity, the disease-related score of the AIS-SAS significantly correlated with RSES ($r = -0.415$ $p = 0.001$), SRS-22 self-image ($r = -0.454$ $p = 0.044$) and SAQ scores ($r = 0.441$ $p = 0.002$). AIS-SAS showed good reliability (Cronbach-$\alpha > 0.8$ ICC > 0.8). **Conclusion:** AIS-SAS is the first valid and reliable high-quality scale assessing stigmatization from AIS, measuring disease, brace, and surgery-related stigma via three subscales.

1678

A311: A comparison of time to return to school and sports in patients undergoing anterior or posterior fusion for scoliosis

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Introduction: Scoliosis surgery is a successful operation but can carry significant morbidity. Pragmatically families want to know when they will return to normal activity. Patient related outcome measure scores whilst validated may sometimes not portray real life. Return to school and sports is an important surrogate marker of recovery. Anterior surgery may have advantages because of motion levels saved. There is a paucity of literature comparing the return to school/activity following anterior or posterior scoliosis correction. The aim is to determine the recovery time for patients with scoliosis who underwent anterior spinal fusion (ASF) and posterior spinal fusion (PSF). **Material and Methods:** Surgery for patients with Adolescent Idiopathic Scoliosis from 2017-20 were examined. We excluded non idiopathic patients and over

Table. ADOLESCENT IDIOPATHIC SCOLIOSIS STIGMA ASSESSMENT SCALE ORIGINAL FINAL VERSION AND ENGLISH TRANSLATION

	Version: Turkish (Orijinal)	Version: English
	ADOLESAN İDİYOPATİK SKOLYOZDA DAMGALAMA DEĞERLENDİRME ÖLÇEĞİ: AİS-DDÖ	**ADOLESCENT IDIOPATHIC SCOLIOSIS STIGMA ASSESSMENT SCALE: AIS-SAS***
	Cevap seçeneği ve puanlar: 0: Hiçbir zaman; 1: Nadiren; 2: Bazen; 3: Sık sık; 4: Her zaman	Response options and score for each item: 0: Never; 1: Rarely; 2: Sometimes; 3: Often; 4: Always
	SKOLYOZ İLİŞKİLİ DAMGALANMA ÖLÇEĞİ	**SCOLIOSIS-RELATED STIGMA SCALE**
	Bütün AIS tanılı hastalar için	*For all patients diagnosed with AIS*
Item 1	Çevremdekiler, skolyozum olduğu için beni küçümsüyorlar	People underestimate me since I have scoliosis
Item 2	Çevremdekiler, skolyozum olduğu için benden daha az şey bekliyor	People expect less from me since I have scoliosis
Item 3	Çevremdekiler, skolyozum olduğu için yeteneklerimin daha az olduğunu düşünüyor	People think I'm less capable because of my scoliosis.
Item 4	Çevremdekiler, skolyozumdan dolayı spor yapamayacağımı düşünüyor	People think that I can't participate in sports since I have scoliosis
Item 5	Çevremdekiler, görünüşümden rahatsız oluyor	My appearance makes people uncomfortable
Item 6	Skolyozumdan dolayı okulda ya da arkadaş ortamında zorbalığa (şiddet, lakap takma, gülme, alay etme) uğruyorum	I am bullied by my friends at school because of my scoliosis
Item 7	İnsanlara skolyozum olduğunu söylediğimde olumsuz tepki verirler diye endişeleniyorum	I worry about negative reactions when I tell people about my scoliosis
Item 8	Olumsuz tepkilerden kaçınmak için insanlara skolyozum olduğunu söylemiyorum	I don't tell people that I have scoliosis to avoid unfavorable reactions
Item 9	Omurgamdaki eğrilikten dolayı utanıyorum	I am ashamed of my spinal curvature
Item 10	Görünüşümden dolayı insanlar bana acıyor	People pity me because of my scoliosis
Item 11	Skolyozum nedeniyle sosyal ortamlardan (alışveriş merkezi, sinema, oyun evi, doğum günü partisi, kafe gibi) dışlanıyorum	I am ostracised from social environments because of my scoliosis.
Item 12	Skolyozum nedeniyle sosyal ortamlara (alışveriş merkezi, sinema, oyun evi, doğum günü partisi, kafe gibi) katılmaktan çekiniyorum	I hesitate to participate in social environments because of my scoliosis
Item 13	İnsanlar, beni kendilerinden farklı görüyor	People see me as different from themselves
Item 14	Skolyozumdan dolayı yeni arkadaşlar edinmekte zorlanıyorum	I struggle to make new friends because of my scoliosis
Item 15	Skolyozumdan dolayı iyi, yakın bir arkadaşım olmayacak gibi hissediyorum	I feel like I won't have a close friend because of my scoliosis.
Item 16	Görünüşümden dolayı hoşlandığım kişilerin beni çekici bulmadığını hissediyorum	I feel that the ones I'm attracted to don't find me appealing because of my appearance
Item 17	Skolyozum nedeniyle vücut hatlarımı belli eden dar kıyafetler giyinmekten çekiniyorum	I hesitate to wear tight-fitting clothes that reveal my body shape because of my scoliosis
Item 18	Skolyozumdan dolayı okul başarımın kötü etkilendiğini hissediyorum	I feel that my school performance is negatively affected because of my scoliosis
	KORSE İLİŞKİLİ DAMGALANMA ÖLÇEĞİ	**BRACE-RELATED STIGMA SCALE**
	Korse takan AIS hastaları için	*For AIS patients who wear braces*
Item 1	Korseden dolayı sosyal ortamlara (alışveriş merkezi, sinema, oyun evi, doğum günü partisi, kafe gibi) katılmaktan çekiniyorum	I'm hesitant to attend social environments because of my brace
Item 2	Korse taktığım için sosyal ortamlardan (alışveriş merkezi, sinema, oyun evi, doğum günü partisi, kafe gibi) dışlanıyorum	I am ostracised from social environments because I wear a brace
Item 3	Korse taktığım için insanlar bana acıyor	People pity me because I wear a brace
Item 4	Korsemi saklamak için daha bol ve kapalı kıyafetler giyerim	I wear looser and closed clothes to hide my brace
Item 5	Korse taktığım için okulda ya da arkadaş ortamında zorbalığa (şiddet, lakap takma, gülme, alay etme gibi kötü davranışlar) uğruyorum	Because of my brace, I am bullied at school or among my friends
	OPERASYON İLİŞKİLİ DAMGALANMA ÖLÇEĞİ	**SURGERY-RELATED STIGMA SCALE**
	Skolyoz cerrahisi geçiren AIS hastaları için	*For AIS patients who have undergone scoliosis surgery*
Item 1	Olumsuz tepkilerden kaçınmak için insanlara ameliyat olduğumu söylemiyorum	To avoid unfavorable reactions, I don't tell people that I've had surgery
Item 2	Ameliyat izimden dolayı utanıyorum	I am ashamed of my surgery scar
Item 3	Ameliyat izimden dolayı insanlar bana acıyor	People pity me because of my surgery scar
Item 4	Ameliyat izimi saklamak için daha kapalı kıyafetler tercih ediyorum	I choose to wear more closed clothes to hide my surgery scar
Item 5	Ameliyat olduğum için bana engelliymişim gibi davranıyorlar	People treat me as if I'm disabled because I've had surgery.
Item 6	Sırtımdaki ameliyat izini görmek bana hastalığımı hatırlatıyor	Seeing the surgery scar on my back reminds me of my disease
Item 7	Sırtımdaki ameliyat izini görmek beni rahatsız ediyor	Seeing the surgery scar on my back bothers me

* Forward translation of AIS-SAS was done by a native speaker of English and an independent translator. This version is not a substitute for English linguistic validation, it was created only for non-Turkish readers to better understand AIS-SAS items.

18y. A validated post-operative questionnaire was administered to patients to complete regarding return to school, sports and other physical activities. Anterior and Posterior group were sub-categorised into: Selective Anterior Thoracic Fusion (SATF) and Thoracolumbar Fusion (TLF), Short Posterior Spinal Fusion (SPSF) and Long Posterior Spinal Fusion (LPSF) and 2-stage procedures. Hospital length of stay (HLOS) and ICU LOS Was recorded. **Results:** 43 patients total; 21% SPSF (n = 9), 28% LPSF (n = 12), 16% SATF (n = 7), 26% TLF (n = 11) and 9% 2-stage procedures (n = 4). Mean HLOS in posterior patients is 6.X days, mean ICU LOS is: 2.x days for SPSF and 1.x day for LPSF. 56% of SPSF and 42% of LPSF patients underwent costoplasty. Mean HLOS for anterior patients is 5.5 days and mean ICU LOS stay is 1.x day. 29% of SATF and 55% TLF patients underwent costoplasty. Posterior surgery (76.4%) returned to school in 1-3 months (78% SPSF, 75% LPSF). Anterior surgery (69.5%) returned to school in 1-3 months (57% SATF, 82% TLF). By 12 months, 64% of Posterior fusions (78% of SPSF and 50% of LPSF) vs 32% of anterior fusions (29% SATF and 36% of TLF patients) had returned to physical education. **Conclusion:** Anterior and posterior fusions had similar return to school rates at 1-3 months. The TLF group return to school the quickest whilst the SATF group had the longest return time. PSF patients returned to PE faster than the ASF group. Costoplasty as an independent factor increased time to return to school and PE. Further research should be conducted to evaluate benefits of shorter fusions.

2236

A312: Medial pedicle wall referencing extra-pedicular (EP) screw insertion technique in narrow dysplastic pedicles in posterior spinal fusion (PSF) in adolescent idiopathic scoliosis (AIS) patients

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Introduction: High incidence of dysplastic pedicles had been widely reported in Adolescent Idiopathic Scoliosis (AIS) patients which increases the complexity of pedicle screw instrumentation. Mastery of extra-pedicular (EP) screw insertion technique in dysplastic pedicles is essential in the armamentarium of deformity surgeons. Conventional EP screw technique have several limitations such as high medial convergence angle which could increase the difficulty of entry into vertebral body leading to anterior perforations. Lateral entry point of conventional technique requires excessive dissection and could lead to malalignment of the screw heads when EP screws are placed next to intra-pedicular screws. The objective of this study is to describe a novel technique of medial pedicle wall referencing EP screw insertion method that has

a more medial entry point and less convergent trajectory (inserted along pedicle axis) compared to conventional technique. Besides that, we would like to compare the EP chord length of this technique with the conventional technique in AIS patients and report the accuracy of the technique based on computed tomography (CT) assessment. **Material and Methods:** Retrospective study whereby 103 patients undergoing Posterior Spinal Fusion (PSF) from 2018 to 2023 were recruited. 2472 thoracic pedicles were analysed on pre-operative CT scan and classified based on Chiu et al. classification. Conventional EP chord length and medial pedicle wall referencing technique EP chord length was measured for all narrow dysplastic pedicles (Type C and D). Post-operative CT scan were used to assess medial perforations using Gertzbein and Robbins classification modified by Rao et al. Anterior perforations were reviewed using Hansen-Algenstaedt et al. grading. Categorical data were analyzed using a Pearson Chi-square test. For continuous data, normality testing using a Kolmogorov-Smirnov test was done. Paired T-test was used to compare continuous data and p-value of <0.05 denoted as statistical significance. **Results:** The prevalence of thoracic narrow dysplastic pedicles in our cohort was 31.3%. Mean chord length of this technique was significantly shorter compared to conventional technique. The longest chord length in conventional technique was recorded in left T8 (53.7 ± 3.5 mm) and T9 (53.7 ± 3.7 mm) in contrary with mean left T8 and T9 chord length using the medial pedicle wall referencing technique which was 38.6 ± 3.2 mm and 38.3 ± 3.2 mm respectively (p < 0.001). Total of 434 EP screws were inserted using medial pedicle wall referencing technique in narrow dysplastic pedicles. 11.3% had medial grade 1 perforations and 4.1% had anterior grade 1 perforations. Only 0.7% grade 2 perforations were found in our study cohort (medial: 0.2%, anterior: 0.5%). None of the perforations were symptomatic and no grade 3 perforations were noted. **Conclusion:** Medial pedicle wall referencing EP screw insertion technique is a safe alternative method especially in narrow dysplastic pedicles. This technique has shorter chord length and less convergent trajectory with low anterior perforation rate.

1834

A313: A comparison of 3D printed custom navigation jigs and freehand pedicle screw insertion for posterior spinal fusion in the treatment of adolescent idiopathic scoliosis

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Introduction: Pedicle screws have allowed better correction of adolescent idiopathic scoliosis (AIS) through 3-column

fixation and segmental de-rotation. However, pedicle can-nulation in a deformed spine with occasionally hypoplastic pedicles is technically challenging and risky. The traditional freehand technique for pedicle screw insertion relies on the use of visible and palpable landmarks and therefore has inherent inaccuracies. A whole spine, low dose, 1mm axial cut CT can be used to create a 3D model of the spine, to which 3D printed custom navigation jigs (3DPCNJ) are created unique to each vertebra. This allows for accurate and precise techniques for pedicle screw insertion. **Material and Methods:** The British Spine Registry and ICLIP were used to identify all scoliosis patients who underwent posterior spinal fusion from 16/01/2017-01/09/2022 at a South London tertiary medical center and a London private hospital. 55 3DPCNJ patients were identified and matched to 55 freehand patients by diagnosis and Lenke classification. Data was then collated regarding age, gender, diagnosis, duration of surgery, estimated blood loss, screw density, hospital length of stay (HLOS), SRS-22 scores, complication and return to surgery rate, and standing Cobb angles (pre- and post-operatively). A "per-screw" time was also calculated, by dividing the total operative time by the number of screws inserted. p-values were calculated using an unpaired t-test and a Fisher's exact test. **Results:** There were no differences in mean age (15.9 vs 15.3), gender (81% vs 80% female), or length of stay (7.2 vs 5.9 days). There were no statistically significant differences between SRS-22 scores, or the changes in radiographic parameters. Two patients in the freehand group had a complication related to incorrect screw placement (versus one in the 3DPCNJ group). With 3DPCNJ, significantly more screws were placed relative to the number of levels stabilized (screw density - 82.9% vs 66.5%, $p < 0.01$), yet there were no statistically significant differences for du-ration of surgery or intra-operative blood loss. Our per screw time for the 3DPCNJ group was significantly faster than in the freehand group (15.03 vs. 18.18 minutes). **Conclusion:** The use of 3DPCNJ is especially attractive due to its enhancement of workflow. Other navigational techniques such as fluoros-copy and intraoperative CT can significantly increase the length of operation, leaving the spine exposed to potential infection. Further data is required to compare 3DPCNJ to other navigational techniques. The use of 3DPCNJ allows for uninterrupted flow of work and rapid screw insertion, with an average time for single screw insertion of 4.07 minutes (in-cluding facet/Ponte osteotomies). It was found that per screw, the use of 3DPCNJ is significantly faster. Higher screw densities seen in the 3DPCNJ patients may allow for more even distribution of forces and mitigate screw pullout. 3DPCNJ as a navigational technique has satisfactory out-comes, with patient-reported outcomes improving in line with the traditional freehand technique. It is safe, efficient, and allows for faster pedicle screw insertion with no compromise in accuracy of patient outcomes.

1511

A314: Automatic selection of surgical fusion level for adolescent idiopathic scoliosis based on deep learning algorithms

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Objective: This study aims to develop a deep learning system which achieves the target detection and instance segmentation of vertebrae in adolescent idiopathic scoliosis (AIS), assisting spine surgeons in choosing the optimal surgical fusion levels to improve the correction effect of scoliosis. **Methods:** This automatic system consists of the following modules: preprocessing module, deep learning network module, target detection module, instance segmentation module, and calculation module for surgical con-fidence. The system concatenates coarse-grained results of in-stance segmentation with the original X-ray image as input for the target detection network, recognizing whether the target vertebra needs to be fused by extracting multi-scale features from X-ray images. Surgical confidence is further refined with prior knowledge. A total of 1079 AIS patients who underwent posterior corrective surgery and were followed up for more than 2 years postoperatively were included for model training and internal testing. **Results:** According to internal test results, the accuracy of our proposed method for surgical levels prediction is 0.840, with a recall rate of 0.942. The mAP50 of the instance segmentation mask is 0.945, and mAP50-95 is 0.563. The mAP50 for the target detection box of our method is 0.951, and mAP50-95 is 0.690. We compared the performance of seven other mainstream al-gorithms: the mAP50 of instance segmentation masks ranged from 0.870 to 0.929, and mAP50-95 ranged from 0.485 to 0.569; the mAP50 for target detection boxes ranged from 0.885 to 0.935, and mAP50-95 ranged from 0.542 to 0.678. **Conclusion:** We propose an automatic method to determine AIS surgical fusion levels. Compared to current algorithms, it demonstrates SOTA (State-of-the-Art) performance. Our method is the first computer-assisted prediction system for AIS surgical fusion level based on instance segmentation and target detection. This proposed system

can simultaneously extract semantic and instance features from spine X-ray images and effectively assess the correction range. Our method provides personalized treatment plans for AIS patients, reducing the risk of postoperative complication.

Keywords: adolescent idiopathic scoliosis, deep learning, target detection, instance segmentation

905

A315: Pelvic fixation in neuromuscular early onset scoliosis treated by magnetically controlled growing rods: mid-term results using an original sacral-bi-iliac construct

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Introduction: Early Onset Scoliosis (EOS) secondary to neuromuscular diseases often requires a long fusion from the upper thoracic spine to the sacrum or pelvis. The aim of this study was to report the results of primary magnetically controlled growing rods (MCGR) in a consecutive group of 35 patients treated for neuromuscular spinal deformities with an original spinopelvic construct using two sacral screws and two iliac screws. **Materials and Methods:** From 2016 to 2022, 35 patients were operated on for neuromuscular scoliosis with a bipolar MCGR long construct fixed to the pelvis with an original sacral bi-iliac (T-construct) fixation. Clinical, functional and radiographic results were evaluated at a minimum of 1 year follow-up. **Results:** Mean age was 9.6 years (range, 5.3-12.1 years). Neuromuscular disease was a Spinal Muscular Atrophy in 17 cases, Congenital myopathy in 7 cases, Cerebral Palsy in 4 cases, Rett syndrome in 4 cases and spina bifida in 3 cases. Mean preoperative frontal deformity (Cobb angle) was 69° with a mean frontal pelvic obliquity of 36°. Mean patient weight was 24.7 Kg (range 16 – 58 Kg). Spinal correction was performed by posterior approach. A special segmental construct was used for pelvic anchorage: two sacral screws and two iliac screws were connected with a horizontal cobalt-chromium rod. Two 90° long-offset connectors were then used to link the pelvic construct to MCGR. Proximal fixation was achieved using rib hooks (13 cases), pedicle screws and laminar hooks (17 cases) and hybrid (ribs and vertebral anchors) in 5 cases. Mean post-operative Cobb angle was 22.7° and mean postoperative pelvic obliquity was 2.3°. At a mean follow-up of 3.4 years (range 1 to 6 years) a significant loss of correction of 7 to 10° was noted in three patients regarding frontal deformity. No loss of correction was noted regarding pelvic obliquity. MCGR were still gradually lengthened from 8 to 12 mm / year in 28 cases and 7 patients ended their lengthening program (Risser 3). No postoperative infection occurred in our series. Two patients had mechanical complications. Outcome

were satisfactory after a simple local revision in these two cases. **Conclusions:** Our results obtained using the "T" iliosacral construct are similar to those obtained with other techniques in term of frontal (global) and pelvic obliquity correction. At last follow-up, adequate pelvic positioning was restored and no significant loss of correction was noted in term of pelvic obliquity. We experienced very few mechanical complications using this technique. The advantage of this technique is a powerful "low profile" construct with a "four-points fixation" in two different planes and three different bones improving earlier mobilization and return to a comfortable sitting position. MCGR constructs anchored to the pelvic using a T-construct fixation may control pelvic obliquity, reduce trunk deformity and support thoracic growth without any need for repeated surgeries in neuromuscular EOS patients. The number of complications in the present series was low compared with the literature.

OP36: Cervical Spinal Fusion

1646

A316: Commonly used patient-reported outcome measures (PROMS) do not adequately reflect patient-perceived changes in health status in patients undergoing anterior cervical discectomy and fusion (ACDF)

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Introduction: Patient reported outcome measures (PROMs) are becoming increasingly utilized in the field of orthopedic surgery as our healthcare system has been shifting more towards a value-based model. Recent studies have demonstrated the utility of these outcome measures in assessing the efficacy of various spinal procedures. Despite this increasing knowledge, there is a relative paucity of data regarding how these PROMs correlate with patients' own perceptions of change in health status postoperatively. The purpose of this study was to evaluate the correlation between commonly used PROMs and perceived changes in spine-related health status in patients undergoing anterior cervical discectomy and fusion (ACDF). **Material and Methods:** This was a retrospective review of prospectively collected data on consecutive patients who underwent ACDF at a single academic institution between April 2017 and February 2023. Various PROMs, including Neck Disability Index (NDI),

Visual Analogue Scale (VAS) for neck and arm pain, Short-Form 12 (SF-12 PCS/MCS) and Patient Reported Outcomes Measurement Information System- Physical Function (PROMIS-PF), were collected at the preoperative visit and postoperatively at 6 weeks, 12 weeks, 6 months, and 1 year. Patients also completed a 'Global Rating Change (GRC)' questionnaire, a 5-item Likert Scale ('much better', 'slightly better', 'about the same', 'slightly worse', 'much worse') which addressed how a patient's spine condition compared to preoperatively and to their prior visit. Spearman correlation coefficient (Rho) was used to determine the correlation between changes in PROMs and GRC. **Results:** This study included 207 patients with a mean age of 58.6 yrs, mean BMI of 27.8 kg/m^2, and comprised of 56% males. Most patients underwent one- or two-level surgery (one-level: 38.2%, two-level: 44.4%) and were discharged on postoperative day 1 (67.2%). Percentage of patients feeling 'Slightly better' or 'Much better' compared to pre-operatively was 79.7% at 6 weeks, 82% at 12 weeks, 79.3% at 6 months, and 81.3% at 1 year. Less than 4% of patients reported feeling 'much worse' compared to pre-operatively at all postoperative time points. Changes in PROMs from pre-operatively demonstrated a statistically significant correlation with GRC at all postoperative time-points for NDI, two out of four time-points for VAS Arm and SF-12 MCS, and one out of four time-points for VAS Neck, SF-12 PCS, and PROMIS-PF. The strengths of the correlations were weak (Spearman's Rho range: 0.201 to 0.341). Changes in PROMs compared to the previous visit demonstrated statistically significant correlation with GRC for all time points for NDI, two out of three time-points for VAS neck, and one time-point for PROMIS-PF. The strengths of the correlations were weak-to-moderate (Spearman's Rho range: 0.225 to 0.410). **Conclusion:** The results of this study showed that a majority of patients undergoing ACDF experienced some level of improvement in the early post-operative period. However, commonly utilized PROMS demonstrated a weak correlation with perceived changes in overall cervical spine-related health status from preoperatively to postoperatively, and demonstrated mostly weak correlation with postoperative changes. These results suggest that commonly used PROMs may not be adequately reflecting changes in patient's overall perception of health status.

1883

A317: Preoperative psychological factors impact anterior cervical discectomy and fusion outcomes

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Introduction: Neck pain is a widespread issue affecting a significant portion of the global population. Cervical spondylotic radiculopathy is a common condition causing pain, numbness, and motor deficits. Psychological factors have been linked to spine surgery outcomes, but the exact nature of this relationship remains unclear. The current study investigated the effects of preoperative psychological health on postoperative outcomes in patients undergoing anterior cervical discectomy and fusion (ACDF) for cervical spondylotic radiculopathy. **Material and Methods:** The study was a retrospective cohort study using data from patients enrolled in the Canadian Spine Outcomes and Research Network registry who underwent ACDF to treat cervical radiculopathy. Psychological health variables were measured at the preoperative baseline utilizing the Patient Health Questionnaire 8 (PHQ-8) and the Mental Component Score (MCS) of the Short Form Survey-12. Moderate-to-severe depression risk was characterized as Scores $\geq$ 10 on the PHQ-8. We applied cut-points to identify two psychological health states based on MCS Scores (MCS < 46 = experiencing depression; MCS < 37 = severe psychological symptomology). Clinical outcomes of pain (numeric rating scale (NRS)-arm pain, NRS-neck pain) and disability (Neck Disability Index) were measured preoperatively and then 3, 12, and 24 months after surgery. Variables controlled for included: age, sex, highest level of education attained, current smoking status, surgical wait time, and baseline physical health related quality of life. Established patient recovery trajectories for arm pain, neck pain, and pain-related disability were identified with latent class growth models. Propensity score models with inverse probability weighting and robust Poisson regression were constructed to estimate average treatment effects. Effect estimates were reported as relative risk (RR). Sensitivity analyses assessed potential bias due to extreme weights and unmeasured confounding. **Results:** Data from 352 (43.8% female) patients (mean age = 50.9 years) were included. Each trajectory model identified a "poor" outcome subgroup with a 15.5% to 23.5% prevalence, depending on the outcome measure. Roughly half (52.1%) of patients were identified as being at moderate-to-severe risk of depression. Moderate-to-severe depression risk had an increased risk of poor outcomes; disability (RR[95% CI] = 14.07 [4.42-44.85]), neck pain (RR[95% CI] = 2.35 [1.42-3.89]), and arm pain (RR[95% CI] = 1.91[1.22-2.00]). Approximately 1 in 3 patients (33.1%) reported MCS scores consistent with severe psychological symptomology. Severe psychological symptomatology was associated with poor disability (RR 95% CI] = 3.91[2.23-6.62]), neck pain (RR [95% CI] = 2.35[1.54-3.59]), and arm pain (RR[95% CI] =

1.92[128-2.87]). Nearly 2 in 3 patients (61.8%) reported MCS scores consistent with a depressive state. These patients exhibited a higher risk of poor disability (RR[95% CI] = 3.46 [1.59-7.50]). Sensitivity analyses confirmed the robustness of these findings, indicating that substantial unmeasured confounding would be needed to explain away the observed effects. **Conclusion:** This study highlights the significant impact of preoperative psychological health on postoperative outcomes in patients undergoing ACDF for cervical spondylotic radiculopathy. Addressing the psychological well-being of patients before spine surgery could be an untapped and important facet for optimizing postoperative recovery. These findings support the need for a comprehensive approach to patient care of spinal disorders.

1123

A318: The predictive value of Housfield units for titanium mesh cage subsidence after anterior cervical corpectomy and fusion

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Objective: To investigate whether bone mineral density (BMD) measured in Hounsfield units (HUs) correlates with titanium mesh cage (TMC) subsidence after anterior cervical corpectomy and fusion (ACCF). **Methods:** A total of 64 patients who underwent one or two levels of ACCF with TMC with a mean follow-up of 19.34 ± 7.86 months were analysed. HU values were measured three times in 3 different planes in the upper and lower vertebrae according to published methods. Subsidence was defined as segmental height loss of more than 3 mm. Pearson correlation analysis was performed. Receiver operating characteristic (ROC) curve analysis was used to obtain optimal thresholds. A multivariate logistic regression analysis was also conducted. **Results:** A Twenty-two patients (34.38%) had evidence of TMC subsidence on follow-up x-ray. The mean HU values in the subsidence group (317.34 ± 32.32, n = 22) were significantly lower than those in the nonsubsidence group (363.07 ± 25.23 n = 42, p < 0.001, t test). At last follow-up, mean disc height loss was 4.80 ± 1.16 mm in the subsidence group and 1.85 ± 1.14 mm in the nonsubsidence group (p < 0.001). There was a negative correlation between HU values and disc height loss (Pearson's coefficient -0.494, p < 0.001). HU values decreased gradually from the C3 vertebra to the C7 vertebra, and the HU values of the C5, C6, and C7 vertebrae in the nonsubsidence group were significantly higher than those in the subsidence group (p < 0.05). Furthermore, there were significant differences between the groups in the segmental angle at the last follow-up

and the mean changes in segmental angle (p < 0.05). The area under the ROC curve was 0.859, and the most appropriate threshold of the HU value was 330.5 (sensitivity 100%, specificity 72.7%). The multivariate logistic regression analysis showed that older age (p = 0.033, OR = 0.879), lower LIV HU value (p < 0.001, OR = 1.053) and a greater segmental angle change (p = 0.002, OR 6.442) were significantly associated with a higher incidence of TMC subsidence after ACCF. **Conclusions:** There are strong correlations between a lower HU value and TMC subsidence after ACCF. More accurate assessment of bone quality may be obtained if HU measurement can be used as a routine preoperative screening method together with DXA. For patients with HU values < 330.5, a more comprehensive and cautious preoperative plan should be implemented to reduce TMC subsidence.
Keywords: anterior cervical corpectomy and fusion, ACCF, Hounsfield units, subsidence, bone mineral density

2582

A319: COVID-19 significantly shortened length of stay but worsened mental conditions of patients undergoing cervical fusion

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Introduction: Given resource limitations during the Coronavirus Disease 2019 (COVID-19) pandemic and caution regarding hospital stays, surgeons tended to modify standard postoperative protocols to minimize patient exposure. Besides, there is a lack of literature focused on the impact of COVID-19 on clinical outcomes of patients. In this study, we intended to compare length of stay (LOS) and patient reported outcomes (PROs)of patients undergoing cervical fusion surgery before and during the COVID-19 pandemic. **Material and Methods:** We identified all patients who underwent lumbar fusion and completed 2-year-followups at a tertiary care center during two distinct time intervals: pre-COVID-19 (before March, 2020, N=121) and during COVID-19 (after March,2020, N = 134). Outcome measures included LOS and PROs. PROs included visual analogue score of neck and arm pain (VAS-N and VAS-A), neck disability index (NDI), and 36-item Short-Form (SF-36). Regression analyses controlled for demographic and surgical factors. **Results:** On bivariate analysis, patients undergoing surgery during the pandemic had shorter LOS (4 vs.6 days) but reported worse mental conditions of SF-36 (31.8 vs. 34.5). After controlling for age and fusion levels on multivariable regression, patients who had surgery during the pandemic had shorter LOS (IRR = 0.77, p < 0.05) and suffered worse mental health (OR = 6.3, p < 0.05). **Conclusion:** During the COVID-19 pandemic, LOS for

patients undergoing cervical fusion decreased. However, mental health of patients deteriorated compared to those undergoing surgery before the pandemic. More attention should be paid to psychological states of patients.

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A320: Postoperative physical therapy for anterior cervical discectomy and fusion: Impact on cost and healthcare utilization

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Introduction: Anterior cervical discectomy and fusion (ACDF) is used to treat degenerative spine conditions when symptoms are refractory to conservative management. With bundled payments potentially emerging for cervical spine surgery, it is imperative to understand if the use of postoperative physical therapy (PT) is cost-effective. The aim of this study was to investigate the costs and future healthcare utilization associated with patients who underwent 1-2 level ACDF alone compared to those who underwent ACDF and postoperative PT. **Material and Methods:** PearlDiver database was used to identify patients who underwent 1,2-level ACDF for degenerative cervical spine disorders without or with postoperative PT from 2010-2021. Demographic and procedural data was obtained using International Classification of Disease 9th and 10th Revision (ICD-9, ICD-10) and Current Procedural Terminology (CPT) codes. Postoperative PT was subcategorized by 1) active+passive, 2) active, and 3) passive. Both Non-PT and PT groups were propensity-matched based on age, sex, Elixhauser Comorbidity Index (ECI), obesity, smoking, myelopathy, fused levels, and psychiatric disorders. Healthcare utilization included revision surgery, opioid use, and emergency department (ED) visits related to the cervical spine. Costs included ACDF, revision surgery, opioid use, ED visits and PT visits. Chi-squared analysis, and independent t-test were performed to assess differences in healthcare utilization and costs, between non-PT and PT subgroups. Further subanalysis was done between PT subgroups beginning either at 1) 2 weeks, 2) 6 weeks, or 3) 12 weeks. **Results:** 337,294 patients underwent 1,2-level ACDF (n = 190,264 no PT, n = 147,030 with postoperative PT). PT cohort had significantly greater proportions of female patients (57.5% vs. 53.5%, p < 0.001) and myelopathy (23.4% vs. 26.0%; p < 0.001). Non-PT cohort had higher proportions of obesity (12.4% vs. 11.7%; p < 0.001), smoking (20.9% vs. 19.6%; p < 0.001), and preoperative opioid use (74.4% vs. 73.3%; p < 0.001). No differences in healthcare utilization were seen between active, passive, and active+passive PT subgroups. Patients beginning PT at 2, 6, and 12 weeks had significantly less postoperative opioid use compared to non-PT patients across all time points (all p < 0.001). 6, 9, and 12-month revisions were significantly lower in the PT group beginning at 12 weeks compared to the non- PT group (all p < 0.05). Non- PT group ($9,030) cost less than PT groups beginning at 2,6,12 weeks ($11,561, $11,294, $10,781) at all time points (p < 0.001). There were no significant differences in healthcare utilization between patients who began PT at either 2, 6, or 12 weeks; however, initiating PT at 12 weeks ($10,781) cost less than at 2 weeks ($11,294) or 6 weeks ($11,561) at all time points (p < 0.001). **Conclusion:** Postoperative PT for ACDF is associated with less postoperative opioid use and revisions at 6,9,12 months. There was no significant difference in subtype of PT, or the timing of PT and its association with healthcare utilization. Postoperative PT may help reduce opioid usage in patients who have undergone 1-2 level ACDF surgeries and may be started as early as 2 weeks without an increased rate of revisions and ED visits. Future prospective RCTs are needed to determine association of these findings with patient reported outcomes, return to work and quality of life.

1318

A321: Assessing surgical outcomes for cage plate system versus stand-alone cage in anterior cervical discectomy and fusion: a systematic review

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Background: Anterior Cervical Discectomy and Fusion (ACDF) is a common surgical procedure for addressing cervical spine conditions. It involves the utilization of either cage plate system (CPS) or stand-alone cage (SC). The objective of our study is to compare perioperative complications, Patient-Reported Clinical Outcomes, and radiographic outcomes of SC vs CPS in ACDF. **Methods:** We carried out a literature search in PubMed, Embase, Cochrane library, Web of science, Medline and google scholar. All included studies directly compared the outcomes between CPS versus SC in

ACDF. **Results:** 33 studies, 27 observational and 6 RCT met the inclusion criteria. We found that both devices demonstrated comparable long-term effectiveness in monosegmental ACDF with respect to JOA score, NDI score, VAS score, and fusion rates. CPS demonstrated superior performance in maintaining disc height, cervical lordosis, and exhibited lower rates of subsidence. SC exhibited significant advantages over CPS in terms of shorter surgical duration, less intraoperative bleeding, shorter duration of hospitalization, as well as lower rates of postoperative dysphagia and adjacent segment disease. **Conclusions:** CPS and SC have similar effectiveness in monosegmental ACDF in terms of the patient reported outcome measures(JOA, NDI, VAS) and fusion rates. Cervical lordosis should be considered before choosing which technique to use. Most of the included studies had monosegmented fusion, and there wasn't enough data to set recommendations for the multisegmented fusions. Larger studies with longer follow up are necessary to draw more definitive conclusions, to provide evidence for clinicians to make clinical decisions. **Keywords:** stand-alone cage, ACDF, plate, outcomes, systematic review

1419

A322: Does preoperative upper cervical sagittal alignment have an impact on adjacent segment changes after subaxial cervical spine fusion?

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Introduction: Adjacent segment degeneration (ASD) is a well-described complication following anterior sub-axial cervical fusion. Given the recent research emphasis on cervical sagittal alignment and its importance in surgical planning, which aims to maintain global cervical alignment at the adjacent operative level, limited understanding exists about the effect of preoperative upper cervical sagittal alignment on adjacent segment change after sub-axial cervical fusions. We aim to characterize these changes, identify predictive radiographic factors, and compare adjacent segment changes (ASC) after sub axial cervical spine fusion or disc replacement. **Materials and Methods:** This is a single center retrospective study. Patients that underwent a single-level cervical disc replacement (CDR) or had single-level anterior cervical discectomy fusion (ACDF) with preoperative and postoperative lateral cervical X-rays (6 months) were included in this study. Pre and postoperative segmental lordosis measurements of lateral x-rays were performed at the operative level and both adjacent levels (cephalad and caudal). Measured parameters included pre-op and post-op C2-C7 lordosis, T1-Slope,

Occiput-C2 angle (O-C2), and C2-C7 sagittal vertical axis. Patients were stratified by operation spinal level, with primary emphasis on the C5-C6 subgroup due to its larger sample size. Both univariate and multivariate analyses were performed for this subgroup. **Results:** 50 patients were included: 23 in the CDR group and 27 in the ACDF group. No significant differences were observed in any measurement between the CDR and ACDF groups. Analysis was also performed on the C5-C6 ACDF/CDR collectively. A greater pre-operative T1 slope demonstrate a weak correlation with a reduction of lordosis at the C5-C6 level (r = -0.24, p = 0.09). Increased C5-C6 segmental lordosis was associated with reduced cephalad (C4-C5) segmental lordosis (r = -0.27, p = 0.06x). Multivariate regression evaluated the combined influence of the 0-C2 and C5-C6 segmental angle changes on the cephalad C4-C5 segmental angle change (R^2 = 0.15, p < 0.05), showing that larger pre-operative 0-C2 lordosis, combined with an increase in C5-C6 segmental lordosis, exerted a stronger influence on the reduction of segmental lordosis at the cephalad C4-C5 level. Notably, no parameter was associated with any segmental lordotic changes of the caudal (C6-C7) level. **Conclusion:** Our preliminary analysis revealed no significant differences between any measurement or parameter of patients undergoing a single-level CDR or ACD. Furthermore, our key finding demonstrated that a greater pre-operative 0-C2 lordosis, combined with an increase in C5-C6 segmental lordosis 6 after surgery, is associated with a reduced segmental lordosis at the cephalad C4-5 level. This insight may enhance pre-op surgical planning and identify patients at risk for cephalad ASD in the future.

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A323: Systematic review and meta-analysis of the effect of osteoporosis on fusion rates and complications following surgery for degenerative cervical spine pathology

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Introduction: As the elderly population grows and the incidence of both osteoporosis and degenerative cervical spine disease continue to increase, there is a need to better understand the interplay between these two variables. The literature currently presents conflicting evidence for many postoperative complications including rates of cage subsidence, pseudarthrosis, readmission, and reoperation in osteoporotic

patients following surgery for cervical spine disease. Thus, the purpose of this review is to systematically gather and analyze current data to provide a more comprehensive understanding of the impact of osteoporosis on postoperative outcomes for patients with cervical degenerative disease. **Material and Methods:** A systematic review using PRISMA guidelines and MeSH terms involving spine surgery for cervical degenerative disease or cervical deformity and osteoporosis was performed. The initial query was carried out on the Medline (PubMed) database, which was searched from 1990-August 2022. The search contained the following terms: "osteoporosis" AND "cervical" AND ("outcomes" OR "revision" OR "reoperation" OR "complication"). Comprehensive Meta-Analysis (Version 2) was used to perform statistical analysis. The effects of different studies were summed using the random effects model. Variables included in the study were either (1) categorical or (2) means with reportable standard deviations. **Results:** Sixteen studies were included in the final analysis, three of which were also eligible for the meta-analysis. Fourteen studies were retrospective reviews, and two were prospective cohort studies. Our findings suggest that osteoporotic patients may be at higher risk for developing cage subsidence and for requiring revision surgery. Most studies reported varied results on the relationship between osteoporosis and other outcomes such as readmission rates, costs, and perioperative complications. Our meta-analysis indicates that osteoporotic patients also carry a greater risk of reduced fusion rates at 1 year postoperatively (68.5% vs 91.3%, p = 0.023). **Conclusion:** The literature suggests that outcomes for osteoporotic patients after cervical spine surgery are multifactorial. Osteoporosis seems to be a significant risk factor for developing cage subsidence and pseudarthrosis postoperatively, whereas reports on medical and hospital-related metrics were inconclusive. Our review indicates that preoperative bone mineral density assessment can provide valuable information to guide surgical management of patients with disease of the cervical spine and highlights the challenges of caring for osteoporotic patients. Further research should attempt to prospectively study how osteoporosis changes the risk index of patients undergoing cervical spine surgery in order to further inform orthopaedic surgeons of avenues to improve outcomes for this vulnerable population.

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A324: Nationwide analysis of hybrid surgery for two-level cervical degenerative disease

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Introduction: Cervical hybrid surgery (HS) is a technique which combines anterior cervical discectomy and fusion (ACDF) and cervical disc arthroplasty (CDA) to attain advantages offered by each, namely range of motion (ROM) preservation and dynamic stabilization. As indications for HS continue to expand, this study evaluates demographic trends associated with two-level HS and evaluates clinical outcomes relative to the current gold-standard - ACDF. **Material and Methods:** Patients who underwent either index two-level ACDF (n = 179,322) or HS (n = 1,841) for degenerative cervical pathology from 2010-2022 were queried from the PearlDiver National database. Exclusion criteria were as follows: age < 18 years, rheumatoid arthritis, osteoporosis, trauma, malignancy, and infection. Relevant diagnoses and procedures were obtained using International Classification of Disease, 9th and 10th Edition (ICD-9, ICD-10) and Current Procedural Terminology (CPT) codes. Annual utilization was recorded and demographic characteristics were recorded and compared between two-level ACDF and two-level HS. Weighted average cost was obtained and adjusted for inflation. Both procedure cohorts were propensity-matched 1:1 to account for age, sex, Elixhauser Comorbidity Index (ECI), myelopathy, smoking, obesity, and other confounding comorbidities. Following assessment of data normality, student's t-test and chi-squared analyses were conducted for continuous and categorical data respectively, and conditional logistic regression was performed to assess risk for 30-day complications and five-year revision between two-level ACDF and HS. **Results:** From 2010 to 2021, 1,841 patients (50.1% female) underwent two-level HS, with utilization steadily increasing through until 2021 (n = 245). Comparatively, the HS cohort was younger (50.3 ± 10.2 vs 56.3 ± 10.6 years; p < 0.001), and had lower percentages of patients who were smokers (27.3% vs 29.7%; p = 0.029) and myelopathic (89.5% vs 85.7%; p < 0.001) relative to ACDF counterparts. Propensity-matching yielded 1,661 patients for each cohort, wherein conditional logistic regression revealed decreased odds of 30-day surgical complications (4.0% vs. 3.1%, OR: 0.85; p = 0.027), all-cause readmission (2.5% vs. 1.4%, OR: 0.54; p = 0.019), opioid use (71.3% vs. 57.7%, OR:0.67; p < 0.001), and revision up to four years postoperatively (all p < 0.05) with two-level HS. Two-level HS was associated with higher admission costs compared to ACDF ($6,989 ± 2,638 vs $5,019 ± 1,825; p < 0.001). **Conclusion:** Utilization of two-level HS has steadily increased from 2010-2020, with regional variations in adoption. These patients tended to be younger and less comorbid than those undergoing ACDF. Despite higher initial costs, comparison between matched cohorts revealed significantly lower risk of 30-day surgical complications, all-cause readmission, opioid use, and revision surgery up to four years postoperatively with two-level HS. These findings suggest that HS, when appropriately indicated, may be a more cost-efficient alternative to ACDF for two-level degenerative cervical pathology.

OP37: MIS Surgical Approach

1864
A325: Outcomes of circumferential minimally-invasive technique vs open technique in adult spinal deformity surgery patients over 80 years of age: a propensity-matched analysis

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Introduction: Circumferential minimally-invasive surgery (cMIS) techniques in ASD surgery may provide benefit in reducing physiologic burden, but the utility of such surgeries in patients with severe deformity has not been assessed. **Methods:** Operative ASD patients ≥18yrs with complete pre-(BL) and 2-year(2Y) postop radiographic/HRQL data were assessed. Patients aged 80 years and older were then isolated for analysis and compared by surgical technique: Open vs cMIS. BL and peri/postoperative factors were assessed using ANOVA and Bonferroni-adjusted ANCOVA while controlling for BL CCI and posterior levels fused. Propensity score matching (PSM) was used to align cMIS vs Open groups by BL CCI, C7-S1 SVA, PI-LL, and C7PL. **Purpose:** Assess 2-year outcomes for cMIS versus open surgery in ASD patients 80 years of age and older. **Results:** Of 1542 patients total (62.85 ± 13.93 years, 75.7% female, 29.23 ± 6.64 kg/m^2), with 19.5% (n = 34) octogenarians, split evenly between cMIS and Open. 19.5% (n = 34) were octogenarians. At baseline, patients were comparable in gender, BMI, and prior history of spine surgery (all p > .05). When assessing baseline frailty, Passias et al. and Miller et al. frailty scores were not significantly different (both p >.05), and Chi-square analysis revealed equal distribution of frailty in cMIS vs Open patients ($\chi^2(2)$ =.446, p =.788). No differences in anterior levels fused were observed (p > .05). cMIS patients were also less likely to require SICU care (p <.001), and had lower mean hospital length of stay (p = .013). Post-operatively, Open patients reported significantly higher SRS-22 Appearance and Mental domain scores (both p < .005), and were more likely to reach MCID in both domains by 2Y (p = .025, .024, respectively). Improvement by ODI and EQ5D/EQ5D-VAS were comparable by 2Y, as well as by MCID in their respective domains (all p > .05). In terms of post-operative complications, while no significant differences were noted in peri- or post-operative major or minor complications (all p > .05), cMIS patients were significantly more likely to require reoperation for radiographic sagittal imbalance by 2Y when controlling for CCI and levels fused (p < .001). By 2Y, there were no recorded deaths in the cMIS nor Open octogenarians. **Conclusion:** Octogenarians present a unique challenge to spine surgeons due to the potential for decreased physiologic reserve, and heightened risk for complications. Our comparison of adult spinal deformity patients undergoing circumferential minimally-invasive versus open surgery demonstrates that while cMIS patients benefit from decreased blood loss, operative time, and SICU and hospital length of stay, both Open and cMIS patients benefit from similar improvement in patient-reported outcomes. Likewise, Open technique, though more invasive, may also reduce the risk for reoperation due to radiographic instability by 2Y post-operatively.

2180
A326: The Growing trend of awake spine surgery under regional anaesthesia in the elderly: empowering patient safety

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Background and Aim: The utilization of awake spine surgery has demonstrated favorable patient-related outcomes in the setting of general orthopedic procedures. Consequently, its integration into spine surgery is of significant interest to spine surgeons, as it has the potential to mitigate the apprehension and complications typically associated with surgeries performed under general anesthesia. The demand for safe spine procedures is becoming ever more critical in developing nations due to advancements in healthcare and the growing number of elderly individuals in the community. In this study, we examine the safety and feasibility of performing spine surgery under spinal anesthesia in a cohort of elderly patients aged 65 years and above. **Methods:** A retrospective analysis was conducted on 83 consecutive cases of lower lumbar spine surgeries performed under spinal anesthesia by a single surgeon at a single hospital from 2015 to 2019. All procedure-related details were collected prospectively for the analysis. This study examines the various demographic factors, surgical aspects, perioperative considerations, and anesthesia-related issues and challenges associated with spine surgery performed under spinal anesthesia. **Results:** A cohort consisting of 83 patients, all of whom were over the age of 65, was included in the study. There was significant improvement seen in VAS and ODI scores at follow up (p-value < 0.05). The highest count was observed in ASA grade 2 patients. Most involved level was at L4-5 level. Approximately 7.2% of patients required a re-spinal procedure. The observed mean induction time was (20.2 ± 9.6) minutes. The average intraoperative procedure duration was found to be (84 ± 17.2) minutes. The length of time needed to begin shifting out process amounted to (7.95 ± 2.1) minutes. The mean intraoperative blood pressure was (70.71 ± 10.8) mmHg, while the mean intraoperative heart rate was (69 ± 7.2) beats per minute. The average time for postoperative analgesia initiation was (79.9 ± 7.7) minutes. The average length of postoperative stay was 3.02 ± 0.83 days. The presence of cerebrospinal fluid (CSF) resulting from needle puncture was observed in 10.8% of the patients. Postoperative hypotension occurred in 1.2% of the

cases, while 12% had nausea and vomiting after the operation. Infection was reported in 2.4% of the patients, and postoperative urine retention was observed in 14.5% of the cases. There were no instances of death, stroke, pulmonary embolism, or the need for conversion to general anesthesia observed. **Conclusion:** This case series demonstrates the feasibility of performing lumbar fusion and decompression procedures in elderly patients with the presence of a competent anaesthesia team. Furthermore, the utilisation of spinal anaesthesia has been found to effectively reduce various risks and concerns associated with general anaesthesia.

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A327: Full endoscopic unilateral approach for bilateral decompression in patient with severe lumbar spinal canal stenosis: 1 year follow up

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Purpose: To evaluate the outcomes of endoscopic unilateral laminectomy, bilateral decompression for lumbar spinal stenosis via interlaminar approach (PEILD). **Methods:** This study includes 50 patients diagnosed with Chronic lumbar spine severe stenosis (CLSS) who failed with conservative treatment and met the inclusion criteria and underwent surgery for PEILD from April 2021 to March 2022. The mean age of the patients, operation time, hospitalization time, time in bed, and complications were recorded. Patients were followed up for at least 12 months. Visual analog scale (VAS) scores for low-back and lower-limb pain and Oswestry Disability Index (ODI) scores were evaluated preoperatively, before discharge, and at 3, 6, and 12 months postoperatively. To evaluate clinical effectiveness 12 months postoperatively, the modified Mac-Nab criteria were used. **Results:** The mean age of the patients was 59.9 years, the mean operation time was 82.1 minutes, the mean hospitalization time was 3.7 days, and the mean time in bed was 20.9 hours. The mean VAS scores of low-back and lower-limb pain improved from 5.9 and 7.2 to 2.0 and 1.6, respectively (p < 0.05). The ODI score improved from 56.0 to 16.7 (p < 0.05). The overall excellent-good rate of the modified MacNab criteria was 89.7%. Two kinds of complications occurred in 4 patients (10.3%), including 1 patient whose inferior articular process was excessively removed and 3 patients who suffered from postoperative dysesthesia. No other severe complications were noted. **Conclusion:** PEILD is a safe, feasible, efficient, and minimally invasive approach to treating CLSS.

Keywords: endoscopic spinal surgery; laminectomy; discectomy; lumbar spinal stenosis

1535

A328: MIS disc excision:a day case surgery minimal invasive

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Background: Minimally invasive procedures are designed to shorten hospital stays and speed up patient recovery, possibly enabling patients to have surgery and go home the same day. With an emphasis on their potential advantages for patient comfort and efficient use of healthcare resources, this study examines the safety and viability of such day-case treatments. **Objectives:** To assess the safety and feasibility of minimally invasive discectomy as a day-case procedure. **Methods:** A total of 300 patients of PIVD L4-L5, L5-S1 treated with MIS technique at the Department of Orthopaedics, Ghurki Trust Teaching Hospital Lahore from a period of 2017-2023 using a retrospective study design were included in our study. The average of PIVD L4-L5 level and L5-S1 227 patients was 35.20 ± 5.67. Demographic profile of patients, presenting symptoms, ASA grade, complications, pain management, and anaethesia complications like nausea and vomiting, overnight stay, and readmission information were collected and analyzed. **Results:** More than half patients were males as compared to females. ASA I grade was observed in 287 and ASA II in 16 cases. Surgery was performed by high surgical trainees with conversion to open disc excision in 8 patients, 33 patients were admitted for an overnight stay for different reasons, while 259 patients were discharged on the same day. Dura repair was performed in 8 patients with conversion to open disc excision. Postop pain was assessed on VAS score and we observed a significant improvement in pain score postoperatively as p < .05 (average pre-op score = 6.25 ± 2.70 and post-op score = 2.52 ± 0.85). **Conclusion:** Day-case Minimal invasive Disc Excision is a safe and feasible method with optimal patient selection, education, and planned postoperative antiemetic and analgesia management.

Keywords: ASA Physical Status Classification System; minimal invasive disc excision; day case; patients management

2010

A329: Sciatica-related spinal imbalance in lumbar disc herniation patients: radiological characteristics and recovery following endoscopic discectomy

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[1]*Original Research Sciatica-Related Spinal Imbalance in Lumbar Disc Herniation Patients: Radiological Characteristics and Recovery Following Endoscopic Discectom, Qilu Hospital of Shandong University, Jinan, China*

Introduction: Sciatica-related spinal imbalance could be observed in lumbar disc herniation (LDH) patients. The trunk tilt

appearance could cause great distress to the patients and influence the doctor's diagnosis. In addition to pain relief, patients worry about whether and when the trunk tilt could recover. However, their characteristics and recovery process remained unclear. The purpose was to analyze the radiological characteristics of spinal imbalance related to sciatica and recovery following endoscopic discectomy. **Material and Methods:** The records of LDH patients with sciatica and spinal imbalance receiving endoscopic discectomy were retrospectively reviewed. Endoscopic discectomy surgeries include posterior endoscopic transforaminal discectomy (PETD), posterior endoscopic interlaminar discectomy (PEID), unilateral biportal endoscopic discectomy (UBED) and microendoscopic discectomy (MED). The patients were divided to Group A (sagittal imbalance), Group B (coronal imbalance) and Group C (sagittal and coronal imbalance). The whole-spine x-ray was performed at pre-operation, immediately post- operation, 3-month and 6-month follow-up and related radiological parameters were measured. **Results:** A total of 110 LDH patients (18.3%) presented with spinal imbalance were included and there were 31 patients in Group A, 38 patients in Group B and 41 patients in Group C. In this study, 77.2% of the coronal imbalance patients present with trunk shifted to contralateral side of disc herniation and 65.3% of the sagittal imbalance patients present with forward trunk. Most patients present mild and moderate sagittal and coronal imbalance. The magnitude of sagittal and coronal imbalance in Group C was significantly more severe than that of Group A and Group B. Most patients ($\geq$ 75%) acquired spinal balance immediately after surgery. The sagittal imbalance improved better than coronal imbalance and single plane imbalance improved better than biplane imbalance. At the postoperative 6-month follow-up, all patients recovered to normal sagittal and coronal balance. **Conclusion:** Sciatica-related spinal imbalance occurs in 18.3% of the LDH patients receiving endoscopic discectomy. Different subgroups of spinal imbalance present different characteristics. Spontaneous correction of the spinal imbalance could be achieved when sciatica was relieved immediately after surgery and well maintained during follow-up.

1966

A330: Mini-incision osteotomy combined with minimally invasive pedicle screw fixation for the treatment of spinal kyphosis deformity

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Introduction: Smith Peterson osteotomy (SPO), Ponte osteotomy, pedicle subtraction osteotomy (PSO) and bone-disc-bone osteotomy (BDBO) are common correction osteotomies for spinal deformity. Osteotomy and internal fixation in open surgery are used to treat spinal kyphosis, but these surgeries may lead to significant morbidity because of extensive dissection and massive blood loss. Our team has designed a minimally invasive method combining mini-incision osteotomy (PSO or BDBO) and freehand minimally invasive pedicle screw fixation (freehand MIPS) for the treatment of spinal kyphosis deformity. In this study, we report the 2-year follow-up data of thirteen consecutive cases of spinal kyphosis deformity treated with mini-incision osteotomy combined with freehand MIPS. **Material and Methods:** Thirteen patients diagnosed with spinal kyphosis deformity and sagittal unbalance of SVA > 5 cm and apical vertebrae from T10 to L5 were recruited, and received freehand MIPS combined with mini-incision osteotomy. Baseline information including age, gender, diagnosis, underlying disease, and operation history were collected. Preoperative and postoperative imaging data (X-ray, 3D-CT, MRI) and clinical data (back VAS, ASIA, ODI) were also collected. Patients were followed-up 3 months, 6 months, 1 year, and 2 years after surgery. Postoperative complications were also recorded. **Results:** Clinical follow-up was available for thirteen patients for at least two years. Spinal kyphosis deformities were dramatically corrected, and the sagittal spinal-pelvic parameters remained unchanged during the follow-ups. Back VAS and ODI significantly improved after surgery. 3 patients presented with ASIA D, and 10 presented with ASIA E before surgery. All 13 patients reached ASIA E at the 3-month follow-up. Although 1 case of BDBO had transient decline of muscle strength immediately after surgery, neurologic deficit improved from ASIA C to E, and the patient in this case regained ambulatory ability and recovered urinary sphincter function during 3 months. **Conclusion:** Mini-incision PSO or BDBO combined with freehand MIPS is a viable option of minimally invasive surgery for the treatment of spinal kyphosis. This method has less trauma and bleeding, shorter hospital stay, faster recovery and fewer postoperative complications.

Keywords: spinal kyphosis; osteotomy; pedicle screw fixation; minimally invasive surgery

1727

A331: The effect of Body Mass Index (BMI) on radiation exposure and pedicle screw accuracy in intra-operative navigation-guided minimally invasive transforaminal lumber interbody fusions (MIS-TLIF)

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Introduction: 3D intraoperative navigation (ION) is increasingly being utilized in minimally invasive spine surgery to provide better visualization of anatomy and improve accuracy of instrumentation, while also decreasing radiation exposure. There is limited data on the effect of body habitus on outcomes of ION-guided minimally invasive transforaminal interbody fusion (MIS TLIF) in terms of perioperative outcomes, including accuracy of pedicle screw placement. Thus, the purpose of this study was to evaluate the effect of BMI on operative time, estimated blood loss, radiation exposure, fluoroscopy time, and pedicle screw accuracy in patients undergoing MIS TLIF using ION. **Material and Methods:** A retrospective review of 110 patients who underwent single-level MIS TLIF using ION at a single institution (2017-2023) was performed. Demographics including age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) score, Charlson Comorbidity Index (CCI), and tobacco use, and surgical parameters such as operative time, blood loss, radiation dose, and fluoroscopy time were recorded. Patients were divided into non-obese (BMI < 30, 85 patients) and obese (BMI $\geq$ 30, 25 patients) groups. Pedicle screw accuracy was assessed postoperatively by computed tomography; accuracy was defined as good (without tip, endplate, pedicle, or facet breach), acceptable (pedicle breach within < 4 mm superior/lateral or < 2 mm inferior/medial, or tip breach), and poor (facet violation affecting the superior unfused level, pedicle breach outside acceptable zone, or endplate breach). **Results:** 110 patients (85 in the non-obese group, 25 in the obese group) were included. There were no statistically significant differences in demographics (age, sex, ASA, CCI, tobacco use), except BMI (non-obese: 25.6 ± 0. 3kg/m^2 vs obese: 37.3 ± 1.7 kg/m^2, p < 0.001). As for surgical parameters, there were no statistically significant differences in operative time (Median 92 vs 93 minutes, p = 0.854), estimated blood loss (median 25 vs 30 ml, p = 0.655), and fluoroscopy time (median 25 seconds for both cohorts, p = 0.855) between cohorts. However, the obese group had higher radiation exposure (non-obese: 44.7 mGy vs obese: 77.6 mGy, p < 0.001). After adjusting for age and sex, multivariate regression modeling showed an association between BMI and radiation dose, with higher BMI being associated with greater radiation dose (Standardized beta = 0.46, p < 0.001). In terms of screw accuracy, 236 of 249 (94.8%) and 43 of 46 (93.5%) navigated pedicle screws in the non-obese and obese groups, respectively, were graded as good or acceptable. There was no statistically significant difference in screw accuracy (p = 0.720). **Conclusion:** Several published studies comparing conventional fluoroscopy to ION have demonstrated benefits of ION in terms of radiation exposure and screw accuracy. However, to our knowledge this is the first study examining the use of ION in obese patients. This study did not find a difference between body habitus and pedicle screw accuracy, and navigated insertion can be performed at high accuracy (94.6%) regardless of patient BMI. Although there were no differences in operative time, blood loss, and fluoroscopy

time, patients that were obese were exposed to higher doses of radiation. This is an important consideration for both surgeons and patients, and would be a valuable aspect of the preoperative discussion.

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A332: Do expandable cages that expand both height and lordosis improve postoperative sagittal alignment following minimally invasive transforaminal lumbar interbody fusion (MIS TLIF)?

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Introduction: This study aims to compare clinical and radiographic outcomes of two different types of expandable cages in minimally invasive transforaminal lumbar interbody fusion (MIS TLIF). The first type of cage is capable of increasing disc height, whereas the second type is specifically designed to expand both disc height and lordotic angle. This study also focused on assessment of the fusion rate, subsidence, and effectiveness in maintaining sagittal alignment during a one-year follow-up period. **Material and Methods:** Seventy-five patients who underwent MIS TLIF using expandable cages were reviewed, including 35 cases using expandable cages that increase only height (Group H) and 40 cases using cages that expand both height and lordosis (Group HL). Clinical outcomes including visual analog score of back pain (VAS-B), leg pain (VAS-L), and Oswestry disability index (ODI) and radiographic parameters including disc height, segmental, lumbar lordosis, regional and global sagittal balance were evaluated. The fusion status, subsidence, and complications were recorded at each follow-up. **Results:** Both groups demonstrated significant improvements in VAS-B, VAS-L, and ODI with no difference between groups. There was also a significant increase in the disc height and foraminal height in both groups postoperatively. For sagittal alignment at 1-year follow-up, Group HL showed significantly greater positive changes in segmental lordosis (4.0 ± 3.3° vs 1.6 ± 5.4°, p = 0.045) and disc angle (5.8 ± 4.1° vs 1.9 ± 4.2°, p < 0.001) compared to Group H. Global and regional sagittal parameters were not significantly different between groups. The overall fusion rate was 92% and incidence of subsidence was 32% (decreased to 20% after the completion of the initial 20 cases as part of the surgeon's learning curve). There was no significant difference observed for overall complications

between the two groups. **Conclusion:** This study findings indicate that MIS TLIF with expandable cages designed to increase the lordotic angle can achieve significantly improved radiographic outcomes, a high fusion rate, and greater increase in segmental lordosis at 1-year follow-up as compared to the expandable cages that can increase only disc height. The surgical experience in utilizing expandable cages is essential to prevent excessive force in the attempt of achieving greater disc height or lordosis since this may lead to cage subsidence and subsequent failure to maintain the improved lordotic alignment postoperatively.

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A333: Prone lateral retropleural or retroperitoneal antepsoas approach spinal surgery using the rotatable radiolucent Jackson table

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Introduction: Prone lateral spinal surgery allows simultaneous lateral and posterior approaches and has recently been proposed to facilitate surgical room efficiency. With the modern advancement of minimally invasive surgical instruments and retractors, the extent of muscle dissections and wound size could be dramatically decreased during lateral retropleural or retroperitoneal approaches, such as oblique lumbar interbody fusion (OLIF) and lateral lumbar interbody fusion (LLIF). Furthermore, a combined posterior approach in the prone position is more familiar to spinal surgeons and enables additional procedures like cement augmentation, decompression, osteotomy, etc. The purpose of the study is to share early experiences and explore the feasibility of prone lateral spinal surgery. **Material and Methods:** From July 2021 to June 2023, a consecutive series of patients who received prone lateral spinal surgery for various etiologies by the same surgical team were reviewed. A Mizuho Jackson Modular Table System was used for all prone lateral surgeries. All patients received combined lateral and posterior approaches surgery on the same day. The lateral approaches were performed with the Jackson table rotated 30-40 degrees away from the surgical side. After careful muscle dissection, a Medtronic/Depuy Synthes OLIF retractor was applied in retropleural/retroperitoneal spaces. Lateral procedures like discectomy or corpectomy were performed after full exposure. Posterior approaches were performed with the Jackson table rotated back horizontally. The disease etiologies, surgical levels, blood loss, operation time, and surgical procedures were collected and analyzed. **Results:** There are 64 patients received prone lateral spinal surgeries with a mean age of 61.8

years (range: 26 - 88). The disease etiologies were 11 (17%) deformities, 15 (24%) degenerations, 25 (39%) infections, 9 (14%) traumas, and 4 (6%) tumors. The mean blood loss was 863 ± 843 ml (range: 50 - 4600) and the mean length of the surgical level was 4.1 ± 2.0 (range: 2 - 10). The mean operation time was 5h51m (range: 2h 02 m - 16h 14 m). The lateral surgical level ranged from T8 to L5 and the posterior surgical level ranged from T6 to ilium. Of the lateral approaches, there were 25 retropleural (2 from right side) and 39 retroperitoneal (1 from right side) approaches. Among the 39 retroperitoneal approaches, 36 underwent antepsoas and 3 underwent transpsoas approaches (1 from right side and 2 from left side). There were 63 patients received lateral discectomies (1-level: 26; 2-level: 29; 3-level: 6; 4-level: 1; 5-level: 1) and 26 patients among them received lateral corpectomies (1-level: 22; 2-level: 4). Among them, 8 underwent lateral instrumentation and 3 underwent en bloc spondylectomy using the prone lateral combined approach. There were 20/44 patients received open/percutaneous posterior pedicle screw instrumentations. For the additional posterior procedures, 20 patients received cement augmentation, and 20 patients required posterior decompression/osteotomy/screw removal/debridement/endoscope. **Conclusion:** Prone lateral spinal surgery is a feasible option for patients requiring combined lateral/posterior approach spinal surgery. Both lateral retropleural and retroperitoneal antepsoas approaches can be applied in combination with various posterior surgical procedures in prone position using the rotatable radiolucent Jackson table.

OP38: Thoracolumbar Trauma

1644

A334: Presentation, management and outcomes of thoracolumbar spine trauma in East Africa: retrospective cohort study

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Introduction: Thoracolumbar (TL) spine trauma is common and can cause substantial disability, deformity, and neurological

deficit. In a cohort of TL spine trauma patients from a prominent East Africa referral center, we sought to (a) describe the presentation and operative treatment patterns, (b) report predictors of surgery and neurologic improvement, and (c) assess predictors of mortality. **Methods:** A retrospective cohort study of TL spine trauma patients presenting to a tertiary hospital in Tanzania was performed. Demographic, injury, and operative data were collected. Neurologic exams on admission/discharge and in-hospital mortality were recorded. Univariate/multivariate logistic regression assessed predictors of operative treatment, neurologic improvement, and mortality. **Results:** Of 257 patients with TL spine trauma, 167 (64.9%) were treated operatively on a median post-admission day of 17.0 (7.0-30.0). Only three patients (1.2%) died. The most common fracture pattern was AO type A fractures (78.6%), and most were burst fractures (61.1%). Almost all patients (97.6%) had a posterolateral laminectomy and fusion. Patients with intact injuries (OR 0.27, 95% CI 0.13 - 0.54, p < 0.001) and a longer time from injury to admission (OR 0.95, 95% CI 0.92-0.99, p = 0.007) were less likely to have surgery. The neurological improvement rate was 11.1%. Operative treatment was associated with neurologic improvement in univariate testing (OR 3.83, 95% CI 1.27-16.61, p < 0.001). In the surgical group, having a thoracic injury was associated with reduced odds of improvement compared to lumbar in multivariate testing (OR 0.09, 95% CI 0.00-0.51, p = 0.027). **Conclusions:** This study highlights various themes surrounding the management of TL spine trauma in a low-resource environment, including lower surgery rates, delays from admission to surgery, safe surgery with low mortality, and the potential for surgery to lead to neurologic improvement.

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A335: Stent-screw assisted internal fixation with apex pushing technique for kyphosing thoracolumbar fractures (SAIFAP)

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Introduction: Short- or long-segment posterior stabilization with vertebral body stent (VBS) in the index vertebra and cement-augmented pedicle screws (stent-screw assisted internal fixation = SAIF) is a treatment option in kyphosing thoracolumbar fractures and may avoid corpectomy in some situations. SAIF was effective in obtaining height restoration, kyphosis correction and pain relief in smaller series with vertebral collapse. There is little information about the effect of the combination of SAIF with the apex pushing technique (APT) to reduce segmental kyphosis. **Material and Methods:** We retrospectively included all patients treated at the Kantonsspital St. Gallen between 2016 and 2023 with a surgical technique, which combines the SAIF and APT (SAIFAP). Radiological and clinical data for all patients with osteoporotic, traumatic and pathological fractures who were treated with SAIFAP were obtained. Statistical analysis was performed through SPSS Version 28, IBM. We performed t-tests for independent samples and a Chi-Square tests to explore statistical significance. **Results:** We included a total of 48 patients (54% male) with a mean age of 75 years (CI 54; 93), ASA score of 2, CCI score of 5 and BMI of 26 kg/m^2. Twenty-two fractures were osteoporotic (46%, OF types II-V), 20 were traumatic (42%, A3, A4, B2 and B3 fractures) and 6 were pathological (12%). Most fractures (67%) were located in the thoracolumbar junction and operated with open midline approach (63%; 37% percutaneous, minimally-invasive technique). The mean length of surgery was 171 minutes (SD 54), mean estimated blood loss 436 ml (SD 497). We achieved a mean sagittal angle correction of 5° (SD 11) and sagittal anterior/posterior wall height correction of 6 (SD 8)/4 (SD 6) mm on first follow up after 54 days (SD 28). While the sagittal angle correction (6° (SD 13)) persisted on last follow up after 627 days (SD 465), the anterior/posterior wall height correction declined to 1 (SD 15) and -4 (SD 14) mm, respectively. Surgical complications (junctional/distant fractures, wound infections, wound healing disorders and screw loosening) occurred in 14/44 patients (29%) for whom the follow up was available on last follow up. Patients with traumatic fractures tended to have less complications (n = 2, 12.5%) than patients with osteoporotic (n = 6, 33%) or pathological (n = 2, 50%) fractures (p = 0.68). **Conclusion:** In our single-center experience the SAIFAP technique appears to be an effective correction method for kyphosing fractures, including those of the thoracolumbar region. However, the initial satisfying correction might be lost in the long-term. Long-term complication rates in elderly patients with osteoporotic and pathological fractures were not negligible.

2269

A336: Thoracolumbar burst fractures: risk factors associated with 90-day readmissions - A nationwide readmissions database study

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Introduction: Thoracolumbar (TL) burst fractures most commonly occur at the thoracolumbar junction and may adversely affect neurologic integrity. These injuries typically occur from high energy trauma or from low energy events

such as ground level falls in aging populations. Management of TL burst fractures varies on the severity of injury. There remains controversy regarding optimal treatment, surgery versus conservative care, despite attempts of using more sophisticated classification and severity scales to help structure treatment plans. Complexity of patient comorbidities may significantly increase utilization of hospital resources including hospital readmissions and length of stay. To our knowledge, there has been no population study on readmissions of TL burst fractures. The objective of our study is to investigate the risk of readmission within 90-days of hospital discharge after sustaining a TL burst fracture. Secondarily, we will determine if risks differed by those treated surgically versus conservatively (non-operatively) and evaluate the association between comorbid risk factors and payer status. Finally, we will calculate the total hospital cost incurred for readmission within 90-days of index hospitalization due to TL burst fracture. **Methods:** We queried the 2018 USA Healthcare Cost and Utilization Project's National Readmissions Database (NRD) which collects data on hospitalizations. We performed a retrospective cohort study of all adult patients (> 18 years) using the 2018 ICD-10 coding system who were identified to have a single level new onset TL burst fracture between January 1, 2018 and September 30, 2018. Demographics were analyzed for patient, comorbidities, hospital characteristics, readmission analysis, length of stay, hospital cost, and payer status were collected. Statistical analyses were performed on the collected data. p < 0.05 was considered statistically significant. **Results:** A total of 4,395 patients sustained TL burst fractures as identified by the 2018 NRD. The total for a 90-day readmission rate was 7.0% (307/4,395). Of the total 4,395 patients, 1,857 (42%) were managed surgically and 2,538 (58%) conservatively. Of the readmitted patients, only 69/307 (22%) were surgical patients. The mean age of patients who were readmitted (65.5, SD 17.6) was significantly higher than those who were not readmitted (58.4, SD 20.1), p < 0.001. There were a greater proportion of females (60%) than males (40%) who were readmitted, p = 0.005. Among the readmitted versus non-readmitted group of patients, Medicare recipients represented the most common payer status (11%). Total hospital costs were significantly greater for those who were readmitted ($224,445, SD $184,681) than those who were not ($131,783, SD $148,029). **Conclusion:** The 90-day unplanned readmission rate following thoracolumbar burst fracture was 7.0%, with a majority of these having been treated conservatively compared to surgery. Furthermore, there was increased readmissions of older patients with multiple medical comorbidities and risks factors; including many patients supported by Medicare payer status. Overall, there was a substantial increase in hospital costs for readmitted patients. The identified risk factors and treatment of patients who sustain thoracolumbar burst fractures are potential areas to focus on guiding optimal management plans in order to reduce readmissions and improve outcomes.

1506
A337: Awake surgery with percutaneousscrews for unstable spinal fractures in severely ill patients

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Spinal fractures, often resulting from trauma or underlying medical conditions, represent a challenging surgical dilemma, particularly in severely ill patients. Awake surgery, a groundbreaking approach, has emerged as a transformative strategy to address this complex issue. Traditionally, surgery for unstable spinal fractures in severely ill patients necessitated general anesthesia, posing significant risks due to comorbidities and compromised physiological status. This approach involves the administration of regional anesthesia, maintaining patient comfort and reducing systemic risks associated with general anesthesia. **Materials and Methods:** All patients with ASA score III or IV who presented with unstable fractures of the spine, to a level one trauma center were assessed and underwent awake spinal percutaneous fixation, with mild sedation and local anesthesia. The patients were operated in a INR suite using biplanar fluoroscopy. Demographics, radiology, and outcome were collected with a 12 month minimum follow up. **Results:** 53 patients were operated between the years 2019-2022. Average follow up was 16 months (range 12-28 months) 17 were female and 36 males. The average age was 77.7, the ASA score was 3-4 to all patients. There were 25 extension type injuries, 15 unstable burst injuries, 9 chance fracture and four teardrop fracture. 50 patients underwent unilateral fixation and three patients underwent bilateral fixation, cement augmentation was performed in 45 of the patients. Surgery time was 25 minutes (range 14-50 minutes). There was no neurological complications. Blood loss was under 20 CCs in all cases No cases of hardware failure in this cohort of patients. There was two cases of infection that presented after surgery. All patients were discharged ambulating. **Conclusions:** Awake surgery with percutaneous screws was safely performed in 53 severely ill patients with unstable spinal fractures. Key benefits of awake surgery with percutaneous screws for spinal fractures included reduced perioperative complications, shorter hospital stays, and improved overall patient experience. The technique allows real-time assessment of neurological function, enabling surgeons to tailor interventions to specific patient needs. Moreover, awake surgery minimizes the risk of postoperative complications, such as pneumonia and delirium, often associated with general anesthesia. Safety remains a paramount concern in awake surgery, with meticulous patient selection, appropriate anesthesia management, and continuous patient

monitoring being essential components. Emerging evidence suggests that this technique can be safely and effectively employed in select cases of severely ill patients, offering a valuable alternative to traditional approaches.

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A338: Incidence and risk factors for 90-day readmission after spinal trauma

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Introduction: Unplanned readmissions after spine surgery are undesired, and cause significant social, functional, and financial distress to the patients and healthcare system. Though critical, knowledge about readmissions after surgery for traumatic spinal injuries (TSI) is scarce and under-evaluated. **Methods:** Consecutive patients surgically treated for TSI and who had unplanned readmission within 90 days post-discharge were studied. Peri-operative demographic and surgical variables, type of surgical treatment, level of injury, delay in surgery, ASIA score, other organ injuries, peri-operative complications, smoking, ICU stay, co-morbidity, and the length of hospital stay were studied and correlated with the causes for readmission. **Results:** Among 884 patients, 4.98% (n = 44) had unplanned readmissions within 90 days of discharge. Notably, 50% (n = 22) patients were readmitted within the first thirty days. Common causes of readmissions were urinary tract related problems (22.7%, n = 12), pressure ulcers (20.4%, n = 9), respiratory problems (13.6%, n = 6), surgical wound related problems (14%, n = 7,) limb injuries (11.4%, n = 5), and other medical problems (11%, n = 5). The total beds lost secondary to readmissions was 314 days, and the mean bed-days lost per patient was 7.2 ± 5.1. Thirteen peri-operative risk factors were associated with unplanned readmissions, among which, smoking (OR 2.2), diabetes (OR 2.4), and pressure sore during index admission (OR 16.7) were strong independent predictors of unplanned readmission. **Conclusion:** The incidence of unplanned readmissions after TSI was 5%, which was similar to elective spine surgeries but the causes and risk factors are different. Non-surgical complications related to urinary tract, respiratory care and pressure sores were the most common causes while surgical wound complications contributed to a smaller percentage. Pre-operative smoking status, diabetes mellitus and pressure sores noted in the index admission were important independent risk factors.

865
A339: Does re-collapse affect the functional results following posterior instrumented fusion for thoracolumbar junction fractures?

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Introduction: Treating thoracolumbar fractures is challenging not only in terms of radiological results but also chasing the best possible functional results. Even in the context of a well-reduced vertebral body fracture, re-collapse remains possible. This re-collapse can result in serious problems like loss of reduction, persistent post-traumatic kyphosis, and metal failure, which often require revision surgery. The aim of our study is to investigate the functional results after re-collapse. **Material and Methods:** The study retrospectively reviewed 120 patients with thoracolumbar fractures who underwent posterior instrumented fusion (PIF). The study population was divided into two groups: stable, well maintained reduction group (G1) and re-collapse group (G2). Patients were assigned to the re-collapse group if their vertebral body height loss was greater than 20% at any follow-up compared with immediate postoperative results. Functional results were evaluated through multiple scores such as the Dallas Pain Questionnaire (DPQ), the Oswestry Disability Index (ODI) and the Visual Analog Scale (VAS). We have also compared return to work and off-work time at the last follow up. **Results:** The mean of follow-up was 45 months. 29 patients had re-collapsed (G2). The mean VAS value in this group was 3 and 2.19 in G1. The mean DPQ was 13.35 in G1 and 24.27 in G2. The mean ODI was 21.92 in G1 and 23.07 in G2. We noticed a significant difference between the two groups for DPQ (p = 0.02). However, the difference was not statistically significant for VAS (p = 0.09) and ODI (p = 0.29). The off-work time was 159.72 days in the well-maintained group compared to 145.83 days when re-collapse occurred without any significant difference (p = 0.51). **Conclusion:** The functional impact of re-collapse on the clinical results has been controversial. In fact, our results showed worse functional outcomes in the re-collapse group compared to the well-maintained reduction group essentially for DPQ. Re-

collapse was responsible for major pain which affected the return to work. Preoperative planning is necessary to reduce the risk of re-collapse and achieve the best possible functional result.

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A340: A prospective randomized controlled trial comparing the outcomes in patients of thoracolumbar burst fractures treated by minimally invasive spine fixation v/s non operative treatment

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Introduction: There are no clear guidelines for managing patients with thoracolumbar Burst fractures (TLBF), (AO type A3 & A4) with an indeterminate posterior ligamentous complex (PLC) injury and no neurological deficit. The Long term outcomes reported in these patients who have undergone surgical fixation are similar to conservatively managed patients. However, most of the studies have compared the outcomes of open surgery v/s no surgery. We hypothesize that these set of patients might have better short term outcomes in terms of pain relief, hospital stay and return to work, if they undergo a minimally invasive Spine fixation (MISS) as compared to patients who are managed non-operatively. **Material and Methods:** The study was designed as a single-centre, open-blinded, Prospective, randomized controlled trial. The study sample size was predetermined and adequately powered using the POST method. After Approval from the institutional ethics committee (JIP/IEC/2020/039) the trial was registered with Clinical Trials Registry – India (CTRI/2020/06/026211). Patients with TLBF were evaluated clinically and radiologically with X-Rays, CT and MRI. Patients without any neurological deficit and with an indeterminate PLC injury were included in the study and randomized to the trial's respective arms (MISS v/s non-operative arm). Patients in MISS group received short/mono-segment Percutaneous Pedicle screw fixation depending upon fracture morphology and those in non operative arm were advised initial bed rest until they had significant pain relief, followed by early mobilization as per their comfort. The same rehabilitation protocol was followed for patients in both the arms. Patient-reported outcomes were measured using pain VAS, ODI score and EQ-5D. The number of days of hospital stay and return to active work/lifestyle was also noted. Any complications resulting from the respective treatments were also recorded. **Results:** 236 patients with TLVF were screened for inclusion into the study; Finally 24 patients fulfilled the inclusion and exclusion. They were randomized to 2 groups of 12 patients each using computer generated random numbers. The two groups were similar in their baseline characteristics.

The mean VAS score at presentation was 9 for both the groups. However at 3 weeks the mean VAS score was 1.75 (±1.815) and 3.92 (±1.782) for the MISS and the non-operative group, respectively and this was found to be statistically significant (p = 0.007). The respective mean ODI and EQ-5D scores at 3 weeks were 4 (2-37) and 0.949 (0.740-1) for the MISS group and 32.5 (16.25-61) and 0.730 (0.197-0.844) for the non operative group. This difference in outcomes between the two groups was also found to be statistically significant (ODI [p = 0.010] and EQ-5D [p = 0.033]). The number of days of Hospital stay and return to work was found similar in both the groups. No complications were observed in any patient from either group. **Conclusion:** In patients with TLBF (AO type A3 and A4) with indeterminate PLC injury, and no neuro-deficit, MISS fixation provides better functional outcomes in terms of pain VAS, EQ-5D, and ODI scores at the end of 3 weeks when compared with non operative treatment.

2559

A341: Thoracolumbar fractures: factors predicting failure of short- and long-segment fixation

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Introduction: The thoracolumbar (TL) transition is a segment of the spine prone to fractures, representing one of the most common spinal injuries. Although short-segment posterior fixation (SSPF) and long-segment posterior fixation (LSPF) are the mainstay treatment of these injuries, there is still some controversy about which one to choose in each case, especially when considering failure rates. Our aim was to better understand what factors may influence treatment failure and the reason behind it. **Material and Methods:** This retrospective cohort study included adult patients with acute TL fractures, without neurological damage, treated with percutaneous SSPF or LSPF. Patients were divided into two groups, according to the presence or absence of treatment failure at follow-up, with a 12-month minimum follow-up time (FUT) for those without failure. We analyzed whether age > 65 years, level of the fracture, posterior ligamentous complex (PLC) lesion, load sharing classification (LSC) score > 6, type of instrumentation (SSPF vs LSPF) and abnormal bone mineral density (BMD) were correlated with failure rates. To achieve this, we evaluated clinical and radiological parameters at the preoperative and follow-up evaluations. **Results:** We included 87 patients in the study, of which 60 (69.0%) without

treatment failure (group 1) and 27 (31.0%) with treatment failure (group 2). Of the variables included on our multivariate logistic regression, age > 65 years (aOR: 3.66, p = 0.020), presence of PLC lesion (aOR: 2.94, p = 0.048) and SSPF (aOR: 6.75, p = 0.013) showed a statistically significant relation with treatment failure. Furthermore, age > 65 years and presence of PLC lesion were associated with a shorter time to failure (35.2 vs 69.1 months, p = 0.013, and 25.2 vs 69.1 months, p = 0.037, respectively). There was no statistically significant difference between patients with PLC lesion treated with SSPF vs LSPF. **Conclusion:** From our study, we conclude that age > 65 years, presence of PLC lesion and SSPF contributed to treatment failure of patients with TL fractures. Furthermore, the first two factors were also associated with a shorter time to failure.

845
A342: How frequently MRI modifies thoracolumbar fractures' classification or decision-making? A systematic review and meta-analysis

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Introduction: Only one previous systematic analysis had shown that magnetic resonance imaging (MRI) could significantly change fracture classification or treatment decisions in thoracolumbar fractures (TLFs). This study aims to provide the first meta-analysis of the impact of MRI on TLFs classification and decision-making. **Materials and Methods:** A systematic review was conducted following PRISMA guidelines. We searched PubMed, Scopus, Cochrane, and Web of Science from inception to 30 June 2023 for studies evaluating the change in TLFs classification and treatment decisions after MRI. The studies extracted key findings, objectives, and patient population. A meta-analysis was performed for the pooled frequency of change in AO fracture classification or treatment decisions from surgical to conservative or vice versa after MRI. **Results:** This meta-analysis included four studies comprising 554 patients. The pooled frequency of change in TLFs classification was 17% (95% CI: 9% to 31%), and treatment decision was 22% (95% CI: 11% to 40%). An upgrade from type A to B was reported in 15.7% (95% CI: 7.2 % to 30.6%), and downgrading type B to A in 1.2% (95% CI: 0.17 to 8.3%). A change from conservative to surgery recommendation of 17% (95% CI: 5.0% to 43%) was higher than a change from surgery to conservative 2% (95% CI: 1% to 34%). **Conclusions:** MRI can significantly change the thoracolumbar classification and decision-making, primarily due to upgrading type A to type B fractures and changing from conservative to surgery, respectively. These findings suggest that

MRI could change decision-making sufficiently to justify its use for TLFs. Type A subtypes, indeterminate PLC status, and spine regions might help to predict a change in TLFs' classification. However, more studies are needed to confirm the association of these variables with changes in treatment decisions to set the indications of MRI in neurologically intact patients with TLFs.

OP39: Adult Deformity: Complications

2183
A343: MEP, SSEP, or EMG. How reliable are intraoperative neuromonitoring alerts during non-cord level spinal deformity surgery? Results from the spinal deformity intraoperative monitoring (SDIM) study

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Introduction: Development of new postoperative neurological deficits is not uncommon following spinal deformity surgery. Intraoperative neuromonitoring (IONM) is routinely used during spinal deformity surgery at the cord level to identify and prevent occurrence of new neurological deficits. However, the benefits of using IONM for non-cord level spinal deformity surgery are less known. This is a prospective multicenter study assessing the utility of IONM in patients underdoing non-cord level spinal deformity surgery. **Material and Methods:** 20 international centers prospectively documented IONM alerts, demographics, radiographic findings, and surgical events in patients undergoing spinal deformity surgery based on a standardized data collection form. Enrolled patients met the following inclusion criteria: age ≥ 10 and ≤ 80 years,

neurologically intact, undergoing spinal deformity correction with a major sagittal or coronal Cobb $\geq 80°$ or undergoing a posterior column or 3-column osteotomy with Electromyography (EMG), Somatosensory evoked potentials (SSEP) and Motor evoked potentials (MEP) monitoring. High-grade spondylolisthesis was excluded from the present study. Detailed neurological examination was performed at baseline, immediately post-op and prior to discharge from hospital. IONM change was defined as a loss of amplitude of > 50% in SSEP or MEP from baseline or sustained EMG activity that lasts > 10 seconds. **Results:** 197 patients underwent surgery at a non-spinal cord level. Neuromonitoring alerts were observed in 22 patients (11.2%), whereas no alerts were observed in 175 patients (88.8%). The mean age of patients was 47.6 and majority (75.1%) were female. There were no statistically significant differences between the alert and no alert groups when comparing age, sex, coronal or sagittal cobb angles, coronal or sagittal deformity angular ratio (DAR), coronal or sagittal C7 plumb line, anterior or posterior fusion, performance of osteotomy, number of osteotomies, or number of levels fused. A higher percentage of patients with a recorded alert were undergoing revision surgery compared to those with no alert (40.9% vs. 18.9%, fisher's exact test p = 0.026). There were a total of 26 alerts in 22 patients; 4 patients (18.2%) had 2 IONM alerts, while the other 18 (81.8%) had 1 IONM alert. MEP alerts were the most commonly observed alerts in non-cord level surgery. MEPs were affected in 21 out of 26 alerts (80.8%). 23.8% of MEP alerts were bilateral, whereas 76.2% were unilateral MEP alerts. In 61.5% (16/26) of alerts, only MEP changes were seen without associated EMG or SSEP changes. SSEPs were affected in 30.8% of alerts. In 11.5% of alerts, only SSEP changes were seen. Lastly, EMGs were affected in only 7.7% of alerts and were not seen in conjunction with MEP or SSEP changes. MEP alerts occurred at a mean 247 minutes after skin incision and 71.4% (15/21) of MEP changes fully recovered intraoperatively. 16.8% (33/197) of patients developed a new postoperative neurological deficit and 12.2% (24/197) of patients without any intraoperative IONM alert developed a new postoperative neurological deficit. The association between an IONM alert and development of new postoperative neurological deficits had a crude positive predictive value (PPV) of 45%, negative predictive value (NPV) of 86.1%, sensitivity of 27.3%, and specificity of 93.1%. The true sensitivity and PPV of IONM alerts may be higher than noted as the current results do not account for the effects of counter-actions and recovery. **Conclusion:** In this prospective study of 197 patients with surgery at a non-cord level, 16.8% of patients developed a new postoperative neurological deficit. MEP alerts were most common, whereas EMG was the least reliable IONM modality and should not be used in isolation. IONM alerts showed a high specificity of 93.1% and negative predictive value of 86.1% in detecting a new postoperative neurological deficit suggesting that an IONM alert should be considered a critical event. Unfortunately, the sensitivity of IONM alerts remains low for non-cord level surgery and highlights the need for further refinement of IONM techniques and alert criteria for non-cord level surgery. More in-depth analyses are required to explore the effects of counter-actions and recovery on the diagnostic accuracy of IONM alerts.

1246
A344: Radiological features and postoperative outcomes in patients of degenerative lumbar scoliosis with pelvic obliquity

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Introduction: Degenerative lumbar scoliosis (DLS) is a prevalent spinal condition in the elderly, with an incidence of approximately 2–68 %. Pelvic obliquity (PO), a sign of coronal imbalance, is frequently observed in patients. PO can cause joint deterioration and aberrant gait, which can have a significant negative impact on the patient's quality of life. Systematic studies and reports on the radiographic characteristics of DLS patients with PO and the outcome of PO following orthopedic surgery are still lacking. The radiological characteristics of DLS patients with PO were collated in this study, and we found that there are two types of patients with PO depending on the orientation of the pelvic iliac spine on the higher side. As each subtype of PO has distinct clinical traits, each subtype should be treated using a different surgical strategy. This study is to investigate the radiological features of PO in DLS patients and discuss the outcome of PO after spinal scoliosis correction and its related clinical parameters. **Material and Methods:** Patients included was those who was diagnosed with DLS and underwent posterior scoliosis correction, internal fixation, and fusion surgery at our institution. Patient-reported outcomes were measured using ODI and JOA scale. Radiological parameters were measured from standing whole-spine anteroposterior (AP) films obtained preoperatively, postoperatively, and at the last follow-up. Clinical data were collected from the pathology of the patients. Patients with PO (POA $\geq 3°$) were divided into type I (n = 48) and type II (n = 48) patients (n = 42). The higher iliac spine of the pelvis was congruent with the direction of the C7PL offset in Type I, whereas in Type II, the higher iliac spine was opposite to the direction of the C7PL offset. A comparative analysis was performed between various patient types' pre- and postoperative radiological parameters and patient-reported outcomes (PRO). **Results:** 90 patients (31%) had PO, of whom 48 were type I and 42 were type II. Compared to patients

who had persistent postoperative PO, type I patients who recovered from PO had lower AVT (13.27 ± 2.59 vs. 20.34 ± 7.32, p = 0.025), CVA (18.54 ± 6.76 vs. 29.46 ± 11.31, p = 0.043), and better PRO while type II recovered patients had lower postoperative SOA (1.62 vs. 3.89, p = 0.015) and better PRO. The percentage of intraoperative fixation to the sacrum was lower in type II patients with recurrent PO (rate of 34.5%) than pelvic recovery group at follow-up (15.8% vs. 60%, p = 0.014). **Conclusion:** In conclusion, we presented a classification system (type I and type II) based on the potential mechanisms of PO for the first time. Radiographically, patients with type II deformities miss the lumbosacral compensatory curvature, and the deformity is more severe, with a higher likelihood of long-term imbalances. Correction of the Cobb angle and AVT was more beneficial for postoperative recovery in type I patients; however, fixation to the sacrum and correction of sacral balance were essential for postoperative pelvic balance in type II patients.

1071

A345: Rod fracture after multiple-rod constructs for adult spinal deformity surgery: a new proposal for lumbar accessory rod placement in posterior arthrodesis with sacropelvic fixation

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Introduction: Rod fracture (RF) after adult spinal deformity (ASD) surgery is reported in approximately 6.8%-33% of patients and is correlated with chronic pain, loss of deformity correction and higher reoperation rates. Multiple-rod constructs (MRCs) are commonly used to ensure greater biomechanical stability in spinopelvic fixation and to stabilize pedicle subtraction osteotomies (PSO). The authors' aim was to compare the effect of anterior-posterior accessory rod (AR) placement with the effect of lateral-medial AR positioning on postoperative occurrence of RF after ASD surgery. **Material and Methods:** This retrospective observational study analyzed patients who underwent ASD surgery between January 2019 and December 2022 at our Institution. Posterior arthrodesis with MRCs were performed in all cases. We divided our population into two groups: MRCs with anterior-posterior lumbar AR placement (Group 1) and MRCs with lateral-medial lumbar AR positioning (Group 2). Inclusion criteria were age > 18 years, primary surgery or revision surgery for ASD, ≥ 7 instrumented levels including sacropelvic fixation and diagnosis of coronal malalignment (CM) or sagittal malalignment (SM), which were defined as the presence of pelvic tilt (PT) ≥ 20°, sagittal

vertical axis (SVA) ≥ 50 mm, thoracic kyphosis (TK) ≥ 60°, coronal Cobb angle ≥ 20°, or pelvic incidence to lumbar lordosis mismatch (PI-LL) ≥ 10°. The central point was on patients with at least 24 months of clinical and radiological follow-up. **Results:** Of 39 patients who otherwise met inclusion criteria, 19 were in group 1 and 20 in Group 2. The patients' mean age was 68.2 ± 12.8 years. The mean body mass index (BMI) was 31.2 ± 2.5. The mean number of levels fused was 10.0 ± 3.0. In 20 patients Smith-Petersen osteotomy (SPO) was performed, 26 patients underwent pedicle subtraction osteotomy (PSO), and 24 underwent transforaminal lumbar interbody fusion (TLIF). Considerably more patients in the Group 1 underwent PSO (74% of the Group 1 vs 32,1% of the Group 2, p = 0.012) and TLIF (85.4% of the Group 1 vs 43.8% Group 2, p = 0.0010). Among the 35 patients who completed follow-up, postoperative event of RF concerned 8 patients (20.51%), within 15.5 ± 7.8 months of follow up. Whereas group 1 patients had greater baseline SM or CM, RF rate was significantly higher among patients in Group 2 compared with those in Group 1 (40% vs 0%, p < 0.0001) at comparable mean follow-up (28.9 vs 27.6 months, p = 0.080). **Conclusion:** We found a considerable reduction in the occurrence of RF in ASD surgery performed with MRCs with anterior-posterior lumbar AR placement, regardless of greater baseline rigid deformity and higher rates of PSO. Due to the mechanical stresses of the load, it is known that the region found to be the most involved in RF is the lumbar one. According to the literature, the instability observed after a PSO is mainly in flexion and shape of rod contour affects the location of maximum stress in the constructs. Consequently, according to our experience, anterior-posterior lumbar AR placement increases elasticity forces in the system so that mechanical events of RF at the lumbosacral junction are reduced.

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A346: Transcranial motor-evoked potentials for detecting neurological injuries during spinal deformity surgery: a prospective multicenter study

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Introduction: Spinal deformity surgeries are often complex and may carry high risks of neurological complications, which

directly affect patient recovery, hospitalization lengths, and the risk of prolonged or potentially permanent morbidity. Transcranial motor-evoked potentials (Tc-MEPs) is a highly effective tool for predicting postoperative motor deficits because it can watch motor pathway of spinal cord. On the other hand, whether Tc-MEPs can monitor nerve root in spinal deformity surgeries remains controversial. This study aimed to clarify the uses and limitations of Tc-MEPs for spinal cord/nerve root injuries during spinal deformity surgeries. **Material and Methods:** We prospectively analyzed neuromonitoring data from 16 institutions in Japanese Neuromonitoring Committee between 2010 and 2020. The subjects were spinal deformity patients surgically treated with posterior corrective fusion using multichannel Tc-MEPs. An alert was defined as a decrease of $\geq 70\%$ in the Tc-MEP's waveform amplitude from baseline, and neurological injury was considered as meeting the focal Tc-MEP alerts, shortly following surgical procedures with postoperative motor deficit in the correspondent muscles. **Results:** 1320 patients with spinal deformity were analyzed. From 2010 to 2016, both the pediatric and adult spinal deformity cases (1009 patients) were included (1st survey). From 2017 to 2020, only adult spinal deformity cases (311 patients) were included (2nd survey). In 1st survey, alerts occurred at derotation in 21 (36.8%) cases, pedicle screw insertion in seven (12.3%) cases, spinal shortening/3-column osteotomy (3CO) in six (10.5%) cases, and were unrelated to surgery in six (10.5%) cases. Most of the interventions by the surgeon consisted of revised procedures such as correction release, pedicle screw replacement, or additional foraminotomy/laminectomy for iatrogenic foraminal stenosis. These interventions were highly effective, and 50%–77.8% of cases with alerts were rescued. However, interventions after 3CO with root sacrifice were ineffective in all three cases. Totally, postoperative motor palsy was observed in 2.1% (22/1009) and included both the cord and nerve root injuries. Sensitivity and specificity were 100% and 89.1%, respectively (1st survey). In 2nd survey, Tc-MEP results revealed 47 cases (15.1%) of alerts, including 25 alerts after 10 deformity corrections, six three-column osteotomies (3COs), four interbody fusions, three pedicle screw placements or two decompressions, and 22 alerts regardless of surgical maneuvers. Postoperatively, 14 patients (4.5%) had neurological deterioration considered to be all nerve root injuries, 11 true positives and three false negatives. 2 false negative cases did not reach a 70% loss of baseline (46% and 65% loss of baseline) and one was not monitored at target muscles. Sensitivity and specificity were 78.6% and 87.8%, respectively (2nd survey). **Conclusion:** Although spinal cord injury in deformity surgery was mostly predictable using multichannel Tc-MEPs, the amplitude reduction warning criteria had the possibility of false positives or false negative for nerve root injury. Therefore, further studies using ideal warning threshold, help of other modalities and a more detailed evoked muscle selection are proposed to solve this problem.

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A347: Predictive factors for mechanical complication in the treatment of adult spinal deformity with a minimum FU of 5 years: a machine learning approach

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Introduction: Adult spinal deformity (ASD) is a heterogeneous spectrum of abnormalities that affect both coronal and sagittal plane of the spine in adult patients. The aim of our study is to evaluate the predictive effect of some morphological and surgical parameters on mechanical and junctional failure in the surgical treatment of ASD with a minimum FU of 5 years and to evaluate. **Material and Methods:** Patients and Design: Retrospective review of a consecutive single-center registry; patients that underwent correction of ASD from January 2008 to October 2016. Inclusion Criteria: Patients > 18 y/o; minimum of 4 levels of Posterior Instrumented fusion; minimum FU of 5 years; no previous spinal surgical procedures; complete clinical and radiological data. Exclusion criteria: Patient with neuromuscular or rheumatic disease or active tumor or infections. Variable analyzed: Demographic data; clinical data were collected preoperatively and at the last available FU; spinopelvic parameters [Pelvic Incidence (PI), Pelvic Tilt (PT), Sacral Slope (SS), Lumbar Lordosis (LL), L4-S1 Lordosis (LL4-S1), Thoracic Kyphosis (TK), Global Tilt (GT), C7 sagittal vertical axis (SVA), odontoid to hip axis center angle (ODHA)] were measured preoperatively and at each follow-up; predictive variables: restoration of Roussouly type according to pelvis and spinal shape and GAP score was measured post-operatively, each subsection of GAP score and Roussouly was assessed, Schwab's criteria were collected postoperatively. Data on mechanical complications (junctional failure and hardware failure) and revision surgery were collected. **Results:** 212 patients were definitively enrolled, 32 males and 180 females, with a mean age of 64 y/o (SD 16) at the time of surgery. The average of FU was 8.3 years (SD 1,7). Mechanical complications were descripted in 40.5% (86/212), of which the 96.5% (83/86) had needed surgery. We had junctional failure in 20.3% (43/212) and hardware failure in 20.3% (43/212). Roussouly restoration seems to be correlated with the occurrence of mechanical failure [chi-square = 5.06, p = 0.024 & Log Rank (Mantel-Cox) = 4.36, p = 0.037]. AUC is 0.713 (IC 95%: 0.62-0.8) in the analysis of GAP score for junctional failure and the value that maximize the Youden Index is GAP score = 4.5, so we used this cut-off in order to create the Kaplan-Meyer curves and we obtained a Log Rank (Mantel-Cox) = 22.65, p = 0.000. We obtained a "scale effect" dividing our cohort in GAP score 0-2,

GAP score 3-6, GAP score 7-12. No correlation was found for the other variables. The machine learning approach shows the GAP score is the most predictive variable for mechanical complications, and for the subsection of GAP and Roussouly Type the best predictors are Age, Lordosis Distribution Index (LDI) and Relative Spinopelvic Alignment (RSA). **Conclusion:** Roussouly type restoration and GAP score are predictive variable for mechanical complication. The need to obtain a proper alignment in terms of global and segmental, together with the restoration of the original Roussouly Type are mandatory with the aim to reduce the risk of mechanical failure.

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A348: Interdisciplinary preoperative optimization conference mitigates the risk of post-operative complications in adult spinal deformity surgery

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Introduction: Surgery for adult spinal deformity (ASD) is associated with high rates of medical and surgical complications. Our institution developed a scoring system to stratify pre-operative risk and to generate a score used to select cases for presentation to a preoperative optimization conference (POC) whose members included medical specialists, anesthesiologists, surgeons, and associated personnel. This "POC score" was used to assess planned procedures and to direct medical optimization in an effort to decrease risks of postoperative complications. **Material and Methods:** POC scores ranging from 0 to 40 were determined based on chart review. All patients with scores > 10 during a 1-year period from June 2021 to June 2022 were included. Patients with scores < 10 were assessed to be low risk and not included in the study or discussed at POC. A chart review of demographics and medical and surgical complications was collected and analyzed using SAS with significance set at $p < 0.05$. **Results:** Of the 273 patients identified with scores > 10, 85 were presented at POC. The average score for patients included in the study but not presented at POC was 11.1, as compared with a score of 14.7 for those who were presented ($p < 0.001$). Surgery was cancelled for 13% (11 high risk cases) of patients presented and additional medical optimization was suggested in 51% (43) of patients. Overall, previously unplanned suggestions were recommended for 91% of presented patients (ex: stress dose steroids, preoperative respiratory therapy, and measures to prevent ocular injury in a Sjogren's patient). The complication rate for patients with POC scores of 10-11 was 2-4.5% while the complication rate for patients with scores > 12 was 40%-100% ($p < 0.001$). For patients with scores >12 the complication rate was 43% (POC 13.7, n = 75) for those who had been presented as compared to 67% for those who had had not been presented (POC 13.6 n = 60) ($p < 0.005$). **Conclusion:** This study confirms that the described scoring system and interdisciplinary POC (preoperative optimization conference) can stratify preoperative risk for patients undergoing ASD surgery. The data validated a score of 12 to be a threshold above which complication rates rose significantly. The value of presentation at POC was confirmed as post-operative complications were significantly lower for patients who had been presented. Calculating POC scores and engaging in discussion at interdisciplinary conference mitigates the risks of complications after ASD surgery.

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A349: Correction of severe kyphotic deformities by doing pre operative distraction using modified halo pelvic distraction assembly

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Introduction: Managing severe kyphotic deformities is always challenging despite the fast-developing modern techniques & instrumentation. Chances of failure and complications increase when the magnitude of deformity increases. These difficult curves require prolonged surgeries with complex osteotomies and are usually accompanied by tissue releases creating a likelihood of problems and complications. Pulmonary complications are most reported followed by implant related complications, infection, neurological complications and pseudoarthrosis. Methods like pre-operative halo-femoral, halo-tibial and halo-gravity traction have been seen to provide significant corrective forces but compliance is a big issue. Keeping in view the halo-pelvic distraction as an effective and affordable means of treatment for severe kyphoscoliosis, halo-pelvic apparatus has been modified using standard Ilizarov set. The constructed assembly was used for severe curves before definitive surgeries to reduce complications. **Material and Methods:** Kyphotic patients having sagittal Cobb angle > 70 were applied modified halopelvic Ilizarov distraction assembly pre-operatively. Pre operatively complete clinical assessment was done, Pulmonary function tests were also taken and scoliosis series x rays were assessed for coronal & sagittal Cobb angle and other spinopelvic parameters were also taken. Modified assembly consisted of a pelvic component and halo ring, and distraction was given at the rate of 2-3 mm/day for 6-12 weeks. Cobb angles and spinopelvic parameters were compared before and after distraction and after surgery.

Results: Seventeen patients (age range 7-40 years 11 M/6 F) were included in the study having coronal cobb angle ranging from 77 degrees to 156 degrees (mean 121). 06 patients had post tuberculous deformity, 09 patients had a congenital deformity and 01 patient had kyphotic deformity because of a fracture in early childhood. Correction obtained through modified halo pelvic distraction assembly was 46%. After definitive surgery an additional 26% correction was further achieved. There was significant improvement in height of the patient. Sagittal balance also significantly improved. Conclusion: The results of this study reveal that our modified halo-pelvic Ilizarov distraction assembly is a device with unlimited potential, which can achieve good correction in severe kyphotic spinal deformities of various etiologies without significant risk to neurology, fewer complications and good patient compliance.

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A350: High prevalence of SI joint pain in patients undergoing thoracolumbar fusion with pelvic fixation for adult spine deformity: initial results from a multicenter randomized trial

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Introduction: The optimal configuration for spinopelvic fixation during multilevel spine fusion surgery for adult spine deformity remains unclear. Sacroiliac (SI) joint pain, S2-Alar-Iliac (S2AI) screw loosening and implant breakage could be related to continued motion of the SI joint with use of only a single point of fixation across the SI joint. The purpose was to Determine the clinical benefit of simultaneous placement of triangular titanium implants (TTI) adjacent to S2AI screws during multilevel spine fusion surgery with pelvic fixation. TTI are designed to fuse the SI joint. Material and Methods: This was a prospective, international, multicenter randomized controlled trial with follow up out to 2 years. 222 patients with adult spine deformity scheduled for multilevel (4 or more levels) spine fusion surgery with pelvic fixation. Perioperative safety and incidence of pelvic fixation failures, and SI joint pain during long-term follow-up. Enrolled subjects underwent detailed clinical and radiographic assessment preoperatively, including physical examination and diagnostic SI joint blocks, when indicated, for suspected SI joint pain. Subjects were randomized 1:1 to receive either S2AI screws alone or S2AI + TTI. Baseline spinal deformity measures were read by an independent radiologist. Site-reported perioperative adverse events were reviewed by a clinical events committee. Quality of life questionnaires and other clinical outcomes are in process. Results: 113 participants were assigned to S2AI and 109 to S2AI + TTI. 35/222 (16%) of all subjects had a history of SI joint pain or were diagnosed with SI joint pain during preoperative workup. All subjects had perioperative safety assessments; 3-month follow-up was available in all but 4 subjects. TTI placement was successful in 106 of 109 (98%) subjects assigned to TTI. In 2 cases, TTI could not be placed due to anatomic considerations. Three TTI ventral iliac breaches were observed, which were managed non-surgically. One TTI subject had a transverse sacral fracture and one subject had TTI malposition. Conclusion: SI joint pain is common in patients with adult spinal deformity. Concomitant placement of TTI parallel to S2AI screws during multilevel spine fusion surgery is feasible and safe. Further follow-up will help to determine the clinical value of this approach to augment pelvic fixation.

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A351: Correlation between the upper instrumented vertebrae screw angles and proximal junctional complications in patients with de novo degenerative lumbar scoliosis

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Introduction: Despite numerous potential factors affecting proximal junctional kyphosis/failure (PJK/F) have been identified, many of these factors cannot be directly modified. The pedicle screws used in the upper instrumented vertebra (UIV) serve as a critical element of proximal fixation, and surgeons have the ability to manipulate the direction of pedicle screw placement. Hence, the purpose of this study was to investigate the impact of UIV screw angles on proximal junctional complications in patients with de novo degenerative lumbar scoliosis (DNDLS). **Material and Methods:** One hundred and twenty patients with DNDLS who underwent posterior long-segment instrumentation and fusion were included. Patients were divided into PJK/F group and non-PJK/F group. Radiographic parameters were measured, including UIV screw angle (the angle between the axis of UIV screw and the superior endplate of the UIV), UIV slope, UIV screw slope, fixed segmental angle (FSA) and spinopelvic parameters. Clinical and radiographic data were compared between the two groups. Multivariate logistic regression model was used to analyze the independent risk factors of PJK/F. ROC curve was used to determine the threshold value to predict PJK/F. **Results:** Thirty-six patients (30.0%) developed PJK or PJF during follow-up. Patients in the PJK/F group had a larger postoperative UIV screw angle, a larger postoperative UIV screw slope, and a larger postoperative PJA. A significant increase was observed in UIV screw angle from immediately postoperative assessment to the final follow-up in two groups ($p < 0.001$). Multivariate logistic analysis indicated that a larger positive postoperative UIV screw angle was an independent risk factor for PJK/F (OR = 1.546, 95%CI = 1.274-1.877). ROC curve analysis indicated UIV screw angle $\geq 1°$ is more likely to develop PJK/F. Compared with Group A (UIV screw angle < 1°), Group B (UIV screw angle $\geq 1°$) had a higher incidence of PJK, PJF, UIV screw loosening, and worse functional scores at the final follow-up. **Conclusion:** Caudally-directed UIV pedicle screws may generate a smoother transfer of mechanical forces between the UIV and the unfused segment. Avoiding insertion of cranially-directed UIV pedicle screws may help to prevent the development of PJK and PJF in patients with DNDLS.

OP40: Degenerative Cervical Myelopathy: Outcomes

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A352: Relationship among peripheral proprioception, spinal cord compression and functional performance in degenerative cervical myelopathy

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Introduction: Proprioceptive deficits may lead to functional disturbances in Degenerative Cervical Myelopathy (DCM). However, the relationships between proprioception with spinal cord compression and functional ability remain unclear. **Methods:** Participants with DCM aged forty-five or above were included. Spinal and peripheral proprioception were measured by the reposition error (RE) using a three-dimensional motion capture system. The degree of cord compression was defined as the cross-sectional area (CSA) at the most stenotic level from MRI, whereas the functional performance was assessed by the mJOA score. Pearson's correlation coefficient was used to examine the relationships among RE, CSA, and mJOA. **Results:** The study included 88 cases with DCM (gender 54 male 34 female; mean age: 63.8 ± 9.5; BMI 24.8 ± 4.2), they presented with mean CSA 42.4 ± 17.4 mm^2 and mJOA at 12.9 ± 2.7. The spinal RE was found to be smaller than the peripheral RE with the neck RE at $3.8° \pm 2.9°$, elbow RE at $6.0° \pm 5.3°$, wrist RE at $7.3° \pm 4.5°$, knee RE at $4.5 \pm 3.5°$, and ankle RE at $6.8° \pm 3.9°$. In the Pearson's correlation analysis, the following pairs were found to be significantly associated, including wrist RE and CSA (r = -0.715, p < 0.001), wrist RE and mJOA (r = -0.374, p < 0.001), knee RE and mJOA (r = -0.398, p < 0.001), ankle RE and CSA (r = -0.709, p < 0.001), ankle RE and mJOA (r = -0.380, p < 0.001) and CSA and mJOA (r = 0.240, p = 0.013). **Conclusion:** This study was the first to demonstrate the interplay among proprioception, cord compression, and functional performance in DCM. It may support that the peripheral proprioceptive deficits are the mechanism of functional disturbances in DCM.

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A353: Development and validation of Degenerative Cervical Myelopathy Subjective and Objective Score (DCM-SOS) to augment the modified Japanese Orthopedic Association (mJOA) Score

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Introduction: Degenerative Cervical Myelopathy (DCM) is characterized by the compression of the cervical spinal cord, resulting in neurological dysfunction. Clinical management of DCM is informed by clinical practice guidelines (CPGs). Classification of DCM severity relies solely on the modified Japanese Orthopedic Association (mJOA) score, which is a simplistic and subjective, assessing four domains using ordinal scales with vague terms like "mild" or "severe." In this study, we sought to develop a novel outcome measure, the DCM Subjective and Objective Score (DCM-SOS) that combines subjective questions with a brief objective scored neurological examination. **Material and Methods:** A prospective cohort study was conducted with

extensive data collection including demographics, medical history, symptom history, mJOA, NDI, QuickDASH, EQ-5D-5L, EQ-VAS, power testing in 22 myotomes, JAMAR grip dynamometer,1-2,1-5, and 2–3-digit pinch dynamometer, sensory testing, GRASSP-Myelopathy, and quantitative gait and balance testing using an electronic Protokinetics Zeno Walkway (self-paced, fast-paced, tandem gait, tandem stance, Romberg, standing on one foot). P-values and correlation with mJOA score were calculated for all outcome variables. Subjective questions were developed based on differences between DCM and healthy subjects, with the intention to include those used in the mJOA but with more explicit scoring of levels. Objective physical measurements were selected for inclusion in the DCM-SOS based on the following criteria: significant differences between DCM and healthy controls, correlation with mJOA score, no/minimal correlation with age (in healthy subjects), and no requirement for specialized equipment. **Results:** The content of the DCM-SOS was based on data from 130 patients with DCM and 82 healthy subjects. Subjective ordinal questions were developed for upper extremity coordination (p-value 1.25E-13), upper extremity strength (4.59E-15), gait (2.99E-18), upper extremity sensation (1.01E-16), urinary/bowel/sexual function (1.52E-09), and overall pain (2.99E-15). Among 281, objective measurements that were considered for inclusion, the following showed strong differences between DCM and healthy subjects and were selected based on the criteria above: manual power testing of 1st dorsal interosseous (7.26E-14), thumb opposition (3.20E-12), finger extension (3.00E-08), elbow flexion (2.25E-04), and elbow extension (6.53E-06); sensory testing upper extremity light touch (1.73E-25, correlation mJOA hand sensation 0.33); tandem gait score (4.0E-8, correlation gait subsection of mJOA 0.4); and reflex testing for Hoffman, Tromner, or Babinski (1.17E-19). A final version of the DCM-SOS has been developed with 6 subjective domains (/60 points) and 4 objective domains (/40 points). **Conclusion:** The DCM-SOS is a data-driven outcome measure that can be performed in 5-10 minutes without specialized equipment and incorporates focused subjective and objective data regarding neurological function. Confirmation through the Delphi process is currently underway with final validation to be performed in the upcoming months, with the hope that this tool may help improve clinical management, inform future CPGs, and enhance clinical trials for patients with DCM.

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A354: Anterior cervical discectomy and fusion versus laminectoy and posterior cervical fusion across 3 interspaces using the QOD CSM module: are there differences in outcomes?

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Introduction: Prior studies comparing anterior versus posterior approaches for multilevel cervical spondylotic myelopathy (CSM) are limited by the heterogeneity of surgical technique. This study specifically focuses on fusions across three interspaces in the cervical spine. **Material and Methods:** The prospective QOD CSM cohort was queried for fusions across three interspaces. Surgeries crossing the cervicothoracic junction were excluded. The cohort was divided into anterior cervical discectomy and fusion (ACDF) and posterior laminectomy and fusion (PCF). Rates of reaching minimum clinically important difference (MCID) for patient-reported outcomes (PROs) were compared at 24 months after anterior versus posterior approaches. Multivariable analyses adjusted for potential confounders elucidated in the univariable analysis. **Results:** Overall, 199 patients met inclusion criteria - 123 ACDF (61.8%) and 76 PCF (38.2%). Twenty-four-month follow-up rates were similar (ACDF: 90.2% vs. PCF: 92.1%, p = 0.67). Preoperatively, ACDF were younger (60.8 ± 10.2 vs. 65.0 ± 10.3 years, p < 0.01), privately insured (56.1% vs. 36.8%, p = 0.02), actively employed at the time of surgery (39.8% vs. 22.8%, p = 0.04), and independently ambulatory (14.6% vs. 31.6%, p < 0.01). The cohorts had similar baseline mJOA, NDI, NRS Arm Pain, NRS Neck Pain, and EQ-5D (p > 0.05). Length of stay (1.6 vs. 3.9 days, p < 0.01) and non-routine discharge (7.3% vs. 22.8%, p < 0.01) were lower for ACDF. Both groups demonstrated improvements in all outcomes at 24 months, compared to baseline (p < 0.05). In multivariable analyses, ACDF was associated with the greatest 24-month NASS Satisfaction (NASS 1 score)

(69.4% vs. 53.7%, OR = 2.44 95%CI [1.17-5.09], adjusted-p = 0.02). Otherwise, the cohorts shared similar 24-month outcomes for reaching an MCID in mJOA, NDI, NRS Arm Pain, NRS Neck Pain, and EQ-5D (adjusted-p > 0.05). There were no differences in 3-month readmission (ACDF: 4.1% vs. PCF: 3.9%, p = 0.97) and 24-month reoperation rate (ACDF: 13.5% vs. PCF: 18.6%, p = 0.36). **Conclusion:** In a cohort limited to 3-level surgeries, ACDF was associated with shorter lengths of hospitalization and higher routine discharge rates. However, the two procedures yielded comparably significant improvements in functional status (mJOA score), neck pain, arm pain, neck pain-related disability, and quality of life at 3, 12, and 24 months. Notably, the ACDF cohort had a significantly higher odds of maximum satisfaction (NASS 1). Given comparable outcomes except for maximum satisfaction, patients should be counseled on the complication profile specific to each approach to aid in surgical decision-making.

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A355: Urinary control in cervical myelopathy: does it improve post-surgery? A quality outcomes database study

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Background: Cervical spondylotic myelopathy (CSM) can be associated with urinary dysfunction leading to inability or marked difficulty with micturition. This study aimed to evaluate the urinary dysfunction, long-term prognosis, and recovery in patients with CSM, following surgical intervention. **Methods:** The CSM cases of the Quality Outcomes Database Spine Core Study Group were analyzed. Urinary control was assessed using the modified Japanese Orthopaedic Association (mJOA) "Urinary Function Subscore." Improvement was defined as a minimum of one-point improvement at 2-year follow-up in the mJOA urinary function subscore. Univariate and multivariate analyses were conducted as appropriate. **Results:** Out of 1,141 patients, 772 patients were identified with a minimum 2-year follow-up out of which 249 (32.3%) reported baseline urinary dysfunction. Of those, 193 (77.5%) patients had improvement in urinary function postoperatively. Of those that improved their function, a larger proportion were female (54.9% vs. 45.8%, p = 0.03). Apart from gender, demographic characteristics of patients who experienced urinary function improvement versus those who did not were similar. Comorbidities that were associated with urinary function improvement at 2-year follow-up were coronary artery disease (16.6% vs. 8.5%), anxiety (29.5% vs. 18%), depression (31.1% vs. 20%), and COPD (10.9% vs. 5.2%). Patients who experienced urinary function improvement had lower overall baseline mJOA scores (10.1 vs. 12.8, p < 0.01). There was no significant difference in total mJOA scores at 2-year follow-up between the improved and not-improved urinary function cohorts. **Conclusion:** Among patients with CSM, with known preoperative urinary dysfunction undergoing surgical management, 77.5% had improved urine control by two years postoperatively.
Keywords: cervical spondylotic myelopathy; urinary function; patient-reported outcome measures; modified Japanese Orthopaedic Association

1010
A356: Does posterior cord compression by ligaments flavum adversely affect clinical outcome of anterior cervical discectomy and fusion?

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Introduction: Anterior cervical discectomy and fusion (ACDF) achieves cord decompression by removing anterior compressive lesions including disc, bone spurs and ossification of posterior longitudinal ligament. However, combined posterior compressive lesions such as ligamentum flavum buckling or hypertrophy cannot be assessed with anterior approach. While ACDF generally results in favorable outcomes for the treatment of cervical myelopathy, it has not been reported whether posterior cord compression by ligamentum flavum could adversely affect clinical outcomes of ACDF. If remaining posterior compression hinders clinical improvement after ACDF, combined posterior approach or single stage posterior operation should be considered. Therefore, the present study was conducted to demonstrate clinical implications of posterior cord compression by ligamentum flavum in ACDF. **Material and Methods:** A total of 195 consecutive patients who underwent ACDF and were followed-up for > 2 years were retrospectively reviewed. Ligamentum flavum cord compression (LFC) was graded in 0-2 scale as demonstrated in Figure 1. Patients with LFC grade 2 were classified as LFC group, while patients with LFC grade 0-1 were classified as no-LFC group. Patient characteristics, cervical sagittal parameters, neck pain visual analogue scale (VAS), arm pain VAS, and Japanese Orthopedic Association (JOA) score were assessed. **Results:** One-hundred and sixty-seven patients (85.6%) were included in the No-LFC group, while

remaining 28 patients (14.4%) were included in the LFC group. Among patients in the LFC group, 14 patients (50.0%) achieved clinical improvement, while other 14 patients (50.0%) did not. Patient baseline characteristics and sagittal parameter did not demonstrate significant difference between the two groups. Spondylolisthesis was significantly more frequently detected in the LFC group (p = 0.001). JOA score significantly improved in the no-LFC group after the operation (p < 0.001) while it did not demonstrate improvement in the LFC group (p = 0.642). JOA score at postoperative 3 months (p = 0.037) and 2 years (p = 0.001) were significantly higher in the no-LFC group. Furthermore, JOA recovery rate at postoperative 2 years was significantly higher in the no-LFC group (p = 0.042). Multiple regression analysis showed that LFC was significantly associated with JOA recovery rate at postoperative 2 years (p = 0.045) while spondylolisthesis did not demonstrate significant results (p = 0.482). **Conclusion:** Previous case reports have suggested that aggravation of ligamentum flavum buckling after ACDF occasionally requires early posterior revision after ACDF. However, clinical impact of cord compression by ligamentum flavum has not been thoroughly studied. The present study showed that posterior cord compression by ligamentum flavum adversely affects clinical outcome of ACDF. Furthermore, multiple regression analysis confirmed that LFC is associated with JOA recovery rate. While ACDF effectively removes anterior compressive pathologies, amount of canal widening that could be achieved is limited when combined posterior compression exists. Additional posterior decompression with laminoplasty or laminectomy might result in better results which warrants further clarification. In conclusion, when preoperative MRI shows indentation of spinal cord by ligamentum flavum hypertrophy or buckling, anterior decompression by ACDF only may not bring sufficient decompression and clinical improvement. Therefore, alternative surgical strategies such as anterior-posterior combined approach or posterior approach should be considered.

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A357: Unplanned readmissions following ambulatory spine surgery: assessing common reasons and risk factors

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Introduction: Although outpatient spine surgery is becoming increasingly popular in the USA, unplanned readmission following outpatient surgery remains a significant postoperative concern. The purpose of this study aimed to (1) describe the incidence and timing of 30-day unplanned readmission after ambulatory lumbar and cervical spine surgery (2) evaluate the common reasons for readmission, and (3) identify the independent preoperative risk factors for readmission in this population. **Material and Methods:** This is a retrospective cohort study. Patients who underwent ambulatory cervical or lumbar spine surgery between 2015 and 2020 identified in the National Surgical Quality Improvement Program (NSQIP) database. Our outcome measures for this study is hospital readmission within 30 postoperative days. Patients who underwent ambulatory cervical or lumbar spine surgery between 2015-2020 were identified using the National Surgical Quality Improvement Program (NSQIP) database. Reasons for and timing of unplanned readmissions were recorded. Multivariable Poisson regressions were employed to determine any independent predictors of readmission. **Results:** A total of 33,092 ambulatory cervical and 68,115 ambulatory lumbar spine surgery patients were identified. Incidences of 30-day readmission were 3.37% and 3.07% among cervical and lumbar patients, respectively. The most common surgical site-related reasons for readmission included uncontrolled pain, recurrence of disc herniation or major symptom, and postoperative hematoma/seroma. Common non-surgical site-related reasons included gastrointestinal, neurological, and cardiovascular complications. Risk factors for readmission among cervical patients included age $\geq$ 55, BMI $\geq$ 35, functional dependence, diabetes, smoking, COPD, and steroid use, whereas readmission following lumbar spine surgery was associated with age $\geq$ 65, female sex, BMI $\geq$ 35, functional dependence, ASA $\geq$ 3, diabetes, smoking, COPD, and hypertension (p < 0.05 for all). **Conclusion:** This study highlights the common reasons and risk factors for unplanned readmission following ambulatory spine surgery. Consideration of these factors may be critical to ensuring appropriate patient selection for ambulatory spine surgery.

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A358: "Knowledge is power": a core information set for degenerative cervical myelopathy

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Introduction: Health education is pivotal in the management of chronic illness where patient involvement determines care quality and long-term outcomes. Its merits span a broad spectrum as illustrated by a growing body of evidence supporting its benefits for a range of biomedical and psychosocial outcomes. Degenerative cervical myelopathy (DCM) is a

globally prevalent condition caused by osteoarthritic changes in the neck. Its variable nature including chronicity, heterogeneous clinical presentation, complex management, and variable disease course, engenders an imperative for a patient-centric approach that accounts for each individual's circumstances, needs and priorities. Central to effective DCM management is the concept of shared decision making between clinicians and patients. This approach necessitates a collaborative effort between well-informed patients and their clinicians to achieve the best possible outcomes. Despite the widespread impact of the condition, the educational landscape for DCM patients is currently fragmented, with a predominant focus on professional-facing resources and inconsistent information dissemination in clinical encounters. The DCM Core Information Set (CIS) was developed as a targeted response to this challenge. It is a co-created checklist designed to streamline an educational conversation between patients and professionals at diagnosis, ensuring key information is shared. Each major topic comes with a set of baseline data, which clinicians tailor to align with individual patient circumstances. Its primary aim is to equip patients with knowledge necessary to engage in onward shared decision-making and effective self-management. **Material and Methods:** The Delphi technique is a systematic mixed-methods approach which uses a longitudinal survey process to incrementally foster a convergence of opinions among a group of experts. This study used a three-round modified e-Delphi structure to achieve consensus on priority items for the CIS: (1) A scoping literature review, clinicians survey and patient interviews were undertaken to identify information of importance to patients at diagnosis; (2) subsequent Delphi surveys allowed patients and clinicians to assess the significance of each item using a four-point Likert scale and open comments; (3) two international consensus meetings were convened to endorse the final CIS. Consensus was predefined as ≥ 75% of participants indicating 'agree' or 'strongly agree' for item inclusion. **Results:** Data sources identified 95 candidate pieces of information that informed a 31-item questionnaire. A panel of 57 experts in the Delphi reviewed the information items and produced consensus on retaining 26 items after the first round and second round. Content analysis of open text responses from the panelists suggested a number of areas of debate that were explicitly considered by the consensus group. Analysis led to seven information items being retained after the online consensus meetings. The final CIS included seven concepts including 1) nomenclature and disease mechanisms, 2) history, physical examination, and symptomatology, 3) magnetic resonance imaging findings, 4) management strategies and clinical decision making, 5) clinical course, 6) severity, and 7) safety netting and impact on quality of life. **Conclusion:** This study has established a CIS for professionals to discuss with patients at diagnosis.

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A359: Correlation of intraoperative neuromonitoring (IONM) signal changes with clinical outcomes in patients with compressive cervical myelopathy: a prospective study

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Introduction: Compressive myelopathy is a result of chronic segmental compression of the spinal cord due to various factors like disc herniation, spondylosis or degenerative changes, ossification of ligamentum flavum, and ossification of the posterior longitudinal ligament. Surgery in the form of decompression with or without fusion is recommended for these patients. Intraoperative neuromonitoring is a mandatory tool to evaluate spinal cord integrity during surgery. Very few studies have shown the correlation between neurophysiological signal changes during cervical spinal cord decompression for cervical compressive myelopathy and postoperative functional outcomes. Therefore, this study's purpose was to prospectively evaluate the correlation between the variations in the IONM signals and postoperative neurological recovery in patients with cervical compressive myelopathy undergoing surgery. **Materials and Methods:** The Prospective study included 58 patients with cervical compressive myelopathy, who underwent decompression and fusion surgery with IONM. The baseline IONM data was compared to the final one after wound closure and additional intraoperative changes were noted. Patients were divided into three groups, group 1 - patients did not show any variations (n = 45), group 2 - patients who have shown improvement (n = 5), and group 3 - patients who had shown deterioration (n = 8) in intraoperative neural monitoring signals compared to baseline. The study was conducted over a period of 12 months from January 2022 to December 2022 with a minimum follow-up of 6 months. Clinical evaluation of these patients pre-operatively and postoperatively at 1 month, and 6 months were done using modified Japanese Orthopedic Association and Nurick grading. Statistical Analysis of Quantitative data was presented as mean, standard deviation, and qualitative data was presented as frequency (percentage). Paired t-tests were used for the comparison of preoperative and postoperative functional scores. One-way ANOVA tests with Bonferroni post-hoc analyses were performed for comparison between the three groups. **Results:** Preoperatively, there was no statistically significant difference between the three groups in mJOA score and Nurick grade. The mJOA score recovery rate at 6 months was 30.74% in group 1 and 37.34% in group 2 (p < 0.001). In group 3 the improvement

was 11.71% and was not statistically significant. Nurick grading showed significant improvement at 6 months compared to preoperative in group 1 (2.5 at 6 months vs. 3.4 preoperatively, p < 0.001) and group 2 (2.6 at 6 months vs. 3.4 preoperatively, p = 0.01). However, no significant improvement was found in group 3 (2.8 at 6 months vs. 3.4 preoperatively, p = 0.14). Complications occurred in 11 patients (24.44%). **Conclusion:** Patients, who had diminished IONM signals at the end of surgery for cervical myelopathy as compared to the baseline, did not have a significant improvement in their mJOA score and Nurick grading by 6 months postoperatively. In contrast, patients with no variation or improvement in IONM signals showed significant neurological recovery.

Keywords: cervical compressive myelopathy; intra-operative neuromonitoring; mJOA score; Nurick score

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A360: Clinical and radiographic outcomes of combined anterior and posterior approach compared with posterior-only approach for the management of complex multilevel cervical spondylotic myelopathy: better outcomes with minimal morbidity

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Introduction: Different alternative surgical strategies have been applied for the treatment of cervical spondylotic myelopathy (CSM). However there is no consensus for complex multilevel CSM with a ≥ 50% canal occupying ratio or focal kyphosis. The purpose of the study was to compare early complication, morbidity and mortality risks in patients with complex multilevel CSM undergoing combined anterior and posterior approach versus a posterior-only approach. **Material and Methods:** Adult patients with complex multilevel CSM at our hospital were enrolled between May 2012 and May 2020 retrospectively. 89 patients of the combined approach group were matched to 103 patients of posterior-only approach group. Patient demographics, Nurick score, surgical characteristics, complications, hospital course, early outcome and 90-day mortality were collected. Comorbidities were classified using the age-adjusted Charlson Comorbidity Index (AACCI). Radiographic measurements were collected included the C2-C7 sagittal Cobb angle, C2-7 sagittal vertical axis and T1 slope pre- and postoperatively. **Results:** All patients had an improvement of neurological function without serious complications in both groups. The combined approach group had a higher operation time and blood loss compared to the posterior-only approach group (p < 0.05). However, there were no difference in complications, hospital course, early outcome and 90-day mortality between the two group (p > 0.05). Moreover, JOA, NDI score and SF-36 score had a significant difference statistically between the two group (p < 0.05), and there were significant difference in C2-C7 sagittal Cobb angle between the two group (p < 0.05). **Conclusion:** Combined anterior and posterior approach may provide more extensive decompression of the spinal cord and may provide better Clinical and Radiographic Outcomes. Concerns regarding operation associated morbidity should not strongly influence whether Combined anterior and posterior approach is performed.