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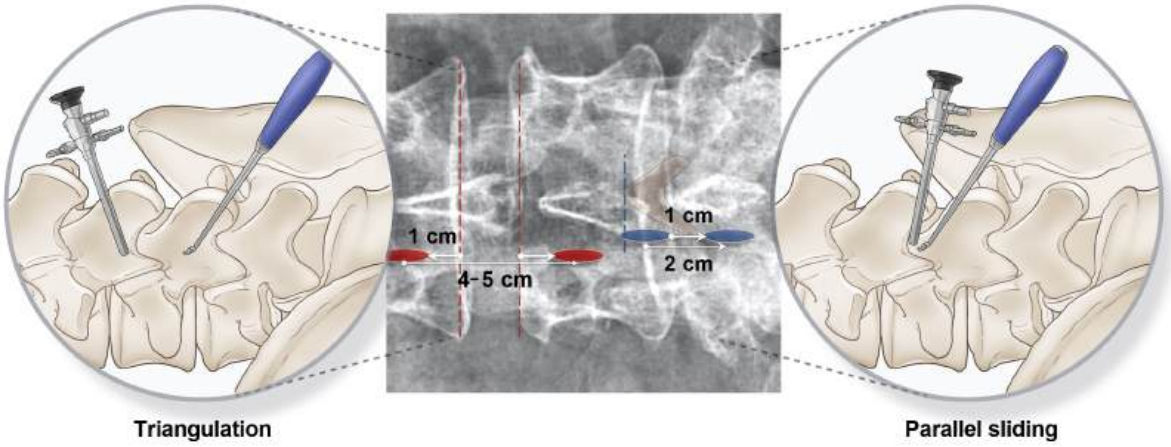

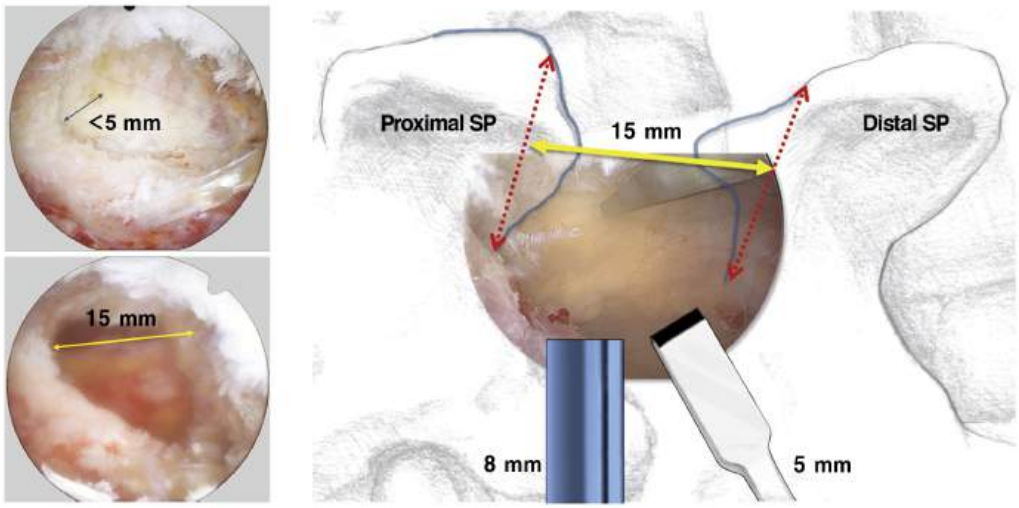

Treatment Concept and Technical Considerations of Biportal Endoscopic Spine Surgery for Lumbar Spinal Stenosis

Dae-Jung Choi et al. - Asian Spine J 2024;18(2):301-323

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Aims & Scope

Asian Spine Journal (Asian Spine J), the official journal of the Asia Pacific Spine Society (APSS), Middle East Spine Society (MESS), Association of Spine Surgeons of India (ASSI), Taiwan Spine Society (TWSS), Chinese Spine Society of Medicine Education (CSSME), and Korean Society of Spine Surgery (KSSS), is an international peer-reviewed journal which publishes articles related to basic and clinical researches of all spine fields bimonthly in end of February, April, June, August, October, and December. *Asian Spine Journal* was founded in 2007.

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Abstracts for Medal Papers
Basic Science Papers

BS026

Impaired glycine neurotransmission causes adolescent idiopathic scoliosis: a novel variant and functional pathway

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Background: Adolescent idiopathic scoliosis (AIS) is the most common form of spinal deformity affecting millions of adolescents worldwide, but it lacks a defined theory of etiopathogenesis. Based on a thorough clinical investigation, genetic analysis, and functional study, we identify the origin of some AIS as neuropathic. Variants of solute carrier family 6 member 9 (*SLC6A9*), which encodes glycine transporter 1 (GLYT1), reduce glycine transportation, impaired glycine neurotransmission, and central pattern generators (CPGs) dysfunction leading to spinal deformity.

Methods: Five multi-generation AIS families and 843 sporadic cases were identified, and along with 3,219 controls, underwent genetic analyses including linkage analysis, genome sequencing, and targeted sequencing to identify pathogenic variants. Paraspinal muscle surface electromyography (EMG) tests were performed on familial cases. Additionally, 858 patients from two additional AIS cohorts in China and the United States were used for validation. After identifying disease-associated variants, cellular mechanisms were studied and zebrafish models were generated to understand the underlying etiology of the spinal curvature and to test candidate treatments.

Results: Disease-causing and predisposing variants of *SLC6A9* in multiple families and many sporadic cases were identified via genetic analyses. *SLC6A9* variants affected subcellular localization and stability of GLYT1, leading to reduced glycine uptake activity in cells. *SLC6A9* mutant zebrafish exhibited discoordination of spinal neural activities and pronounced spinal curvatures which resembles the human patients carrying the *SLC6A9* pathogenic variant. Administration of a glycine receptor antagonist or a clinically used glycine neutralizer sodium benzoate partially rescued the phenotype (scoliosis phenotype dropped from 70.2% to 30.3%). Aberrant EMG bursts were found in *SLC6A9* pathogenic variants suggesting an impairment of paraspinal muscle balance control.

Conclusions: Genetic variants affecting glycine transportation are strong causal risk factors of AIS. This is a novel genetic variant and confirmed functional pathway that leads to AIS pathogenesis. Results from patients and animal models suggest a neuropathic origin for "idiopathic" scoliosis, involving the dysfunction of CPGs, potentially a common cause of AIS. Our work suggests further avenues for early diagnosis and prevention of AIS. A true breakthrough for work in AIS etiology.

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BS064

Biomechanical comparison of different instrumentations for severe thoracolumbar pott's deformity after posterior vertebral column resection: a finite element study

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Background: The purpose of this study was to assess the differences in implants stress and vertebral displacement between three multi-rod models utilized in posterior vertebral column resection (PVCR) for severe thoracolumbar Pott's deformity correction.
Methods: A patient with severe T9–T11 Potts kyphosis was selected, and the spinal three-dimensional stereo model was created. PVCR was simulated using modeling software, and pedicles, rods, and titanium mesh cage were inserted into model according to three different instrumentation designs. Model A: two accessory short rods spanning osteotomy site were attached to conventional dual rods construct by dominos. Model B: single level screw-rod fixation was applied to the two vertebrae adjacent to the osteotomy site, and the proximal two vertebrae and distal two vertebrae were instrumented by using long dual rods. Model C: the screws in proximal three vertebrae and distal three vertebrae were staggered, and bilateral two rods were accordingly engaged. A torque of 10N·m was applied to each model to simulate four working conditions including flexion, extension, lateral flexion, and rotation, respectively, and the implants stress and vertebral displacement of each model were recorded.
Results: Under the flexion condition, the maximum implants stresses of model A, B, and C were all located at the most cephalic screws, which were 92.0 MPa, 99.0 MPa, and 131.1 MPa, respectively. Under the extension condition, the maximum implants stresses of model A, B, and C were also all located in the most cephalic screws, which were 95.0 MPa, 101.0 MPa, and 131.6 MPa, respectively. Under the lateral flexion condition, the maximum implants stresses of model A, B, and C were all located at the cranial end of the rods, which were 125.9 MPa, 118.5 MPa, and 155.0 MPa, respectively. Under the rotating condition, the maximum implants stresses of model A, B, and C were all located at the most cephalic screw, which were 213.7 MPa, 199.0 MPa, and 214.0 MPa, respectively. Under the flexion condition, the maximum vertebral displacements of model A, B, and C were 2.4 mm, 2.5 mm, and 2.8 mm, respectively. Under the extension condition, the maximum vertebral displacements of model A, B, and C were 2.7 mm, 2.8 mm, and 3.1 mm, respectively. Under the lateral flexion condition, the maximum displacements of the vertebrae in model A, B, and C were 1.3 mm, 1.4 mm, and 2.3 mm, respectively. Under the rotating condition, the maximum displacements of the vertebrae of model A, B, and C were 1.6 mm, 2.4 mm, and 2.1 mm, respectively.
Conclusions: The largest stress of implants in PVCR is mainly located at the cephalic screws and the cranial end of rods, and the successful placement of cephalic screws should be paid more attention. The strategy of short rods connecting the conventional dual rods by dominos, or adding a short segmental instrumentation adjacent to the osteotomy site can reduce the implants stress and increase the fixation stability.

BS119

Can a simple smartphone be a cornerstone in school health screening program for detecting scoliosis in resource poor developing countries? revisiting the "scoliometer"

Aman Verma, Pankaj Kandwal, Saptarshi Barman

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Background: Scoliometer is an inclinometer that quantifies rib hump which indirectly measures the degree of scoliosis. It is now possible to use various apps which can methodically function same as a scoliometer. In our study, we revisit the reliability, validity of scoliometer; its correlation with various app based digital inclinometers and try to extrapolate the role of digital inclinometers in the overall diagnostic accuracy of scoliosis.
Methods: An observational study was conducted on patients with early onset scoliosis and adolescent idiopathic scoliosis. Two independent observers noted three scoliometer values separately. Cobb's angle, apical vertebral rotation (Nash-Moe grading and computed tomography) and Scoliosis Research Society-22 revised

(SRS-22r) questionnaire were also noted. The accuracy and reliability of app based digital inclinometers were also analyzed. All the values were compared statistically.

Results: The interobserver agreement for scoliometer instrument and app based digital inclinometers were found strong to substantial, respectively. A strong positive correlation exists between scoliometer and digital inclinometers from the same patients. Except for SRS-22r score which has a substantial negative correlation, all radiological parameters have a substantial to strong positive correlation. A mathematical formula was also derived between scoliometer values and Cobb's angle. Based on that, a suitable referral criterion of 7° of digital/manual scoliometer value to higher center was opined.

Conclusions: Scoliometer and app based digital inclinometers have a strong predictive power to measure the degree of deformity in scoliosis. If incorporated into latest School Heath Screening Programs, these instruments have the potential to decrease the overall burden of scoliosis in society.

BS128

Early prediction of curve progression to surgical threshold in adolescent idiopathic scoliosis with bone microarchitecture phenotyping: a step closer to precision medicine

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Background: Adolescent idiopathic scoliosis (AIS) is a complex three-dimensional (3D) deformity of the spine. Skeletal maturity, curve magnitude, and curve type are commonly used to guide clinical decisions for observation, bracing, or surgery. Active ongoing research for an effective prognostication model that can accurately predict curve progression, thus allowing timely management for groups with a high risk of curve progression, while avoiding unnecessary overtreatment in those with low risk is an important common goal. In multifactorial etiopathogenic AIS patients, bone quality has shown a potential to be a significant prognostic factor in curve progression. High-resolution-peripheral-quantitative-computed-tomography (HRpQCT) is now available for low radiation and 3D skeletal evaluation and can generate 11 quantitative bone quality parameters. However, to perform composite analysis on these complex parameters can be difficult and time-consuming. Previous studies were limited by investigating only bone mineral density without combined evaluation of different bone qualities, there is a need to search for a novel way to perform composite analysis of HRpQCT-generated bone parameters and explore their associations with curve progression in AIS patients. Our study therefore aims to (1) utilize unsupervised machine-learning technology to analyze and identify hidden bone phenotype clusters amongst HRpQCT-generated quantitative parameters, and (2) investigate the association of bone phenotype with curve progression and progression to the surgical threshold in a 6-year longitudinal cohort.

Methods: One hundred and one AIS girls (age, 12.26±0.87 years) were recruited and followed up longitudinally till skeletal maturity (age, 18.47±0.96 years). Anthropometric data, curve magnitude, and bone quality parameters by HRpQCT were documented at their first clinic visit. Their skeletal maturity was staged by the Thumb Ossification Composite Index and were all at peripubertal peak height velocity. The average baseline major curve Cobb angle was 25.95°±9°, and their HRpQCT-bone quality parameters were analyzed and clustered by Fuzzy-C-Means—an unsupervised machine learning model.

Results: In our cohort, three bone microarchitecture phenotype clusters were identified by our machine learning model. Patients with phenotype-1 had normal bone characteristics. Phenotype-2 was characterized by a significantly lower periosteal perimeter and trabecular area. Phenotype-3 had significantly lower cortical bone quality parameters, trabecular bone volume fraction, and trabecular thickness. During the 6 years of longitudinal follow-up, their respective bone-microarchitecture phenotype was found to be persistent till skeletal maturity, and phenotype-3 was associated with a significantly increased risk of curve progression to >50°, which is our surgical threshold (odds ratio, 4.88; p=0.029).

Conclusions: With an artificial intelligence machine learning algorithm, three bone microarchitecture phe-

notypes can be identified in peri-pubertal AIS girls at the first clinic visit. Those with bone microarchitecture phenotype-3 have a significant risk of curve progression to the surgical threshold (>50°) compared to phenotypes 1 and 2. Bone phenotypes 2 and 3 were associated with a significantly increased risk of curve progression compared to normal bone phenotypes. The three phenotypes in our cohort have similar baseline skeletal maturity and scoliotic curve severity, we found the key difference in curve progression was their bone quality and microarchitecture. Further ongoing expanded multicenter validation of our prognostication model and clinical trials could have significant clinical implications in the management and prevention of curve progression for early AIS patients.

BS132

Deep learning model for automated detection and classification of degenerative cord signal abnormality, spinal canal and neural foraminal stenosis on cervical spine magnetic resonance imaging

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Background: A deep learning (DL) model for degenerative cervical spondylosis on magnetic resonance imaging (MRI) could make reporting more consistent and efficient. We created a DL model to detect and classify cervical cord signal abnormalities and spinal canal and neural foraminal stenosis.

Methods: In this retrospective study, cervical spine MRI performed from January 2013 to July 2021 were included. Studies with instrumentation, suboptimal image quality, post-contrast studies, and scoliosis were excluded. Axial T2-weighted gradient echo and sagittal T2-weighted images were utilized. The internal training and test set splits were 90% and 10%, respectively. The training data were labeled by a musculoskeletal radiologist with 12 years of experience using pre-defined gradings. A transformer-based DL model was developed for the automated detection and classification of the regions of interest on axial and sagittal images. An internal test set was labeled by the musculoskeletal radiologist (reference standard), two subspecialist radiologists (Rad1/Rad2), and two in-training radiologists (Res1/Res2). The DL model's performance on an external test set was evaluated. Detection recall (%), inter-rater agreement (Gwet's kappa), and sensitivity/specificity were calculated.

Results: Overall, 504 MRI cervical spines were analyzed (504 patients; mean age, 58±13.7 years; 202 women). On internal testing, the DL model showed high agreement (κ=0.95, p<0.001) for binary spinal canal classification (normal/mild versus moderate/severe), superior to all readers (κ range, 0.85–0.91; p<0.001). For binary neural foraminal stenosis the DL model agreement (κ=0.90, p<0.001) was also superior to all readers (κ range, 0.82–0.84; p<0.001). DL model recall for altered cord signal (92.3%) was similar to all readers (range, 92.3%–100.0%; p>0.05). External testing demonstrated high agreement for the binary spinal canal (κ=0.92, p<0.001) and neural foramina (κ=0.81, p<0.001) classification, and high recall for altered cord signal (98.2%). In conclusion, a DL model for cervical spondylosis on MRI outperformed specialist and in-training radiologists for the classification of the spinal canal and neural foraminal stenosis.

Conclusions: A DL model for degenerative cervical spondylosis on MRI showed superior agreement to specialist and in-training radiologists for detection and classification of spinal canal and neural foraminal stenosis, and cord signal abnormality.

BS204

How the curve morphology differs between curve types in patients with adolescent idiopathic scoliosis during brace treatment?

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Background: Previous studies have reported curve progression in the braced population was related to the curve type. However, documentation of the change in spinal morphology during bracing for each curve type is limited. This study aims to compare the spinal morphology at pre-brace and brace wean in patients who

completed brace treatment with major thoracic, major lumbar, and double major curves.

Methods: A retrospective review was conducted on patients who completed brace treatment. Patients who met the Scoliosis Research Society brace inclusion criteria, had a right-sided thoracic curve and/or a left-sided lumbar curve, and were at Risser stage 4 at brace weaning were included. Radiographs taken at pre-brace and at brace weaning were assessed. Change in coronal curve type referred to a shift of the curve with the largest Cobb angle from the thoracic to the lumbar curve or vice versa. Change in curve span was defined as a change of at least two vertebral levels in the end vertebra of the curve. Change in apical vertebrae referred to change of at least one vertebral level. Curve progression, coronal imbalance, apical vertebral rotation, change in coronal curve type, change in curve span, and change in apical vertebrae were compared between patients with different curve types. Logistic regression was used to detect association between parameters at pre-brace and progression of major curve and change in curve patterns.

Results: A total of 794 patients who completed brace treatment were screened, and 217 patients were included in the study. Of these, 72 (33.2%) had major thoracic curves, 77 (35.5%) had major lumbar curves, and 68 (31.3%) had double major curves. There was a significant association between curve types and coronal imbalance at pre-brace (listing: χ^2 [2, N=217]=22.0, p<0.001; truncal shift: χ^2 [2, N=217]=22.4, p<0.001), change in coronal curve type (χ^2 [2, N=217]=19.4, p<0.001), change in apical vertebrae (χ^2 [2, N=217]=11.7, p=0.003), and curve progression (χ^2 [2, N=217]=19.4, p<0.001). The logistic regression model showed significance in the major lumbar group for changes in curve span (χ^2 [5]=12.5, p=0.029) and change in apical vertebrae (χ^2 [5]=14.9, p=0.011). Patients in the major lumbar group who had a larger truncal shift were more likely to experience a change in curve span, while those with a larger major Cobb angle or listing were more likely to have a change in apical vertebrae.

Conclusions: The major lumbar group was more likely to have coronal imbalance at pre-brace and changes in apical vertebrae at brace wean. On the other hand, the double major group was more likely to have a change in coronal curve type and curve progression of the major curve at brace wean. Furthermore, a significant association was observed only in the major lumbar group between changes in curve patterns and pre-brace parameters. These findings highlight the changes in spinal morphology differ between curve types and contribute to our comprehension of the brace mechanism.

F220

Unraveling complement protein c1q dysregulation: insights from plasma and tissue proteomics in degenerative disc disease

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Background: Degenerative disc disease (DDD), a prevalent musculoskeletal disorder, is characterized by dysregulation of the complement activation, leading to inflammation and tissue damage within the intervertebral discs. Complement protein C1q, a key initiator of the inflammatory cascade presents as a promising molecule of therapeutic use for mitigating disc degeneration. This study aims to elucidate the relationship between complement proteins in the plasma and disc tissue of individuals diagnosed with DDD. This study hypothesizes that systemic activation of the complement proteins (C1q, C1r, C1s) in plasma may mirror local changes within intervertebral discs.

Methods: Eleven healthy volunteers (HV) and 39 patients diagnosed with disc degeneration (DD) were recruited. Plasma samples collected from the HV group were considered as controls. DD group consists of plasma (DD-plasma) and their corresponding disc specimens (DD-tissue) collected from patients undergoing lumbar discectomy. High-throughput proteomic techniques, including mass spectrometry, were employed for global proteome profiling and downstream analysis of human plasma and tissue samples.

Results: Global plasma protein profiling revealed: 526 proteins in HV-plasma, 691 in DD-plasma, and 1,842 proteins in DD-tissue, respectively. Total proteins exhibited complement and coagulation cascades to be the top significant pathway in both HV and DD-plasma groups. Among the identified proteins, 470 were common to both HV and DD plasma, with 66 proteins showing statistical significance. Interestingly, the expression levels of C1q and C1r molecules, which

play key roles in initiating innate complement activation, were downregulated in DD-plasma, while C1s showed upregulation in DD-plasma. In contrast, we observed an upregulation of the C1 complex (C1q, C1r, C1s) in DD-plasma compared to their respective tissue samples. Levels of C1q in the plasma and tissue of DDD patients serve as a potent indicator of disease implications. Further investigations would warrant the development of targeted treatment strategies.

Conclusions: Early identification of C1q dysregulation holds promise for improved prognosis and the development of biomarkers for DDD. By pinpointing aberrant complement activation, especially at earlier stages of the disease, clinicians can potentially intervene more effectively, mitigate tissue damage, and modulate inflammatory stimuli. The identification of C1q-related dysregulation may thus serve as a crucial diagnostic and prognostic indicator, offering insights into disease progression and paving the way for the development of targeted therapeutic interventions aimed at mitigating the adverse effects of complement dysregulation in DDD.

BS274

Non-radiative postural alignment assessment: generating radiograph comparable images with three-dimensional imaging and deep learning

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Background: Assessing thoracic kyphosis (TK) and lumbar lordosis (LL) angles is crucial for evaluating postural alignment. While radiography is the standard measurement technique, its drawbacks include high costs and ionizing radiation exposure, limiting its frequent use. Photogrammetry offers a non-radiative alternative, but its effectiveness is hampered by the difficulty in locating some landmarks and the variability in evaluators' anatomical knowledge, leading to inconsistent results. This study introduces a novel approach using the non-radiative three-dimensional (3D) imaging device, mskalign Wukong, to capture 3D images and employs a deep learning model to produce radiograph-comparable images (RCIs) for measuring TK and LL angles with high precision.

Methods: We recruited 3,315 adolescent idiopathic scoliosis patients from a territory-wide tertiary scoliosis referral center. The 3D image acquisition process is conducted in parallel with the routine radiograph scanning. Specifically, we shoot the unclothed back view 3D images with mskalign Wukong and then utilize 3D projection-based algorithm to obtain the 3D image of patient's unclothed back at a predetermined viewing angle. Two anatomical landmarks, i.e., the 7th cervical vertebra and tip of coccyx are used to register the radiographs and 3D images. A two-stage deep generative model was developed to generate the lateral body contour mask from the input 3D image (1st stage), and subsequently synthesize RCIs (2nd stage). The quality of resulting RCIs was assessed in terms of structural similarity index (SSIM) against actual radiographs. TK and LL angles from RCIs and radiographs were confirmed on our mskalign platform by two spine specialists and analyzed with linear regression. Deformity severity grading accuracy was evaluated using confusion matrices.

Results: Among the recruited patients (72% female; mean age±standard deviation, 15.96±1.63), data from 1,671 patients were used for model development and training, i.e., 1,336 for model evaluation, and 335 for prospective testing. Our experimental results showed that the obtained RCIs can achieve a SSIM of 0.612. TK and LL angle measurements from RCIs correlated strongly with actual radiographic measurements (TK: R^2=0.827; LL: R^2=0.735; both p<0.001). For deformity severity grading, our model can accurately detect the abnormal TK with a sensitivity of 0.83 and a specificity of 0.91, and can detect the abnormal LL angles with a sensitivity of 0.91 and a specificity of 0.90.

Conclusions: The RCIs generated by our proposed model closely resemble actual radiographs, and measurements of TK and LL angles on RCIs are consistent with those obtained from radiographs, suggesting this approach as a viable radiation-free alternative for postural assessment. Despite these promising results, further independent validations are necessary to confirm the method's efficacy across different settings.

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Abstracts for Medal Papers
Clinical Papers

BC002

Predicting neurologic complications in thoracic three-column osteotomy: a clinical application of a novel magnetic resonance imaging-based classification approach

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Study Design: Retrospective comparative study.
Purpose: To investigate and compare the occurrence of neurologic complications in patients undergoing thoracic three-column osteotomy (3CO) with varying spinal cord morphologies, utilizing an magnetic resonance imaging (MRI)-based classification system that assesses spinal cord shape and the presence of cerebrospinal fluid (CSF) at the curve apex. Additionally, this study aims to evaluate the prognostic utility of this classification system in predicting postoperative neurologic deficits.
Background: Recent advancements in spinal instrumentation and correction techniques have improved outcomes for severe spinal deformity patients undergoing 3CO. A novel MRI-based spinal cord classification system was introduced, but its validation and association with postoperative complications remained unexplored.
Methods: Between September 2012 and September 2018, a retrospective analysis was conducted on 158 patients (74 males, 84 females; mean age, 32.0±23.7 years old) with spinal deformities undergoing 3CO. Radiographic parameters, including the Cobb angle of the main curve, the horizontal distance between the C7 plumb line and central sacral vertical line, global kyphosis, and sagittal vertical axis were measured and documented. T2-weighted axial MRI was employed to describe spinal cord morphology at the apex. Intraoperative neurophysiologic monitoring (IONM) alerts were recorded, and preoperative and postoperative neurologic functions were assessed using the Frankel score.
Results: Patients were categorized into three groups: type 1, type 2, and type 3, consisting of 12, 85, and 61 patients. Significant differences (p<0.05) were observed across these groups concerning etiology, fusion levels, operative time, and estimated blood loss. Notably, patients with type 3 spinal cord morphology exhibited larger Cobb angles of the main curve than those with type 1 and 2 spinal cord morphologies (p<0.001). This disparity persisted both postoperatively and during follow-up (p<0.05). The IONM alerts were triggered in 32 patients (20.3%), with a distribution of one case in type 1, six cases in type 2, and 22 cases in type 3 spinal cord morphologies (p<0.001). New neurologic deficits were observed in 15 patients (9.5%), with varying occurrences of one, three, and 11 cases in type 1, 2, and 3 spinal cord morphologies, respectively.
Conclusions: Patients with type 3 spinal cord exhibited greater spinal deformity severity, higher preoperative neurologic deficit occurrence, and an elevated risk of postoperative neurologic complications. This underscores the utility of MRI-based classification of spinal cord shape and CSF presence at the curve apex, as a reliable tool for predicting postoperative neurologic complications in thoracic 3CO patients during preoperative assessment.

BC025

The proximal femur maturity index is a novel tool to predict curve progression risk in patients with adolescent idiopathic scoliosis undergoing bracing

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Background: The proximal femur maturity index (PFMI) can be used to assess skeletal maturity on existing whole-spine radiographs without additional radiation. However, the relationship between the PFMI at the initiation of bracing for adolescent idiopathic scoliosis (AIS) and subsequent curve progression remains unknown. This study aimed to investigate the relationship between the PFMI and curve progression, and the predictability of risks to adulthood curve progression and surgical thresholds based on the PFMI grade at brace initiation.
Methods: This was a prospective study of 202 patients

with AIS who were prescribed underarm bracing according to the Scoliosis Research Society criteria and had good brace-wear compliance. The patients were followed from brace initiation until complete skeletal maturity. Longitudinal data on the coronal Cobb angle and skeletal maturity assessments using Risser staging, Sanders staging, the distal radius and ulna classification, and the PFMI were collected. Each patient was assessed on whether the major curve progressed to ≥40° (adulthood deterioration) and ≥50° (the surgical threshold). Logistic regressions were used to predict probabilities of curve progression to the two thresholds, adjusted for factors that were significant in univariate analyses.

Results: The PFMI correlated with the other skeletal maturity indices (rs=0.60 to 0.72, $p<0.001$ for all). The pre-brace PFMI grade correlated with progression to ≥40° (rrb=−0.30, $p<0.001$) and to ≥50° (rrb=−0.20, $p=0.005$). Based on regression models ($p<0.001$) adjusted for the pre-brace major Cobb angle and curve type, brace initiation at PFMI grades 2 and 3 for a curve of ≥30° had predicted risks of 30% (95% confidence interval [CI], 4% to 55%) and 12% (95% CI, 7% to 17%), respectively, for progression to the surgical threshold. Brace initiation at PFMI grade 5 had 0% progression risk.

Conclusions: The PFMI can be used for predicting curve progression and prognosticating brace outcomes in AIS. Patients with brace initiation at PFMI grade 4 for a curve of <30° or at grade 5 were unlikely to progress to the adulthood deterioration or surgical threshold. In comparison, skeletally immature patients initiating bracing at a PFMI grade of ≤3 for a major curve of ≥30° had a higher risk of progression despite compliant brace wear.

BC027

Single position lateral lumbar interbody fusion with navigated percutaneous pedicle screw fixation: technique modification with resultant resource usage optimization

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Background: In surgical practice, the operating theatre (OT) is a resource intensive environment, with studies reporting OT costs to be the second most expensive contributor to a patient's surgical care. The literature on cost analysis of elective lumbar fusion surgeries is sparse. Among the various techniques for lumbar fusion, lateral lumbar interbody fusion (LLIF) emerges as a highly effective minimally invasive surgical choice for patients afflicted with degenerative lumbar disease. Traditionally, two patient positions were required—lateral decubitus for intervertebral disc space access and prone position for percutaneous pedicle screw (PPS) insertion. However, some surgeons reported performing LLIF in a single position. With the elimination of positional changes, the authors postulate that there will be a reduction in resource utilization in single position LLIF. The principal objective of this study was to assess the aforementioned hypothesis.

Methods: This was a retrospective cohort study conducted in a tertiary hospital. All patients who underwent primary single-stage, single-level LLIF by the senior author between September 2020 and September 2023 were identified. Interbody cage insertion was done under fluoroscopy guidance while PPS insertion was performed with navigation. Demographic details, operative variables, and complications were evaluated. Variables related to resource usage were length of stay (hours), consumables fee (Singapore dollars, SGD), anesthetist fee (SGD), and facility fee (SGD). Independent *t*-test was used to compare quantitative outcomes between groups and presented as means with standard deviation. Significance level was set as $p<0.05$.

Results: There were four patients in the single position group (SP) and three patients in the dual position (DP) group. None of the patients had intraoperative or postoperative complications. There was no statistically significant difference in the length of stay for the SP and DP groups (61.3 hours vs. 59.7 hours, $p=0.9418$). The operative time for the SP group was 145 minutes (standard deviation [SD]=7.07; 95% confidence interval [CI], 133.7–156.3) while the operative time for the DP group was 193.3 minutes (SD=24.7; 95% CI, 132.1–254.6; $p=0.0123$). The consumables fee ($2,312.5 vs. $3,935, $p=0.0066$) and anesthetist fee ($154.2 vs. $179.6, $p=0.7204$) for the SP group were all lower than the DP group although only the difference in consumables fee achieved statistical significance. There was no difference in facility fee ($1,253.9 vs. $1.227.2, $p=0.958$) comparing the SP and DP group. When comparing the sum of consumables fees, anesthetist fee, and facility fees between the two groups, SP had a lower cost ($3,720.5, SD=1,305.5; 95% CI, 1,643.1–5,797.9) compared to DP ($5,341.9, SD 941.1; 95% CI, 3,004.0–7,679.8), but the

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difference was not statistically significant (p=0.1302).
Conclusions: The minimally invasive surgical technique of SP LLIF outlined in this study demonstrates efficient resource utilization and a notable absence of intraoperative or perioperative complications among all patients. Nevertheless, more studies are required to assess the long-term outcomes of SP LLIF.

BC063

The risk factors for implant failure after posterior vertebral column resection for severe thoracolumbar Pott's deformity

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Background: Implant failure is not rare in correction surgery for severe kyphosis and there are few studies to identify the risk factors. We identified comprehensively the risk factors of implant failure subsequent to posterior vertebral column resection (PVCR) surgery in patients with severe thoracolumbar Pott's kyphosis, and to explore the prevention strategy for this complication.
Methods: Patients with severe thoracolumbar Pott's kyphosis who received PVCR were reviewed from multicenter. A total of 120 patients (68 men and 52 women) were included in this study based on inclusion and exclusion criteria. Patient's demographic and clinical characteristics, including age, sex, body mass index (BMI), apex location, number of resected vertebrae and instrumented segments, and the use of multiple rod constructs (three or more), were documented from patient medical records. Patients' preoperative and postoperative radiographic parameters were measured. All patients in this study were divided into the implant failure group (group A) and the non-implant failure group (group B). logistic regression analysis was used to figure out the risk factors and the receiver operating characteristic (ROC) curve was employed to calculate the cutoff value of residual kyphotic angle.
Results: There was no significant difference between the two groups in preoperative local kyphosis (Konstam angle), operation time, and blood loss (p>0.05). Similarly, no significant difference was observed between the two groups in age, gender, apex location, and the number of resected vertebrae (p>0.05). Implant failure occurred in 18 patients (15%). The BMI in group A was significantly higher than that in group B (25.1±1.7 kg/m^2 vs. 21.6±2.8 kg/m^2, p<0.05). Implant failure occurred in 7.8% (5/64) of patients with 6–7 levels instrumentation and 23.2% (13/56) of patients with 8 levels instrumentation (p<0.05). Implant failure occurred in 4.2% (2/48) of patients with multiple rod constructs and 22.2% (16/72) of patients with dual-rod constructs (p<0.05). The postoperative Konstam angle in group A was significantly greater than that in group B (31.7°±6.9° vs. 27.8°±4.2°, p<0.05), and there was also a significant difference in postoperative residual segmental kyphotic angle (RSKA) between the two groups (41.0°±9.6° in group A vs. 30.5°±4.7° in group B, p<0.05). Furthermore, the postoperative sagittal vertical axis in group A was found to be significantly different from that in group B (-22.3±19.5 mm vs. 9.4±15.2 mm, p<0.05). The logistic regression analysis revealed that the occurrence of implant failure in PVCR surgery was independently correlated with RSKA (odds ratio [OR], 1.277), BMI (OR, 1.991), and the usage of the multi-rod construct (OR, 0.123). When RSKA reached 37.9°, the area under the ROC curve was the largest, and the related sensitiveness, specificity, and Youden index were 0.778, 0.961, and 0.739, respectively.
Conclusions: RSKA, BMI, and the use of a multi-rod construction are variables that may impact implant failure after PVCR for severe thoracolumbar Pott's deformity. PVCR requires adequate anterior column supports and kyphosis correction, and multi-rod constructs are recommended to reduce implant failure.

BC080

Risk factors of surgical complications for early-onset scoliosis

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Background: The surgical correction of early-onset scoliosis (EOS) is associated with a variety of perioperative and postoperative complications. The identification of

risk factors associated with complications is important for the management of patients with EOS. We aim to characterize the prevalence of complications associated with scoliosis surgery for EOS, and the potential risk factors of these complications.

Methods: We retrospectively reviewed patients with EOS who underwent spinal surgery at Peking Union Medical College Hospital from January 2008 to December 2017. Standard demographic information, radiographical data, genetic testing results, and surgical records were collected. Potential risk factors were identified by univariate analysis. Multivariate logistic regression was used to evaluate independent risk factors of surgical complications.

Results: We recruited 319 patients who underwent scoliosis correction surgery with a minimum of a 2-year follow-up after the initial surgery. Among them, 65 patients (20.4%) developed perioperative or postoperative complications. The univariate analysis revealed that the etiology of EOS, the underlying Mendelian syndromes, the occurrence of chest wall/rib deformity, the preoperative lumbar Cobb angle, and the instrumented vertebral levels were significantly associated with the development of complications (p<0.05). Multivariate analysis revealed that Mendelian syndromes caused by chondrogenesis-related genes (odds ratio [OR], 11.392; 95% confidence interval [CI], 2.769–46.871; p=0.001), male gender (OR, 1.869; 95% CI, 1.028–3.369; p=0.040), and presence of chest/ribs deformity (OR, 2.175; 95% CI, 1.098–4.309; p=0.026) were independent risk factors for the complications.

Conclusions: By integrative analysis of clinical and genetic information, we found that Mendelian syndromes caused by chondrogenesis-related genes, male gender, and the presence of chest wall/ribs deformity were independent risk factors for complications following surgical treatment in EOS patients.

BC106

Current trends in intraoperative neurophysiological monitoring among asian countries: an Asia Pacific Spine Society survey

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Background: Intraoperative neurophysiological monitoring (IONM) is a crucial tool for reducing neurological complications. To date, the IONM situation in Asian countries is unknown. Therefore, we identified the need to investigate the current IONM situation in Asia.

Purpose: To clarify the current trends of IONM in Asian countries and to evaluate the details of IONM.

Methods: This was web-based survey from October 1 to November 30, 2023. It was sent to all Asia Pacific Spine Society members (n=626 as of October 2023). Survey included nationality, years of experience in spine surgery, years of experience in IONM, the number of spine surgeries performed annually, and commonly used monitoring modalities. For transcranial motor-evoked potentials (Tc-MEP) monitoring, we surveyed the following details: (1) the wave amplitude reduction that was considered an alarm point, (2) management (preparation, intraoperative-management, judgment of wave amplitudes), (3) the number of channels used for Tc-MEP, (4) the experiences and details of complications related to Tc-MEP and steps for prevention of complications, (5) alarm point management, and (6) wake-up test experiences. We also asked the respondents (7) to clarify how they managed situations in which adequate wave amplitudes were not obtained

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from Tc-MEP during the initial operation.
Results: One hundred and ninety-three responses were received (response rate: 30.8%). The highest responses were from the Philippines (22.8%) > Malaysia (19.7%) > India (18.1%) > China & Hong Kong (14%) > Japan (8.3%). One hundred and seventy-seven respondents used IONM while 16 respondents (8.3%) did not use at all. One hundred and sixteen respondents had more than 10 years' experience in spine surgery but only 76 respondents had more than 10 years of IONM use. Sixty-five respondents (33.7%) had less than 100 spine surgeries per year. Twelve respondents work in high volume spine centers with more than 1,000 spine surgeries a year. The most common modality was Tc-MEP (n=160) followed by somatosensory-evoked potential (n=144), spontaneous electromyogram (EMG; n=78), and triggered EMG (n=67). Multimodal IONM was common (n=130). In Tc-MEP, the most frequent alarm point was more than 50% reduction (n=103). Although medical technologists provided the preparation, intraoperative management and judgment of alarm points, the surgeon still decided the final judgement of any alarm point. The eight to 14 channels were most common use. Seventy-eight respondents experienced complications of Tc-MEP (49%: Tc-MEP users) and tongue injury was most common. The prevention methods were as follows: (1) minimize the intensity of stimulation, (2) fill the oral cavity with gauze, and (3) fill with hard bite block. Regarding the management for alarm point, half of respondents determined before surgery (n=83). For the situation of no recovery of Tc-MEP during surgery, the wake-up test was still used to check for neurological deficit during surgery (n=82). For insufficient Tc-MEP wave amplitudes before starting surgery, respondents usually try to achieve at least one wave amplitude (n=69), and subsequently add the other modality (n=51). It was rare to postpone surgery (n=10).
Conclusions: This is the first report regarding IONM in Asia. We clarified the trend, alarm point, experiences of complication related to Tc-MEP, prevention methods, and the experiences of wake-up test.

BC179

The relationship between postoperative proximal junctional kyphosis and magnetic resonance imaging-based pedicle bone quality scores in thoracic adolescent idiopathic scoliosis

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Background: Proximal junctional kyphosis (PJK) is a major postoperative complication in patients with thoracic adolescent idiopathic scoliosis (AIS), and poorer bone quality condition is an important risk factor for the occurrence of PJK. The use of computed tomography Hounsfield units (CT-HU) and quantitative computed tomography (QCT) to assess the quality of the pedicle bone condition can predict the occurrence of postoperative proximal junctional problems. However, there is a lack of a magnetic resonance imaging (MRI)-based site-specific bone quality scoring system for assessing the condition of pedicle bone quality and its relationship with PJK. Therefore, the purpose of this study was to create an MRI-based site-specific bone quality scoring system for the pedicle and to evaluate its correlation with pedicle CT-HU values and its ability to predict thoracic AIS PJK, comparing the predictive ability of the Pedicle Bone Quality (PBQ) Score and the Vertebral Bone Quality (VBQ) Score.
Methods: This is a retrospective study to assess the relationship between postoperative PJK and the PBQ and VBQ scores in patients with Lenke 1 and 2 AIS. Demographics, procedure-related data, and radiological data were collected, and PBQ and VBQ values were measured on MRI T1-weighted unenhanced sagittal images, respectively. Simple linear regression and Pearson correlation analyses were used to determine the relationship of PBQ and VBQ score with pedicle HU values and proximal junctional angle (PJA). Multivariate logistic regression analyses were used to identify risk factors associated with PJK, and in addition, univariate linear regression analyses were used to identify potential factors associated with PBQ score. Finally, Receiver operating characteristic analysis and area-under-the-curve values were used to assess the predictive ability of PBQ and VBQ scores.
Results: A total of 181 patients (mean age, 15.44±3.22

years) were included in this study and the PJK occurred in 30 patients (16.6%), and patients in the PJK group had significantly higher PBQ and VBQ values (3.25±0.34 and 3.69±0.27) than those in the non-PJK group (2.65±0.51 and 2.86±0.53, $p<0.001$). Simple linear regression analyses showed a significant negative correlation between PBQ and VBQ with the pedicle HU values ($r=-0.639$, $p<0.001$ and $r=-0.592$, $p<0.001$, respectively), and a significant positive correlation was found between PBQ ($r=0.642$, $p<0.001$) and VBQ ($r=0.608$, $p<0.001$) with PJA. The results of multivariate logistic regression showed that the PBQ score was the risk factor for PJK (odds ratio, 3.763; 95% confidence interval, 4.324–12.844; $p<0.001$), with 86.3% predictive accuracy, higher than VBQ (79.2%).

Conclusions: The novel PBQ score is a reliable tool for predicting postoperative PJK in patients with thoracic AIS. Compared to the VBQ score, it has a better correlation with pedicle CT-HU values and PJA, as well as better predictive ability for PJK.

BC208

Lateral plane fulcrum bending radiographs predicts postoperative thoracic normokyphosis in adolescent idiopathic scoliosis

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Background: Fulcrum bending radiographs can be used to predict the direction of surgical thoracic kyphosis (TK) correction from the coupling behavior of the spine. Adolescent idiopathic scoliosis (AIS) is often associated with hypokyphosis. Despite studies suggesting the use of Ponte osteotomies to improve sagittal correction, indications for these kyphosis restoration procedures remain unclear. This study aims to identify predictors of postoperative normokyphosis on fulcrum bending radiographs and denote cutoffs for the identified predictors in which additional procedures should be performed to improve sagittal correction.

Methods: This is a retrospective single-center study of AIS patients undergoing posterior spinal fusion (PSF) with pedicle screw constructs (one or two additional hooks may be used when pedicle screws cannot be inserted) from 2003 to 2021. Patients included are of Lenke type 1, undergoing selective thoracic PSF with follow-up of 2 years or more. Patients with non-idiopathic scoliosis, multistep surgery, and poor visualization of T5–T12 TK on fulcrum bending were excluded. Preoperative coronal and sagittal view fulcrum bending radiographs, coronal and sagittal standing whole spine anterior-posterior (AP) radiographs are taken preoperatively, postoperatively and at 2-year follow-up. Radiographical assessment includes, from standing AP radiographs: main thoracic (MT) Cobb angle, global TK (T1–T12), T5–T12 TK, thoracolumbar kyphosis (TLK; T10–L2), lumbar lordosis (S1–L1); on fulcrum bending radiographs: MT Cobb angle and T5–T12 TK. Fulcrum TK change is defined as the difference between standing and fulcrum bending T5–T12 TK. Patients are divided into hypokyphotic, normokyphotic, and hyperkyphotic groups based on their T5–T12 TK as TK<20°, TK=20°–40°, and TK>40°, respectively. Preoperative factors with moderate correlation ($p<0.2$) identified from univariate analyses are entered into logistic regression to find significant predictors ($p<0.05$) for postoperative normokyphosis. A receiver operating (ROC) curve is then used to determine the cutoff for the identified predictors with the highest sensitivity and sensitivity.

Results: Eighty-nine patients were studied, 71.9% (n=64) were Lenke 1A, 22.5% (n=20) Lenke 1B, and 5.6% (n=5) Lenke 1C. Preoperatively, 67.4% (n=60) were hypokyphotic, 28.1% (n=27) normokyphotic, and 4.5% (n=4) hyperkyphotic. Postoperatively, 69.7% (n=62) were hypokyphotic and 30.3% (n=27) normokyphotic. Global TK, T5–T12 TK, fulcrum TK, fulcrum TK change, and TLK showed moderate correlation ($p<0.2$) and were entered into logistic regression. Increase in T5–T12 TK (odds ratio [OR], 1.20; 95% confidence interval [CI], 1.10–1.30; $p<0.001$) and fulcrum TK change (OR, 1.10; 95% CI, 1.01–1.19; $p=0.02$) were significant predictors of postoperative normokyphosis in logistic regression. From an ROC curve, the cutoff for TK was 19.2° (area under the curve [AUC], 0.85; 95% CI, 0.76–0.94; sensitivity, 0.78; specificity, 0.84). For patients with TK<19.2°, 4.1° was the cutoff for fulcrum TK change (AUC, 0.80; 95% CI, 0.66–0.94; sensitivity, 0.83; specificity, 0.62).

Conclusions: Increase in T5–T12 TK and fulcrum TK change are predictors of postoperative normokyphosis. When TK<19.2° and fulcrum TK change<4.1°, there is an increased risk of postoperative hypokyphosis and kyphosis restoration procedures such as Ponte osteotomies should be considered.

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Abstracts for Free Papers

F001

Surgical management strategies for unstable sacral fractures

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Background: Unstable sacral fractures usually have posterior pelvic and spinopelvic instability, which can be classified by AO classification as AO type C and some vertically unstable fractures as AO type B. These injuries are rare conditions but can result in poor outcomes if improperly managed. There are many controversial points concerning the management of these fractures without a definite treatment guideline due to their rarity. Herein, we retrospectively review cases of this injury in our institute and propose a surgical treatment guideline for unstable sacral fractures.
Methods: We retrospectively reviewed 20 consecutive patients diagnosed with an unstable sacral fracture who were treated surgically at Songklanagarind Hospital between 2017 and 2022. The fractures were classified with the AO classification system based on plain radiographs and computed tomography scans. Magnetic resonance imaging was performed in cases with neurological deficits on examination. All demographic information, associated fractures, surgical data, pre- and postoperative images of the pelvis, instrument-related complications, and ambulation programs were documented. Oswestry Disability Index (ODI) and pain scores based on Numerical Rating Scale (NRS) were noted at the final follow-up.
Results: The unstable sacral fractures of the 20 identified patients were classified as AO type C3 in seven patients, AO type C2 in four patients, AO type C1 in six patients, AO type C0 in two patients, and one case of AO type B3. The mean age of the patients was 34 years (range, 18 to 62 years). The most common injury cause was motorcycle accidents (55%). And 85% of the cases had an associated pelvic ring injury. Ten patients underwent bilateral lumbopelvic fixation; most of these cases had either iliosacral or transiliac-transsacral screw fixation for transverse plane stabilization. Only four patients underwent iliosacral or transiliac-transsacral screw fixation without vertical stabilization. Triangular osteosynthesis was performed on six patients and three patients had hardware removal as planned to preserve lumbosacral motion. The mean follow-up time was 16.6±11 months. There were four cases of postoperative complications: two patients with wound complications (infection and dehiscence) and two patients with a broken rod that was found accidentally by follow-up radiographs without significant clinical complaints. The mean final ODI and NRS scores were 8±3.7 and 1.3±1.7, respectively.
Conclusions: Unstable sacral fractures with posterior pelvic and spinopelvic instability are rare conditions usually resulting from a high-energy injury. The current knowledge and treatment guidelines remain a matter of controversy due to the rarity of this injury. We have proposed a surgical management strategy for this group of fractures with an optimal fixation method based on patient factors, fracture morphology, and lumbosacral integrity.

F004

Full endoscopic over-the-top decompression for single-level lumbar spinal stenosis: a single-center experience

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Background: In recent years, there has been an increasing acceptance of minimally invasive lumbar complete endoscopic spinal decompression as a feasible substitute for conventional open decompression techniques. The use of the full endoscopic technique enables surgeons to see the neuronal processes of the lateral recess with enhanced precision from an off-axis perspective, hence minimizing the need for removing a significant number of facet joints. This research presents an analysis of the clinical outcomes and effectiveness of our method.
Methods: A retrospective study was conducted on a cohort of 40 consecutive patients with single-level lumbar stenosis who had complete endoscopic over-the-top decompression for lumbar spinal stenosis. The procedure had been performed by a single spine surgeon. The study analyzed patient demographics, surgical details, clinical outcomes, and complications.
Results: The study sample included 30 female and 10 male patients, with an average age of 56 years. All patients in the study had stenosis at the L4L5 level, with the remainder of patients undergoing decompression

surgeries that included an over-the-top approach. The duration of the surgical procedure using the endoscopic approach was recorded as 120±5.0 minutes. The average duration of hospitalization for patients undergoing endoscopic procedures was found to be 1.5±0.5 days. At the 1-year follow-up, patients who had endoscopic procedures exhibited a statistically significant reduction in Visual Analog Scale scores for leg pain compared to their preoperative scores (8.0±0.4 vs. 1.5±0.5, $p<0.01$). Furthermore, there was a substantial reduction in the back pain disability index score in the endoscopic surgery compared to the preoperative score (16.5±2.5 vs. 13.0±3.1, $p<0.01$). Following the full endoscopic surgery, only one of the patients had a surgical site infection necessitating a return to the operating room.

Conclusions: Surgical lumbar endoscopic over-the-top decompression has a low risk of complications and excellent long-term results for patients.

F005

Artificial neural networks model detection for osteoporotic vertebral compression fracture

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Background: An osteoporotic vertebral compression fracture (OVCF) may cause excruciating pain, altered balance, decreased gait velocity, muscular exhaustion, and additional fractures. It also significantly lowers a person's health-related quality of life. For the diagnosis of OVCF, a computed tomography (CT) scan is presently the gold standard.

Methods: Deep learning-based artificial intelligence models show potential for automatically and rapidly recognizing and displaying OVCF. This research looked at the use of deep artificial neural networks (ANN) for the detection, classification, and grading of OVCF. The sagittal images of 1,050 OVCF CT scans with symptomatic low back pain were divided into 934 CT scans for a training dataset (89%) and 116 CT scans for a test dataset (11%), using annotation methods. The training dataset was annotated, cleaned, and tagged by a radiologist. All lumbar discs were evaluated for disc degeneration utilizing the AO Spine-German Society for Orthopedics and Trauma (DGOU) Osteoporotic Fracture Classification System. The deep learning ANN model was used to train the identification and grading of OVCF.

Results: The ANN model training were validated by testing an automated model for dataset grading. There were 5,010 OVCF from osteoporotic fracture (OF)1, 1,942 from OF2, 522 OF3, and 336 from OF4 in the sagittal lumbar CT training dataset. The deep ANN model was able to recognize and classify lumbar OVCF with above 95% accuracy. Nevertheless, the OF5 cannot be categorized by this methodology.

Conclusions: The ANN model uses the AO Spine-DGOU Osteoporotic Fracture Classification System to automatically and reliably evaluate regular CT images, providing a quick and efficient method of classifying lumbar OVCF.

F010

Single-cell nuclear transcriptome sequencing resolves cellular heterogeneity in a single segmental compression model of chronic spinal cord injury in rabbits

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Background: The incidence and prevalence of non-traumatic spinal cord injury (NTSCI) have been increasing gradually. Long-term NTSCI can cause irreversible damage to the spinal cord and a high disability rate. Previous studies on spinal cord injury (SCI) models have mainly focused on SCI caused by cutting or contusion.

Methods: In this study, we constructed a single-segment compression model for NTSCI in rabbits and cellular heterogeneity at different stages of NTSCI using single-cell nuclear transcriptome sequencing technology (snRNA-seq). Uniform manifold approximation and projection (UMAP) were further conducted to explore the cellular composition of NTSCI. Pseudotime cell trajectory and gene enrichment analysis revealed the molecular pathways underlying cell fate decisions. The intercellular communication network of different cell

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types of NTSCI was constructed by CellChat.
Results: We focused on the changes in inflammation-related biological processes during the progression of spinal cord chronic injury (SCCI) and explored the possible role played by injury-activated microglia and macrophages in SCCI. In addition, we investigated the interaction between different cell types in the neurovascular unit (NVU) and the role of neovascular endothelial cells at different stages of SCCI. Finally, we stored the snRNA-seq data in the MSKCA (Musculoskeletal Cell Atlas) database and performed an interactive visual display.
Conclusions: This study described the cellular heterogeneity of SCCI in rabbits and the biological processes related to inflammation and changes in the NVU during SCCI.

F014

Analysis of risk factors affecting lumbosacral pseudoarthrosis in multi-segmental fusion: a computed tomography-based study

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Background: Proximal and distal junctional failure at the fusion site in spinal fusion surgery is a significant complication requiring reoperation due to deformities, pain, and neurological symptoms. Particularly in long-level fusion involving the lumbosacral joint, located at the fusion's lowest level, stress concentration and morphological features contribute to a high incidence of pseudoarthrosis. Our study aimed to evaluate factors influencing the occurrence of pseudoarthrosis in L5–S1 fusion during long-level fusion.
Methods: This retrospective analysis spanned from 2005 to 2022, examining 88 patients' medical records from Seoul St. Mary's Hospital. All patients had a minimum 1-year follow-up. Inclusion criteria involved patients undergoing interbody fusion at L5 and S1, excluding those with trauma, infection, neuromuscular disease, ankylosing spondylitis, multiple myeloma, or previous L5–S1 interbody fusion. Clinical outcomes, including preoperative assessments, 1-year Numerical Rating Scale, Oswestry Disability Index, wound complications, and postoperative infections, were evaluated. Radiological outcomes assessed postoperative fusion. Nonunion evaluation utilized computed tomography scans 1-year post-surgery. Risk factor analysis included pre- and postoperative radiographic measurements, evaluation of paraspinal muscle fatty infiltration at L4 level on preoperative magnetic resonance imaging, and general medical status assessment.
Results: Among 88 patients, 73 achieved union, while 15 (20.5%) experienced pseudoarthrosis. Univariate analysis revealed that nonunion was more likely in males (p=0.018), those with a history of fusion in other segments (p=0.034), and those with less sacral slope correction (p=0.017). Multivariate analysis identified male gender (p=0.034; odds ratio [OR], 3.665; 95% confidence interval [CI], 1.104–12.170) and prior fusion in other segments (p=0.045; OR, 3.099; 95% CI, 1.025–9.343) as significant risk factors for nonunion.
Conclusions: Interbody fusion at the lumbosacral joint demonstrates a relatively high rate of nonunion, especially in males and patients with prior fusion in other segments. Caution is warranted in performing interbody fusion at the lumbosacral joint in such cases due to an elevated risk of nonunion.

F016

Which patients do we need to consider augmentation of muscle active potentials regarding motor-evoked potential monitoring before spine surgery?

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Background: Transcranial electrical stimulation motor-evoked potentials (Tc-MEPs) is current trend and important tool to prevent intraoperative neurological deficit. Post-tetanic Tc-MEPs (p-MEP) is augmenting technique of the amplitudes of compound muscle active potentials (CMAPs), especially in the case with insufficient for conventional Tc-MEPs (c-MEP). However, pre- and intraoperative factors that necessitate p-MEP during spinal surgery are not clear so far. Therefore, the purposes of this study were (1) to retrospectively investigate the pre- and intraoperative factors necessitating p-MEP (study 1) and (2) to examine the changes in the success rates of baseline Tc-MEP measurements before

and after tetanic stimulation in patients with such factors (study 2).
Methods: Patients who underwent spinal surgery with Tc-MEP monitoring between August 2020 and July 2022. Technician decided to use p-MEP based on the wave amplitudes. We classified patients with c-MEP alone and with p-MEP. We selected (1) level of surgery, (2) degree of manual muscle testing (MMT), (3) duration of illness, and (4) comorbidity diseases as factors for analysis. We compared preoperative and intraoperative factors between the c-MEP and p-MEP groups using univariate and multivariate analysis (study 1). In cases where the factors were identified, we investigated the success rate of the baseline MEP measurement of each muscle before and after tetanic stimulation (study 2).
Results: We recruited 157 patients. Of those, 87 showed sufficient CMAPs with c-MEP. Meanwhile, 70 needed p-MEP because of insufficient CMAPs. In univariate analysis, cervical/thoracic surgery (p<0.001), preoperative MMT 3 or below (p=0.009), shorter duration of illness (p=0.037), previous cerebrovascular disease (p=0.014), and dialysis (p=0.031) were significantly associated with p-MEP group. Finally, preoperative MMT 3 or below was the only factor requiring p-MEP (odds ratio, 3.34; 95% confidence interval, 1.28–8.73; p=0.014) in multivariate analysis using age, sex, and factors identified the univariate analysis as independent variables. In the p-MEP group, 24 patients had preoperative motor deficits; 16 patients with complete data were included in the analysis (study 2). The success rates of MEP monitoring before and after tetanic stimulation of the all lower-extremity muscles were 42.7% and 57.3%, respectively (p<0.001). However, no significant differences were observed in success rates in terms of each muscle (abductor pollicis brevis: 81.3% to 96.9%; tibialis anterior: 34.4% to 50.0%; gastrocnemius: 25% to 40.6%; abductor hallucis longus: 68.8% to 81.3%).
Conclusions: Patients with preoperative MMT 3 or below highly needed p-MEP. The success rate of baseline MEP monitoring increased with tetanic stimulation even in patients with preoperative motor deficits. We believe that p-MEP monitoring can result in reliable CMAP recording, especially in cases of preoperative motor deficits with MMT scores of 3 or below.

F033

Proximal junctional kyphosis in adult spinal deformity correction surgery: a new evaluation method for upper instrumented vertebra using comfortable seated simple X-ray evaluation

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Background: The surgery for adult spinal deformity (ASD) has focused on how to correct fixed vertebrae. If you were to restore the balance to that of a standing spine profile, you will naturally restrict movement and you will cause adjacent stress to areas that still wants to move but cannot move. Therefore, unfixed vertebrae that have undergone a significant change in alignment may develop proximal junctional kyphosis (PJK) due to changes in their environment. We spend most of our day in a sitting posture, saving energy by getting our lumbar to thoracic spine kyphotic. We hypothesized that PJK is unlikely to occur without altering the sitting alignment of the thoracic spine in the non-fixed vertebrae. The purpose of this study was to investigate the evaluation method of non-fixed vertebrae for postoperative PJK.
Methods: This is a retrospective cohort study. The study included 51 of 68 patients for ASD who underwent surgery from the lower thoracic spine to the pelvis between 2019 and 2021 at our institution. Exclusion criteria were reoperation cases within 1 year, fixation from the upper thoracic to the pelvis and cases difficult to follow. After excluded, the study included 51 cases (mean age, 72.4 years; four males and 47 females). The study items included sex, age, body mass index (BMI), sagittal evaluation of preoperative pelvic incidence, pelvic tilt, sacral slope, lumbar lordosis, C7 sagittal vertical axis, proximal junctional angle (PJA), preoperative T1-upper instrumented vertebra (UIV) angle (angle between T1 and superior margin of UIV vertebra) in comfortable sitting position, postoperative T1-UIV angle and C7 plum line. PJK was defined as kyphosis with a PJA of more than 10° progression from preoperative to 1 year postoperative. Patients were divided into two groups: postoperative PJK (27 cases) and non-PJK (24 cases).
Results: Regarding background factors, there were no significant differences in sex, age, BMI, and spinal

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sagittal parameters between the two groups. The difference between the preoperative sitting T1-UIV angle and the immediate postoperative T1-UIV angle (ΔT1-UIV angle) was predominantly higher in the PJK group (17.4°±7.8° in the PJK group and 6.2°±6.5° in the non-PJK group, p=0.0005). Furthermore, when the postoperative standing UIV angle was divided into two groups: right ascending (UIV+) and right descending (UIV-), the ΔT1-UIV angle was significantly smaller in the UIV+ group.

Conclusions: Postoperative T1-UIV angle was significantly increased in the PJK group in patients with ASD. The UIV+ group showed less change in T1-UIV. When the lower thoracic spine or the upper lumbar spine is overcorrected, the thoracic spine above the UIV becomes compensatory kyphosis and PJK is likely to occur.

F036

Analysis of risk factors for persistent postoperative neuropathic pain after surgery in patients with spinal stenosis

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Background: In clinical settings, patients with spinal stenosis frequently present with neuropathic pain. Neuropathic pain may persist without improvement after surgery, and in such cases, it has a negative impact on the patient's satisfaction after surgery and the doctor-patient relationship. Despite this clinical importance, little research has been conducted on the frequency of neuropathic pain in patients with spinal stenosis and whether it improves after surgery.

Methods: This study was conducted on patients who underwent surgery for degenerative spinal stenosis at one institution from September 2021 to October 2022. All patients were evaluated for neuropathic pain using the painDETECT score before surgery, and for patients with neuropathic pain, the underlying disease, smoking status, and American Society of Anesthesiologists (ASA) score were examined before surgery. Numerical Rating Scale and Oswestry Disability Index of back pain and radiating pain were evaluated. In addition, painDETECT scores were evaluated at 3 months and 1 year after surgery to confirm persistent postoperative neuropathic pain (PPNP), and the patients were divided into a group with PPNP and a group without PPNP. the cross-sectional area of the dural sac narrowed by central stenosis due to spinal stenosis was measured through preoperative magnetic resonance imaging (MRI), and the grade of central and foraminal stenosis was evaluated. The total number of segments with stenosis and the presence or absence of spondylolisthesis were investigated. An analysis of risk factors for PPNP was conducted based on clinical information and radiological evaluation.

Results: Among 166 patients who underwent spinal stenosis surgery, 50 patients (30.1%) had neuropathic pain before surgery. Among them, 20 patients (40%) had PPNP. There was no significant difference between the two groups in age, gender, and underlying disease. In the PPNP group, the preoperative ASA score was higher and the duration of symptoms was longer, but this was not statistically significant (p=0.073, p=0.187, respectively). The preoperative painDETECT score was significantly higher in the PPNP group (22.70±4.01 vs. 26.30±5.81, p=0.019). Preoperative MRI evaluation showed no significant differences between the two groups in the area of the dural sac, degree of central stenosis, location of central stenosis and foraminal stenosis, and presence of spondylolisthesis. (p=0.285, 0.431, 0.491, 0.449, 0.297, respectively) The grade of foraminal stenosis was higher in the PPNP group (p=0.004). In multivariate analysis using logistic regression analysis, preoperative painDETECT score and grade of foraminal stenosis were confirmed as risk factors for PPNP (odds ratio [OR], 1.144; p=0.044; OR, 3.449; p=0.014, respectively).

Conclusions: Patients with high preoperative painDETECT scores and severe foraminal stenosis have a high possibility of postoperative PPNP. Although not statistically significant, PPNP patients had higher ASA scores and longer duration of symptom.

F037

Short-term outcomes of biportal endoscopy-assisted extraforaminal interbody fusion

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Background: The biportal technique used for endoscopic spine surgery is highly flexible, applicable for both surgical visualization and work, and suitable for fusion surgery. Various fusion surgery assisted biportal endoscopy techniques have been reported. We performed biportal endoscopy-assisted extraforaminal lumbar interbody fusion (BE-ELIF) where two expandable cages were inserted through both sides of the Kambin's safety triangle. The triangle was enlarged by resecting only the superior articular process, allowing preservation of posterior components, and enabling interbody fusion without dura exposure. Four small skin incisions allowed for two cage insertions and bone grafts as well as four screw insertions. The main advantage of BE-ELIF is that it is minimally invasive. However, the clinical outcomes of BE-ELIF are still not clear. We aimed to reveal the clinical short-term outcomes of BE-ELIF.
Methods: From 2019 to 2021, 38 consecutive patients who underwent single-level interbody fusion for lumbar disorder were enrolled. A retrospective assessment of 30 patients (mean age, 65.2 years old; 15 males and 15 females) was performed at 2 years after index operations. Eight patients dropped out before 2-year follow-up. Recovery rates in terms of Japanese Orthopedic Association (JOA) scores for lower back disorder; Visual Analog Scale scores for lower back pain, pain in buttocks and lower limbs, and numbness in buttocks and lower limbs; and Japanese Orthopedic Association Back Pain Evaluation Questionnaire (JOABPEQ) scores were used as clinical outcome measures at final follow-up. Fusion statuses were assessed by computed tomography scans. A solid fusion was defined as the presence of bridging between grafted bones to both sides of endplates within or around cages.
Results: At final follow-up, respective recovery rates for JOA scores, back pain, pains in buttocks and lower limbs, and numbness in buttocks and lower limbs were 69.5%, 52.5%, 61.4%, and 47.6%. JOABPEQ effectiveness for lower back pain, lumbar function, walking ability, social life function, and mental health were 74%, 65%, 97%, 60%, and 43%, respectively. Fusion rate was 70% (21/30).
Conclusions: The main advantage of BE-ELIF is that it is minimally invasive, only requiring partial superior articular process resection and less muscle detachment. Although it is difficult to achieve both minimal invasiveness and good outcomes in interbody fusion, the BE-ELIF has achieved satisfactory short-term results. Further evaluation of mid-term and long-term outcomes, as well as larger scale studies, are needed.

F038

Association between thoracic diffuse idiopathic skeletal hyperostosis and spinal cord injury without radiographic evidence of trauma

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Background: Our study has revealed that diffuse idiopathic hyperostosis (DISH) is more common in patients with cervical spinal cord injury (CSCI) than in the general population and affects severe CSCI (Frankel A and B). The purpose of this study was to clarify whether thoracic DISH (t-DISH) affects spinal cord injury without radiographic evidence of trauma (SCIWORET) with CSCI.
Methods: The present study included 300 patients (223 men and 77 women; mean age, 64.3 years) who underwent cervical spine magnetic resonance imaging (MRI) and whole spine computed tomography between 2011 and 2023 and were diagnosed with C3–7 CSCI. T-DISH was defined as a case in which DISH was found only in the thoracic spine and did not extend to the cervical spine. In accordance with previous reports, SCIWORET was defined as a case in which there is no fracture or dislocation of the cervical vertebral bodies, and the alignment of the cervical vertebrae is maintained. Spinal cord compression (SCC) was defined as a

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case in which the spinal cord was compressed on MRI sagittal images. Statistical analysis was performed using Pearson's chi-square test between the two groups. Additionally, multivariate logistic analysis explored the relationship between SCIWORET and T-DISH after adjustment of age, sex, high-energy trauma (traffic accidents, falls from height, etc.), and SCC including ossification of posterior longitudinal ligament (OPLL) as confounding factors.

Results: SCIWORET was confirmed in 116 cases, accounting for 38.7% of all cases. SCC was observed in 82.1% (92 cases) of the 112 cases with t-DISH, which was statistically significantly higher than 67.6% (127 cases) of the 188 cases without t-DISH (p<0.001). Additionally, the incidence of SCIWORET in cases with t-DISH was 70.5% (79 cases), and the incidence of SCIWORET without t-DISH was 55.9% (105 cases), which was also statistically significant (p<0.05). Furthermore, presence of t-DISH was significantly associated with SCIWORET (odds ratio, 1.85; 95% confidence interval, 1.02–3.32; p<0.05).

Conclusions: T-DISH was found to be significantly associated with SCC and SCIWORET. Our previous report clarified the significant association between DISH and OPLL as skeletal hyperostosis. Therefore, the restriction of spinal column mobility due to t-DISH might increase mechanical stress on the cervical region with SCC. T-DISH might be risk factor of SCIWORET.

F039

Non-cervical diffuse idiopathic skeletal hyperostosis is a risk factor for severity of cervical spinal cord injury

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Background: Diffuse idiopathic skeletal hyperostosis (DISH) is characterized by the progressive ossification of anterior longitudinal ligaments, originating from the middle thoracic vertebrae, which restricts spinal flexibility. While there are reports suggesting that cervical DISH (cDISH) extending to the cervical region is associated with increased severity of paralysis, there is a lack of investigation into the impact of DISH (non-cDISH) that has not yet extended to the cervical region on the severity of cervical spinal cord injury. This study explores the relationship between DISH and the severity of paralysis in cases of cervical spine injury.

Methods: Among 516 cases of cervical spine injury between 2011 and 2023, 403 cases with whole-spine computed tomography scans and classifiable paralysis according to the Frankel classification were included. The relationship between DISH presence, older age (>65 years), high-energy trauma (traffic accidents, falls from height, etc.), gender, and the presence of ossification of posterior longitudinal ligament with severe paralysis (Frankel A and B) was examined using analysis of variance. Multivariate logistic analysis, employing the stepwise selection method, was conducted. Additionally, multivariate logistic analysis explored the relationship between severe paralysis and both cDISH and non-cDISH.

Results: The study involved 303 men and 100 women with an average age of 64.5 years. In the DISH group, the distribution of Frankel classifications was as follows: A (13.8%), B (13.2%), C (34.2%), D (15.8%), and E (23.0%). In the non-DISH group, the distribution was A (6.8%), B (8.0%), C (28.3%), D (20.3%), and E (36.6%). A statistically significant difference was observed between the two groups (p<0.05). Multivariate analysis revealed a significant association between severe paralysis and the presence of DISH, particularly in men (odds ratio [OR], 1.98; 95% confidence interval [CI], 1.0–4.2; OR, 2.30; 95% CI, 1.2–4.5). Additionally, not only cDISH but also non-cDISH was significantly associated with severe paralysis compared to non-DISH (OR, 1.76; 95% CI, 1.0–3.1).

Conclusions: This study provides novel insights, indicating that severe paralysis may occur even in the absence of DISH progression to the cervical region, where cervical spinal cord injury occurs. It is hypothesized that thoracic DISH, through ligament ossification, restricts spinal flexibility leading to overall body imbalance, thereby elevating the risk of falls and the severity of paralysis.

F040

Gender differences in spinal mobility during postural changes: a detailed analysis using upright computed tomography

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Background: Lumbar spinal alignment is crucial for spine biomechanics and is linked to various spinal pathologies. However, limited research has explored gender-specific differences using computed tomography (CT) scans. There is also evidence to suggest that lumbar degenerative spondylolisthesis is more common in female, particularly at high L4/5 levels, indicating the existence of diseases where the pathology varies between men and female. The objective was to evaluate and compare lumbar spinal alignment between standing and sitting CT in healthy individuals, focusing on gender differences.
Methods: Twenty-four young healthy individuals (21–40 years; mean age, 30.3±5.8 years; 13 males, 11 females) and 25 elderly healthy individuals (61–79 years; mean age, 65.7±3.8 years; 12 males, 13 females) were imaged in standing and relaxed sitting positions using CT scans, and gender differences were analyzed. Parameters measured and compared between genders included lumbar lordosis (LL), sacral slope (SS), pelvic tilt (PT), pelvic incidence (PI), intervertebral angle (IVA), foraminal height (FH), and bony boundary area (BBA).
Results: Females exhibited a significantly higher LL during standing position (male vs. female: 40.4° [29.0 to 47.1] vs. 46.6° [37.3 to 54.3], p=0.026). Transitioning from standing to sitting, females exhibited significantly larger changes in SS and PT (SS: -15.2° [-25.5 to -7.7] vs. -26.4° [-30.9 to -15.5], p=0.044; PT: 16.2° [9.8 to 28.3] vs. 28.7° [15.5 to 33.1], p=0.038). Additionally, in the lower lumbar spine (L4–S), elderly females showed a significantly larger change in LL (-9.3° [-13.2 to -5.1] vs. -14.1° [-17.1 to -10.5], p=0.039). No significant changes in IVAs were observed between postures, but a trend towards greater change was seen in L4/5 for females (-8.2° [-11.3 to -3.3] vs. -10.4° [-13.0 to -4.6], p=0.28). Females consistently exhibited larger FH and BBA values, particularly in lower lumbar segments (L4/5 FH: 2.2 mm [0.4 to 3.2] vs. 2.3 mm [1.6 to 3.2], p=0.276; BBA: 10.8 mm^2 [0.2 to 25.4] vs. 23.8 mm^2 [9.9 to 37.2], p=0.034), which was more prominent in the elderly group (L4/5 FH: 0.40 mm [-0.06 to 1.34] vs. 1.75 mm [1.10 to 2.25], p=0.039; BBA: 3.5 mm^2 [-2.0 to 11.0] vs. 11.1 mm^2 [1.0 to 14.3], p=0.152)). These findings underline distinct gender-related variations in lumbar alignment and flexibility, with a focus on noteworthy changes in BBA and FH in females.
Conclusions: This study comprehensively analyzes lumbar components in healthy individuals using standing CT, while making a comparison between genders. The findings reveal significant differences in the pelvic tilt and sacral slope between male and female, with female showing greater mobility in the pelvis and sacrum. This difference is particularly amplified in a sitting posture, suggesting a potential for increased stress on the lower lumbar spine. The study also highlights age-related changes in the vertebral foramen, showing significant gender differences and suggesting distinct spinal degeneration patterns. A key observation is the potential impact of these changes at the L4/5 level, possibly explaining the higher incidence of lumbar degenerative spondylolisthesis in females. As the inaugural study of its kind, it illuminates physiological lumbar spine differences between genders, aiding the understanding of spinal pathologies like degenerative spondylolisthesis.

F041

Ultrasound guidance in lumbar unilateral biportal endoscopy

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Study Design: Experimental study.
Purpose: This study aims to establish a novel method to identify the landmarks for unilateral biportal endoscopy using ultrasound guidance (US) and compare that with fluoroscopy imaging for the surgical procedure.
Background: The role of ultrasound in spine endoscopy has been underappreciated, partly because of the unfamiliarity and partly because of the perceived difficulty

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in imaging through the narrow acoustic windows produced by the bony framework of the spine. However, this is also the basis for the utility of ultrasound: the major bony landmarks for spine endoscopy have a signature ultrasound appearance, thereby permitting identification and targeting of the needle.

Methods: Nineteen patients with lumbar disc herniation or lumbar canal stenosis were enrolled prospectively in this study and randomly divided into ultrasound and X-ray (C-arm) guidance groups. The time to puncture, cannulation, total duration of the surgery, and the number of fluoroscopy shots were recorded in both groups.

Results: The puncture, cannulation and operation times in the US group were comparable to those in the X-ray group. The patients in the US group had received about 4 fluoroscopy shots, significantly lower than the values in the X-ray (C-arm) group (9.9 shots). The time duration taken to targeting and cannulation in the US group was about 6.32 minutes, similar to the X-ray group (5.59 minutes). The overall duration of the surgery was longer in L5/S1 level in the ultrasound group when compared to the X-ray group. No complications were observed in either group.

Conclusions: US guidance is a new method that reduces the number of fluoroscopy shots and time duration to puncture and cannulation in unilateral biportal endoscopy.

F043

Outpatient intermittent percutaneous cerebrospinal fluid drainage as treatment of cerebrospinal fluid leak in spine surgery

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Background: A dreaded complication of spine surgery is cerebrospinal fluid (CSF) leak. A CSF leak may result in pain, wound healing complications, infection, meningitis, spinal abscess, increased hospital stay, and/or reoperation. A gold standard of post operative management of CSF leak is still lacking. The authors describe a technique of CSF drainage that may improve the current management of post operative CSF leak without addition hospital stay or reoperation.

Methods: A retrospective case series review of spine surgery cases performed by two attending surgeons from the Brain and Spine Institute, Cardinal Santos Medical Center, was performed. In all, 241 charts were reviewed, spanning a 5-year period. There were 18 cases in which CSF leak was detected. All cases of CSF leak were managed by outpatient intermittent percutaneous drainage using a gauge 23 butterfly needle and a 20-mL sterile syringe. Patients were reevaluated at regular intervals for and underwent repeat drainage every 1–4 days dependent on the need and persistence of CSF leak.

Results: All patients observed in this study had CSF leak, all patients were treated using intermittent percutaneous CSF drainage and none of the patients needed revision surgery to close the CSF leak. The duration of the leak for the all patients were at approximately 20 days on average, with a standard deviation of 15 days. The most common factors noted in the study population were increasing age, number of operative levels, use of the posterior approach, and corticosteroid use.

Conclusions: The use of outpatient intermittent percutaneous CSF drainage represents a viable alternative in the treatment of CSF leak as seen in the resolution of signs and symptoms of all 18 patients. On the risk factors for the occurrence of CSF leak, the most noted factors besides increased age were the number of operative levels, use of the posterior approach, and corticosteroid use.

F044

Influence of barium sulfate contrast agent in bone cement on its physical and mechanical properties in the vertebra of an animal model for the treatment of vertebral compression fractures

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Background: Cement failure in Kyphoplasty and Vertebroplasty is often caused by microfracture and fragmentation. The problems associated with the use of cement are basically its high viscosity and a radiopacity that is insufficient to adequately observe the injection process and ensure the perfect location of the reinforce-

ment. This study will determine the optimum amount of radiopaque contrast agent that would provide optimal opacity of the bone cement under fluoroscopy during kyphoplasty or vertebroplasty that will not decrease the compression strength of the bone cement.

Methods: Bone cement was mixed with barium sulfate contrast agent in a 0%, 5%, 10%, 15%, 20%, and 25% weight of the bone cement. There were six lumbar vertebrae isolated from a pig. Each of the six-bone cement mixture was injected into each of the six lumbar vertebrae under fluoroscopy. Three persons observed the fluoroscopy printout and graded the radiopacity of the bone cement and determined which vertebra had the most radiopaque bone cement on 3 different days. Intraobserver and interobserver variability were computed using Fleiss Kappa statistics. Intraobserver variability showed slight to fair agreement. Interobserver variability showed fair agreement. Bone cement was again mixed with the same concentration of barium sulfate to make six cubes of bone cement-barium sulfate mixture. The six cubes underwent compression testing. The bone cement without barium sulfate had the strongest compressive load.

Results: The compressive load showed non-consistent results as the amount of barium sulfate increased which means that the compressive strength of the bone cement is not affected by increasing the amount of barium sulfate. The bone cement with a 20% barium sulfate concentration had an optimum radiopacity under fluoroscopy and at the same time had an optimum compressive strength.

Conclusions: Grading of the radiopacity under fluoroscopy is observer dependent as showed by the different grading and ranking of the three observers. The compressive load is not affected with the increasing amount of barium sulfate used in this study.

F047

Dural tears incidence and its outcome in minimally invasive spine surgery versus open spine surgery for degenerative lumbar spine pathologies

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Background: Dural tears are one of the very common complications of spine surgery irrespective of open or minimal invasive spine surgery (MISS) approach. Purpose of this study is to compare the incidence of unintentional dural tears (DTs) & complications related to it and its association with immediate postoperative recovery & return to work after open surgery vs. MISS for different degenerative lumbar spine pathologies.

Methods: We assessed 578 patients operated for any degenerative lumbar spine pathologies between November 2018 to November 2022 at single institute and by single surgeon. Among those, 172 (135 instrumentation+37 only decompression) were open surgery and 406 (315 microendoscopic discectomy/decompression+91 MIS transforaminal lumbar interbody fusion) were MISS. We studied the incidence of DTs in both open and MISS as well as influence of previous surgery and single vs. multilevel on the rate of DTs. We assessed formation of pseudo meningocele, leakage of CSF from operated wound or requirement of revision surgery after DTs and period of recovery and return to work in both open and MISS group.

Results: Twenty-four patients (13.95%) suffered dural tears in open surgery group while 34 patients (8.37%) in MISS group. Open surgery group has higher rate of DTs than MISS group and that was statistically significant ($p<0.05$). In MISS group, stenosis decompression surgeries have higher rate of dural tear (21/117) vs. discectomy surgeries (6/198) and the difference was highly significant ($p<0.001$). All the patients in MISS group were treated conservatively with bed rest and symptomatic treatment. No direct DTs repair was done in any of MISS group patients except in one case where it was converted to open and dural tear was repaired. In open surgery group, all the major tears were repaired primarily with prolene or mersilk 4-0 suture and fat/fascia graft. Rate of dural tears was high in cases of revision (five DTs in 14 revision surgeries vs. 46 DTs in 564 primary surgeries) surgery ($p<0.05$). Two patients had CSF leakage through operated wound in open group and one patient develops pseudo meningocele in postoperative period in open surgery group. All three patients required revision surgery but none of the patients in MISS group developed a transcutaneous CSF leak or pseudo meningocele. Complications and revision ratio were higher in open group (three revision required) and that was statistically significant ($p<0.05$) compared to MISS group (0 revision required). Postoperative recovery and return to work were also fast in MISS group compared to open surgery group.

Conclusions: MISS approach has lower frequency of dural tears occurrence as well as complications related

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with it compared to open lumbar spine surgeries. MISS approach has less dead space as muscles are not erased so it does not allow enough CSF to collect and form pseudo meningocele or to form fistula. It is not necessary to repair every dural tears in MISS surgery. MISS techniques provide speedy recovery and early return to work even after dural tears compared to open surgeries for various degenerative lumbar spine pathologies.

F050

Analyzing pedicle morphology of thoracic and lumbar vertebra using computed tomographic measurement among filipino population in a tertiary hospital

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Background: Surgical interventions for spinal instability often use transpedicular screw fixation. In the thoracic region, the insertion of pedicle screws poses challenges due to anatomical variations, especially in pedicle angles and their alignment with the vertebral body. Research emphasizes the risk of improperly positioned screws in this area, with potential clinical consequences for the nervous system, blood vessels, and visceral organs, highlighting the crucial need for precise pedicle screw placement.

Methods: This is a cross-sectional analysis of thoracic and lumbar vertebra using computed tomography scan. We have included 198 patients (range, 18–60 years old) and a total of 1,522 pedicles for analysis. We measured five parameters including pedicle width, height, length, and transverse and sagittal angle. We also assessed significant differences based on gender and ethnicity.

Results: Females consistently showed smaller pedicle widths compared to males across all levels, with significant gender differences (p<0.05) noted from T1 to T10. Pedicle axis lengths were shorter in females at all thoracic levels, showing an ascending trend from T1 to T12. In the lumbar region, gender differences in pedicle lengths were observed from L2 to L5, with an increasing pattern from T1 to T12. Transverse pedicle angles showed no significant gender differences, with the greatest angle in the thoracic region at T1 (25.7°±4.8°) and the largest lumbar angle at L5 (27.2°±3.1°). Significant gender differences in pedicle height were observed from T1 to T6, with a consistent increasing trend from T1 to T12 and the largest height at T12. In the lumbar vertebrae (L1–L5), females had smaller pedicle heights, with the smallest at L5 (12.45±1.50 mm). There is noted significant gender difference in pedicle height observed, with female poses consistently having smaller measurements from T1 to T6 and from L1 to L5. The largest pedicle height was observed at T12 for both males (14.78 mm) and females (14.45 mm), showing an increasing trend from T1 to T12. In the lumbar region, the smallest angle was noted at L3 for both males (1.89°) and females (1.84°).

Conclusions: During spine surgery, a significant challenge arises from the use of a blind technique, wherein the surgeon lacks direct visual access to the pedicle. Additionally, the precision of pedicle screw insertion is vital for the effectiveness and stability of the surgical procedure. The study recommends screw sizes based on pedicle width, suggesting a 4 mm diameter for the mid-thoracic region and a larger 5 mm diameter for the upper, lower thoracic, and lumbar areas. To prevent complications such as anterior cortex violation, the study proposes using a 25 mm screw length in the upper thoracic and a 30 mm screw in the mid and lower thoracic regions. Acceptable screw lengths in the lumbar area are suggested to be between 40 to 45 mm. Emphasizing the importance of the transverse pedicle angle, the study advises specific angulations at different thoracic levels to avoid anterior cortex violation. Variations in the sagittal angle are deemed equally crucial. Pedicle morphology exhibit consistent trends across various Asian countries, with specific variations noted in American population.

F052

Are there correlations between surgical timing or weather conditions and early post-spinal fusion surgery infections? big data analysis

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Background: Post-spinal fusion surgery Infections (PSFI)

have been extensively studied, but limited research employs big data to assess the influence of surgical timing and weather conditions. This study uses both clinical and climate big data to investigate these factors.

Methods: Utilizing the Clinical Data Warehouse system of eight Catholic Medical Center hospitals, we included clinical information from January 2013 to November 2022 for cervical and thoracolumbar fusion surgeries. PSFI within 3 months post-surgery were considered for weather-related analyses. Exclusions comprised cases related to spondylitis or immunocompromised patients. Infection rate variations by day, month, and season were analyzed. Additionally, weather big data from the Korea Meteorological Administration were used for correlations.

Results: Our study encompassed 10,880 cases (cervical: 3,076, thoracolumbar: 7,084) with an overall spinal fusion surgery infection rate of 3.94% (cervical: 2.24%, thoracolumbar: 4.61%). Day of the week analysis highlighted the lowest infection rate on Wednesdays (Monday–Friday: 4.4%, 3.7%, 3.0%, 4.6%, 4.2%; $p<0.05$). Monthly and seasonal analyses showed no significant differences. Weather analysis revealed a positive correlation between the surgery day's increased daily average temperature and infection rate (correlation coefficient: 0.41; $p<0.01$). Similarly, an elevated daily average humidity on the surgery day correlated positively with the infection rate (correlation coefficient: 0.29; $p<0.01$). No significant differences in infection rates were observed during the monsoon season in South Korea (Jangma).

Conclusions: Our findings suggest the day of the week may influence PSFI, and climatic factors, specifically the rise in temperature and humidity on the surgery day, are associated with increased infection rates. Surgeons could consider these insights when determining the optimal surgical day.

F053

The fate of pre-existing L5–S1 degeneration following oblique lumbar interbody fusion of L4–L5 and above

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Background: Previous studies have identified various risk factors for adjacent segment disease (ASD) at the L5–S1 level after fusion surgery, including preoperative sagittal imbalance, longer fusion, and preoperative disc degeneration. However, only a few studies have explored the risk factors for ASD at the L5–S1 level after oblique lumbar interbody fusion (OLIF) at the L4–L5 level and above. This study aimed to identify the risk factors for symptomatic ASD at the L5–S1 level in patients with pre-existing degeneration after OLIF at L4–L5 and above.

Methods: We retrospectively reviewed the data of patients who underwent OLIF at L4–L5 and above, with a minimum follow-up period of 2 years. Patients with central stenosis or Lee grade 2 or 3 foraminal stenosis at L5–S1 preoperatively were excluded. Patients were divided into ASD and non-ASD groups based on the occurrence of new-onset L5 or S1 radicular pain requiring epidural steroid injection (ESI). The clinical and radiological factors were analyzed. Logistic regression was used to identify the risk factors for ASD of L5–S1.

Results: A total of 191 patients with a mean age±standard deviation of 68.6±8.3 years were included. Thirty-four patients (21.7 %) underwent ESI at the L5 root after OLIF. In logistic regression analyses, severe disc degeneration (odds ratio [OR], 2.65; 95% confidence interval [CI], 1.16–6.09), presence of facet effusion (OR, 2.55; 95% CI, 1.05–6.23), and severe paraspinal muscle fatty degeneration (OR, 4.47; 95% CI, 1.53–13.05) were significant risk factors for ASD in L5–S1.

Conclusions: In this study, the presence of facet effusion, severe disc degeneration, and severe paraspinal muscle fatty degeneration at the L5–S1 level were associated with the development of ASD at L5–S1 following OLIF at L4–L5 and above. For patients with these conditions, surgeons could consider including L5–S1 in the fusion when considering OLIF at the L4–L5 level and above.

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F056

Vertebral body tethering of main thoracic curve results in spontaneous correction in untethered proximal thoracic cobb and shoulder balance: a three-dimensional analysis

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Background: Vertebral body tethering (VBT) has shown to improve tethered thoracic Cobb for adolescent idiopathic scoliosis (AIS) patients but spontaneous correction of untethered proximal thoracic curve has not been assessed. This study aims investigate the radiological and three-dimensional (3D) corrections at proximal thoracic curve after VBT surgery.
Methods: AIS patients with main thoracic VBT and 3D spinal reconstructions were studied. Proximal and main thoracic Cobb, apical axial rotation, shoulder height, clavicle angle, and T1 tilt were assessed preoperatively and immediate postoperatively. Shoulder imbalance was defined as radiological shoulder height of >2 cm.
Results: Nineteen patients (16 females, three males; mean preoperative age, 12.1±1.1 years) with thoracic idiopathic scoliosis were assessed. All and 18 patients (95%) had main and proximal thoracic Cobb angle correction, respectively. The mean Cobb angles of the proximal and main thoracic curves are 28.3°±11.8° and 48.9°±9.0° preoperatively and 20.5°±8.8° and 23.4°±9.1° postoperatively. The mean axial rotation angle at proximal and main thoracic curve apexes are 8.5°±7.9° and -8.1°±11.6° preoperatively and 6.2°±5.6° and -4.5°±8.7° postoperatively. Clavicular angle and T1 tilt angle were 2.1°±2.3° and 2.9°±4.7° preoperatively and -0.8°±2.9° and 6.5°±7.5° postoperatively. Preoperatively, nine patients (47%) had shoulder imbalance averaged at 19.4°±11.6°. Postoperatively, five patients (26%) had shoulder imbalance averaged at 13.9°±12.6°.
Conclusions: Proximal thoracic Cobb correction in 95% and shoulder balance correction from preoperative 26% to 47% postoperatively highly reflects the potential of spontaneous correction of proximal thoracic curve following main thoracic VBT. More studies with larger sample sizes and longer-term follow-up are needed to investigate axial correction overtime in VBT patients.

F057

Early postoperative outcomes of posterior spinal tuberculosis surgeries: a single-institutional prospective analysis of 15 consecutive cases

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Background: Traditionally, spinal tuberculosis (TB) is surgically approached anteriorly to allow direct access to the focus of infection. However, anterior instrumentation can be fragile because concomitant osteoporosis renders the affected vertebrae weak. The present paper aimed to compare preoperative and early postoperative clinical, radiological, and functional outcomes of spinal TB following the posterior approach.
Methods: Fifteen patients with Gene-Xpert-proven spinal TB cases who underwent posterior surgeries with minimum 6-week follow-up were consecutively recruited for the analyses. Pre- and postoperative kyphosis angles, modified Frankel scores, Prolo Functional Outcome scores, and Numerical Rating Scale pain scores were determined, and the Mann-Whitney *U* test was performed to compare means.
Results: Analyses of kyphosis (19.1° vs. 11.9°, p=0.025) and Prolo (8 vs. 23, p<0.001), modified Frankel (22.7 vs. 8.3, p<0.001), and pain scores (23 vs. 8, p<0.001) showed marked improvements following the posterior surgeries, which were found significant following statistical analysis.
Conclusions: The posterior approach seems to be a reliable and effective option for treating surgical cases of Pott's disease.

F058

Awareness of trainees on diagnosing tuberculosis spondylitis: an analysis of cross-sectional data among Filipino orthopedic residents

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Background: While current literature shows that timely diagnosis of tuberculosis (TB) spondylitis is crucial to reducing morbidities, there is lack of specific clinical diagnostic criteria, and symptoms can be nonspecific. Thus, the lack of experience may cause further difficulty in arriving at the diagnosis, particularly in cases with atypical manifestations. The present paper aimed to determine the awareness among Filipino orthopedic residents on diagnosing TB spondylitis, for future comparisons needed for the development of an appropriate training strategy.
Methods: A total of 35 participants from ten different institutions in the country were included for the analysis. We recognized various factors such as resident attitudes, health-care system, knowledge sources, and socio-economic variables in our conceptual model for developing proper diagnostic skills among the residents, which served as basis for developing the questionnaire. For the statistical analysis, Fisher's exact test was utilized to compare proportions.
Results: A relatively high misdiagnosis rate (46%) was found among the residents, and the proportion of residents foregoing preoperative biopsy (51%) mirrors the lack of surgical exposure among the majority (57%) of them. Sixty-three percent of participants treat more cases of TB spondylitis than tumor, and following comparative analysis using Fisher's exact test, there were no significant differences between the senior and junior residents' responses to the questions.
Conclusions: Prevalence of TB spondylitis remains high in the country, providing the need to standardize a valid and reliable diagnostic approach. Therefore, establishing correct methods and criteria for diagnosing TB spondylitis is a valid and relevant goal of Filipino orthopedic residency.

F059

Clinical effect of intraoperative use of tranexamic acid in minimal invasive scoliosis surgery in patients with adolescent idiopathic scoliosis

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Background: Intraoperative use of tansaminic acid is known to be effective in minimizing intraoperative blood loss and reducing intraoperative and postoperative blood transfusion. However, few studies have been reported on the clinical effect of its use in minimal invasive scoliosis surgery.
Methods: Our center started using tranexamic acid intraoperatively in minimal invasive scoliosis surgery from June 2022. Consecutive data were collected from 67 patients who underwent surgery for adolescent idiopathic scoliosis from 2021 to 2022. All patients underwent minimal invasive scoliosis surgery done by a single surgeon. Thoracoplasty was done if needed. Expected blood loss, hemovac drainage amount, and complication (hemothorax, pleural effusion, etc.) were compared between two groups.
Results: Thirty patients underwent surgery without intraoperative use of tranexamic acid (group A), and 37 underwent surgery with tranexamic acid (group B). To confirm homogeneity between the two groups, age, gender, height, weight, body mass index, Cobb's angle, curve type, fusion extent, amount of correction, and preoperative hemoglobin level were compared. There was no difference between two groups (all $p>0.50$). An average of 1.45 pack of red blood cell transfusions were performed. Group A needed an average of 1.58 packs and group B needed 1.25 packs, reducing the amount of transfusion, but there was no statistical significance ($p=0.166$). There was no difference in postoperative hemoglobin level between the two groups on the day before and day 1, 2, 3, and 4 after surgery (all $p>0.05$). There was statistical difference in amount of change in hemoglobin level (3.27 vs. 2.54, $p=0.036$). Nine patients needed thoracentesis or chest tube insertion after minimal invasive scoliosis surgery in group A but did not need these invasive procedures in group B.
Conclusions: In minimal invasive scoliosis surgery, intraoperative use of tranexamic acid can reduce the amount of blood transfusion after surgery and reduce

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the amount of hemoglobin decrease. Its use also reduced the incidence and severity of hemothorax and pleural effusion associated with thoracoplasty performed during surgical procedure.

F060

Thoracic chord length in scoliosis using the ideal pedicle entry point based on facet joint: a computed tomography study

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Background: Pedicle screw insertion has become one of the most commonly performed procedures in spine surgery. Although commonly used, questions remain about its safety, especially in the thoracic spine, where positioning can be difficult and the pedicle can break or damage adjacent structures.
Methods: This is a prospective study of 30 patients with adolescent idiopathic scoliosis. Between August 2022–May 2023, 89 patients underwent correction and fusion for scoliosis with transpedicular screw fixation using the freehand technique in which ideal pedicle entry point was taken as entry point for thoracic pedicles. Among the patients who underwent correction and fusion for scoliosis with transpedicular screw fixation using the freehand technique correction from august 2022 to May 2023 patients who underwent preoperative computed tomography (CT) and also postoperative CT were enrolled. Only the patients who underwent whole T spine from T1–T12 were enrolled and the patients who did not underwent whole T spine were excluded. The average age is 16.38 years (range, 11–20 years) of which 27 were females and three were males. All the patients underwent CT scan using Siemens 4th generation scanner. The scans were analyzed by measuring the expected screw length with the trajectory vertical to facet joint starting from one third lateral and just distal point of facet joint; all the measurements being made both on the convex as well as the concave pedicle. Statistical analysis was performed with paired *t*-test.
Results: A total of 3,240 measurements were performed from 30 patients and 720 pedicles were assessed for each set of the measurements made. Average of pedicle screw length was bigger than 38 mm in T3–T11. There was no difference between convex side and concave side in pedicle screw length. Comparing the pedicle screw length with previous measured technique in same CT image, it was significantly longer in mid thoracic level (T5–8) and no difference in other levels.
Conclusions: Screw insertion through a vertical trajectory starting from lateral one third and just distal of facet joint might be a safe technique in deformed spine of AIS for T3–T11 level.

F062

The safety and efficacy of posterior vertebral column resection in treating severe thoracolumbar Pott's deformity in more than 5-year follow-up

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Background: It is still unclear the long-term results of posterior vertebral column resection (PVCR) in treating severe Potts kyphosis more than 90°. This study comprehensively analyzed the safety and efficacy of PVCR in treating thoracolumbar Potts kyphosis in more than 5-year follow-up.
Methods: A total of 40 patients with severe thoracolumbar Potts kyphosis (≥90°) who underwent PVCR with more than 5-year follow-up were included. The operation time, estimated blood loss (EBL), length of hospital stay, complications, and bone fusion time were collected. The spinopelvic parameters and Frankel grades were compared before, after surgery, and at final follow-up.
Results: This study included 22 males and 18 females, with an average age of 38.3 years and an average follow-up time of 80.8 months. The mean operation time was 365.2±86.5 minutes, the intraoperative EBL was 1,371.9±610.1 mL, the length of hospitalization was 12.3±2.2 days, and the mean bone fusion time was 7.6±1.4 months. The magnitude of scoliosis decreased from 20.8° before surgery to 6.1° after surgery (p<0.05), and to 6.5° at final follow-up. The local kyphosis angle decreased from 109.6° before surgery to 31.6° after surgery (p<0.05), and increased to 38.3° at final follow-up.

There were no significant differences in coronal balance and sagittal vertical axis before, after surgery, and at the final follow-up (p>0.05). Before surgery, 22 patients had normal neurological function (Frankel grade E), and 18 patients showed neurological impairment. The neurological function of 32 patients was Frankel E at 3 months follow-up and 33 patients at the final follow-up. The Scoliosis Research Society-22 score was increased from 2.9±0.7 points before surgery to 3.9±0.5 points at the final follow-up (p<0.05). Perioperative complications including temporary neurodeficit, cerebrospinal fluid leaking, and girdle pain occurred in six patients, all of which were successfully resolved by treatment. Late complications presented in eight patients, including implant failure in six cases, proximal junctional kyphosis in one case, and nonunion in one case. Permanent paraplegia occurred in one patient in our early-stage practice.

Conclusions: PVCR is effective in treating severe thoracolumbar Potts deformity, leading to improved spinal alignment, neurological function, and quality of life in the long term. Care should be taken to prevent and manage complications related to neurodeficit and implant failure.

F067

Pelvic incidence as a predictor of proximal junctional kyphosis in Lenke type 5 adolescent idiopathic scoliosis patients

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Background: In recent years, sagittal alignment is recognized crucial in adolescent idiopathic scoliosis (AIS) patients, alongside coronal alignment. However, few studies have investigated the risk factor for proximal junctional kyphosis (PJK), a common complication of sagittal malalignment following posterior correction and fusion surgery (PSF). While the significance of pelvic morphology in relation to PJK has been suggested, a consensus has not been established. Therefore, our aim was to assess the relationship between pelvic incidence (PI) and the occurrence of PJK in patients with Lenke type 5 AIS.

Methods: We retrospectively analyzed 92 Lenke type 5 AIS patients who underwent selective thoracolumbar PSF with minimum of 18-month follow-up. Data were collected pre- and postoperatively, and patients were categorized into the PJK group or the non-PJK group. Binary logistic analysis was conducted to evaluate the influence of PI on the occurrence of PJK. Subgroup analysis was performed based on the value of PI (low PI, <45°; high PI, ≥45°) to investigate factors affecting the occurrence of PJK.

Results: The incidence of PJK was 17.4% (16 out of 92 cases) with no difference in demographic data between the two groups. Binary logistic analysis found that low PI was a risk factor for PJK (odds ratio, 0.933; p=0.017). Following the subgroup analysis, the mean value increase of upper instrumented vertebra slope in the postoperative phase, detected in PJK cases, was comparable in both the low PI and high PI groups. In contrast, lordotic change by surgery at the fused area was significantly larger in the PJK cases with low PI. No statistical difference of postoperative Scoliosis Research Society-22 score was found between the PJK group and non-PJK group.

Conclusions: This study elucidated the risk of PJK in low PI patients undergoing selective thoracolumbar PSF for patients with Lenke type 5 AIS. Due to the lordotic change at the fused area and the limited compensatory capacity at the pelvis, PJKs were more likely to occur in patients with low PI.

F069

Erector spinae atrophy correlates with global sagittal imbalance and postoperative proximal junctional kyphosis incidence in lumbar degenerative kyphosis

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Background: Lumbar erector muscle atrophy has been studied in lumbar degenerative kyphosis (LDK). However, its role in compensatory mechanism is still under intense discussion, especially the role of erector spinae

(ES) muscle is always overlooked. It aims to investigate the relationship between lumbar erector muscle atrophy and global sagittal imbalance in LDK, and with the postoperative proximal junctional kyphosis (PJK).

Methods: Fifty-one LDK out of 382 adult degenerative spinal deformity patients were enrolled in the study. Baseline information was reviewed including demographic data and complications. Sagittal spinopelvic alignments and global imbalance parameters were assessed on full-length spine X-ray films. Muscularity and fatty infiltration area of ES and multifidus (MF) was measured at L4/5 level on preoperative magnetic resonance imaging to evaluate the lumbar erector muscle atrophy. Stratification by sagittal vertical axis (SVA) was performed: group 1 with SVA <100 mm and group 2 with SVA >100 mm, comparison was performed between both groups. Spearman correlation and multivariable logistic regression analysis was performed to analyze define the risk factors for postoperative PJK.

Results: Group 2 had lower ES and MF muscularity than group 1. ES muscularity correlated with SVA (r=-0.510, p=0.003), lumbar lordosis (r=-0.415, p=0.018), and postoperative PJK (r=-0.508, p=0.022). MF muscularity was not correlated with the parameters above. Multivariable logistic regression analysis verified ES muscularity (odds ratio [OR], 0.001; p=0.039) and SVA (OR, 1.034; p=0.048) as the risk factors for postoperative PJK.

Conclusions: ES atrophy, besides MF, is an important predictor to distinguish decompensated LDK from the well-compensated ones. It plays an important role in compensatory mechanism, not only correlates with global sagittal imbalance, but also ties to PJK after deformity corrective surgery.

F070

Clinical and radiological outcome of selective fusion for rotatory olisthesis in degenerative lumbar scoliosis: a retrospective cohort study

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Background: Degenerative lumbar scoliosis is often associated with rotatory olisthesis (RO), and selective fusion of RO is a common option for surgical treatment. However, the clinical and radiological outcome is still controversial. It aims to investigate the longtime clinical and radiological outcome of selective fusion for RO in degenerative lumbar scoliosis.

Methods: A cohort of 54 consecutive degenerative lumbar scoliosis cases with RO was included in the study. All the included cases underwent selective RO fusion and at least a 2-year follow-up. They were divided into two groups: group 1 with a curve <30° and group 2 with a curve ≥30°. Clinical outcome was evaluated by the Oswestry Disability Index (ODI) and Numerical Rating Scale. The radiological assessment included RO location, the value of offset and subluxated disc orientation, Cobb angle, and coronal and sagittal alignments.

Results: The value of offset was greater in group 2 than in group 1 (13.4±4.7 mm vs. 9.3±3.5 mm, p<0.001). The subluxated disc is mainly oriented to the concave side in group 2 (15/21), but to the convex side in group 1 (20/33) (p=0.022). Group 2 had a higher rate of postoperative adjacent RO than group 1 (14/21 vs. 1/33, p<0.001). ODI was similar between both groups preoperatively, but higher at the final follow-up in group 2 (34.9±9.5) than in group 1 (24.4±6.2). Multiple various logistic regression analysis chose thoracolumbar and lumbar curves as the risk factor of postoperative adjacent RO (odds ratio, 1.400; p=0.007). Receiver operating characteristic analysis verified it with the area under the curve=0.960 (p<0.001).

Conclusions: The clinical and radiological outcomes are well-maintains in group 1, but not in group 2. It is a rational option to do selective RO fusion in degenerative lumbar scoliosis with a lumbar curve <30°. It should be avoided in those with lumbar curves over 30°, due to a higher complication rate and worse clinical outcomes at the final follow-up.

F071

Vertebral body tethering results in improvement in coronal Cobb angle but deterioration in axial rotation: a three-dimensional analysis

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Background: Vertebral body tethering (VBT) has shown

improvements in coronal and sagittal plane correction in adolescent idiopathic scoliosis (AIS) patients, but axial correction over time remains unexplored. Three-dimensional (3D) spine reconstruction was used to analyze correctional changes in all spinal planes post VBT surgery.

Methods: AIS subjects who underwent thoracic VBT surgery with a minimum 2-year follow-up were assessed. Biplanar radiographs were used for 3D spinal reconstructions, 3D coronal, sagittal thoracic kyphosis (TK), lumbar lordosis (LL), and axial rotation measurements were compared at preoperative (preop), immediate postoperative (postop), 1-year, and 2-year follow-up.

Results: Eight patients (seven females, one male) with a mean age of 11.8±1.3 years with right thoracic curves (mean 50.4°±8.1°) were followed for 26.8±4.1 months. Based on 3D reconstruction results, the mean coronal Cobb angle showed significant improvement: 28.4°, 19.2°, and 27.1° at postop, 1-year, and 2-year follow-up (p<0.001), respectively. Comparing preop to latest follow-up, there was minimal change in the TK and LL, which measured 35.2°, 39.0°, 31.3°, 37.0° for TK; 46.1°, 42.8°, 36.5°, 42.8° for LL at preop, immediate postop, 1-year, and 2-years of follow-up. Apical axial rotation improved from -5.5°±5.0° to -1.4°±4.8° postop, then deteriorated to -3.2°±4.9° at 1 year and -7.0°±5.9° at 2 years, with no significant changes.

Conclusions: This is the first study to use 3D radiographic digital measurements to reveal apical axial rotation progression in thoracic curves despite improved coronal curvature. While larger scales studies with longer follow-up are needed to verify our findings, surgeons and patients should be aware of such findings in their decision to select VBT as their procedure of choice.

F076

Does anterior surgery provide good surgical outcome for k-line (-) and/or huge (occupying ratio >50%) ossification of posterior ligament in cervical spine?

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Background: The patients who have apparent neurological disorders with ossification of posterior ligament (OPLL) in cervical spine, need surgical intervention. There are two main surgical approaches, anterior and posterior. Both approaches have advantages and disadvantage. However, we do not have enough information about surgical results of anterior surgery for patients with huge OPLL in cervical spine. The aim of this study is to investigate the pros and cons of anterior surgery for the patients with K-line (-) and/or huge OPLL (occupying ratio >50%) in cervical spine.

Methods: Twenty-two patients who suffered from cervical OPLL (K-line [-] and/or occupying ratio >50%) and underwent anterior surgery were included in this study. All patients underwent surgical resection or floating method of OPLL and anterior fusion, with or without posterior fixation, from 2007 to 2022. A bone graft from the iliac crest was performed in all cases. Anterior fusion with anterior pedicle screw fixation was done in seven cases, anterior pedicle screw and plate fixation in seven cases anterior pedicle screw fixation followed by posterior pedicle screw and rod fixation in six cases, and conventional anterior fusion in two cases. All patients were followed more than 12 months and evaluated with the Japanese Orthopaedic Association (JOA) score. Surgical invasiveness; surgical time, blood loss, and complications; neurological deterioration, CSF leakage, C5 palsy; and so forth were investigated.

Results: The average surgical time was 250 minutes, and the average blood loss was 317 mL. Fusion levels were one level in one case, two levels in six cases, and three levels in 15 cases. The average JOA score was 10.7 preoperatively and improved to 14.1 at the final follow-up. The mean recovery rate was 59%. The local alignment was 0.5° kyphotic preoperatively and 4.6° lordotic at the final follow-up. Dura tear occurred in two cases, and one of them needed spinal drainage for 1 week. C5 palsy was seen in three cases and improved spontaneously. One case needed removal of a hematoma postoperatively. Another required additional laminoplasty due to inadequate decompression with insufficient floating of the OPLL. Two cases who underwent anterior pedicle screw fixation alone showed postoperative kyphotic deformity and required posterior fusion. One case showed loss of motor-evoked potential during surgery and developed paresis postoperatively. He needed 6 months of rehabilitation to recover his motor function.

Conclusions: Anterior surgery with OPLL resection/floating provided good surgical outcomes with a 59% improvement rate in the JOA score for patients with large OPLL (K-line [-]/occupying ratio >50%). However, moderate to severe complications occurred in 10 cases, and four of them needed additional surgery

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or procedures. Anterior decompression and fusion provided good surgical results for patients with large OPLL, but with a high rate of severe complications.

F078

Impact of osteoporosis on clinical outcomes after corrective fusion for adult spinal deformity and reoperation rates for mechanical complications

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Background: Corrective fusion surgery for adult spinal deformity (ASD) often involves multiple implants to align and stabilize the spine and pelvis. However, bone fragility in the spine or its adjacent areas may lead to mechanical complications, influencing clinical outcomes. The purpose of the study was to compare the health-related quality of life (HRQOL) and revision surgery rates due to mechanical complications in ASD patients undergoing corrective fusion, both with and without osteoporosis.
Methods: This study analyzed the patients (aged 40 years and above) who underwent corrective fusion from thoracic spine to the pelvis for ASD between 2010 and 2017, with a minimum follow-up of 5 years post-surgery. ASD patients were classified into an osteoporosis group based on a T-score ≤2.5 at the femoral neck, or pre-existing fragility fractures of the spine or proximal femur. We investigated preoperative and 5-year postoperative revised Scoliosis Research Society-22 (SRS-22r), Oswestry Disability Index (ODI), and revision surgery rate for mechanical complications within 5 years after surgery, and compared the results between groups without and with osteoporosis.
Results: The study included 139 patients (125 females; average age, 67.2 years). In the non-osteoporosis group (n=75; average age, 65.4 years) and the osteoporosis group (n=64; average age, 69.4 years), SRS-22r Function improved from a preoperative mean of 2.7 vs. 2.4 (no osteoporosis group vs. osteoporosis group) to 3.5 vs. 3.1 at 5 years postoperatively. Pain improved from 3.0 vs. 3.1 preoperatively to 4.0 vs. 3.7 at 5 years postoperatively, and ODI improved from 41 vs. 44 preoperatively to 23 vs. 31 at 5 years postoperatively in both groups (p<0.001). No significant difference was observed in SRS-22r Function and ODI changes between the groups (p>0.05). However, the improvement in SRS-22r Pain was significantly greater in the non-osteoporosis group (no osteoporosis group vs. osteoporosis group) (1.0 vs. 0.6, p=0.046). SRS-22r Satisfaction scores at 5 years were 3.6 and 3.4, respectively, with no significant difference (p=0.101). The 5-year revision surgery rate for mechanical complications was 17.3% in the non-osteoporosis group versus 32.8% in the osteoporosis group (p=0.034).
Conclusions: Corrective fusion surgery for ASD, including those with osteoporosis, showed improvement in function and pain after 5 years. However, the presence of osteoporosis negatively impacted pain improvement and increased the likelihood of revision surgery for mechanical complications.

F079

Factors associated with non-contiguous spine fracture in patients with traumatic cervical spine injury: a 12-year retrospective study

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Background: Multilevel non-contiguous spine fractures are defined as the lesions separated by at least one normal vertebra. Multilevel non-contiguous spinal fractures in traumatic cervical spine injury patients often miss diagnosis of secondary injuries due to neurological symptoms and extraspinal injuries. Missed secondary injuries with unstable type has been reported as 21% of non-contiguous cervical spine injuries. Purpose is to identify factors associated with non-contiguous spine fracture in patients with traumatic cervical spine injury.
Methods: The 12-year retrospective observational study included 588 patients with traumatic cervical spine injury who be admitted at Maharaj Nakorn Chiang Mai Hospital between January 2011 to December 2022.

Patients were categorized into two groups: those with non-contiguous spine fractures and those without non-contiguous spine fractures. Outcomes were analyzed using multivariable logistic regression. Results are presented as odd ratio (OR) and 95% confidence interval (95% CI).

Results: Among 588 patients, the incidence of non-contiguous spine fractures was 17.01% (100 of 588 patients). Independent factors associated with non-contiguous spine fracture were motor weakness (OR, 1.89; 95% CI, 1.19–3.01; p=0.007), intracranial injuries (OR, 2.61; 95% CI, 1.61–4.23; p=0.000), intrathoracic injuries diagnosed by the extended Focused Assessment with Sonography in Trauma (FAST) and chest radiograph (OR, 2.88; 95% CI, 1.77–4.69; p=0.040), and intraabdominal injuries diagnosed by FAST (OR, 1.91; 95% CI, 1.03–3.55; p=0.000).

Conclusions: The risk of non-contiguous spine fracture in patients with a traumatic cervical spine injury will increase if patients have motor weakness, intracranial injuries, intrathoracic injuries, and intraabdominal injuries. Whole spine computed tomography or magnetic resonance imaging is beneficial in these patients to avoid missing the remote spinal injury.

F081

Multifactorial genetic analysis as a prospective predictor of adolescent idiopathic scoliosis development: ladybird homeobox 1 and estrogen receptor mRNA expression

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Background: Adolescent idiopathic scoliosis (AIS) is a multifactorial disease influenced by genetic and environmental factors. The etiology of AIS remains unknown; however, the presence of a gender disparity suggests the importance of genetic factors in its incidence. Previous studies have shown a correlation between the development of AIS with the messenger RNA (mRNA) gene expression of estrogen receptor (ESR) and ladybird homeobox 1 (LBX1). This proves an interesting factor with potential prospective use in predicting development of severe AIS in early detected AIS not indicated for surgical intervention yet. This study aims to evaluate the mRNA expression of LBX1 gene and ESR as a prognostic factor for the development of severe AIS in the Indonesian population.

Methods: This was a preliminary study conducted on severe AIS patients undergoing correctional deformity operative management. The specimens used were paravertebral muscle tissues obtained during the operative procedure. We examined the mRNA gene expression of LBX1 and ESR quantitatively by real time polymerase chain reaction. Samples were analyzed against a control and subsequently analyzed multi-factorially with clinical profiles which included the number of structural curves, location of major curves, sagittal profile, lumbar spine modifiers, major curve degree angle, flexibility, and post-correctional degree angle.

Results: Twenty-four subjects participated in this study. We found that there was an overexpression of LBX1 mRNA in severe AIS patients (p<0.05). Both LBX1 and ESR mRNA expressions were shown to have a positive correlation with the severity of curvature degree, flexibility, and post correction angle with significant results (p<0.05). LBX1 was significantly correlated with the location of the major curve (p<0.05). No significant correlations were found between both ESR and LBX mRNA expression with the number of structural curves, location of major curve, sagittal profile, lumbar spine modifier (p>0.05).

Conclusions: We found significant mRNA overexpression of LBX1 and ESR gene in patients with severe AIS. These findings were also significantly correlated with the severity of the curvature degree. This study supports the prospective use of mRNA expression of LBX1 gene and ESR as a promising prognostic factor in the early prediction of severe AIS cases.

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F083

Evaluation of mRNA tumor necrosis factor alpha level from nucleus pulposus, annulus fibrosus, and facet joint tissue on degenerative lumbar canal stenosis patient

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Background: 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 structures that presumably elicit the pain is intervertebral disc and facet joint. Increasing pain which is 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 messenger RNA (mRNA) specific for TNF-α which is expressed in related structure of degenerative lumbar canal stenosis disease; nucleus pulposus, annulus fibrosus, and facet joint. Along with the evaluation of TNF-α expression, this study aimed to observe the correlation between level of mRNA TNF-α and subjective parameters such as Visual Analog Scale (VAS) score for pain severity, pain characteristic and preoperative score Oswestry Disability Index.
Methods: This study used a cross-sectional model involving 10 patients with degenerative lumbar canal stenosis who had undergone surgery. Six male and four 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 were 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-α between each source and to observe its correlation with subjective parameters.
Results: The level of mRNA TNF-α expression in facet joint groups was (4.13±11.63) which was significantly higher compared to the annulus fibrosus group (2.32±6.01) and nucleus pulposus group (-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), and axis pain type (p<0.002).
Conclusions: 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 also has a strong positive correlation with the subjective parameters (pain severity, pain characteristic and preoperative condition,).

F097

Results of single level discectomy and decompression by unilateral biportal endoscopy: does it have the potential to become a gold standard technique?

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Background: Surgical management after failed conservative methods for lumbar disc herniation has evolved from open and microscopic discectomy to advanced minimally invasive techniques. Unilateral biportal endoscopy (UBE) technique is one such rapidly growing method and results from Southeast Asian countries who have pioneered in this method are encouraging. We present the clinical outcomes of this novel technique in single level discectomy and decompression surgery in our population. We compared the results with a matched retrospective sample of microdiscectomy (MLD) done at same center by the same surgeon.
Methods: UBE technique is performed using two small incisions and discectomy is done using zero-degree endoscope in a saline flow medium with minimal bony work involved. Patients who underwent single level discectomy by UBE technique from October 2022 to September 2023 (25 cases) were compared with MLD from March 2022 to August 2022 (25 cases). Outcomes of the patients were assessed with operation time, hospital stay, complications, and total hospitalization cost. Clinical outcomes of Visual Analog Scale (VAS) for back and leg pain and the Modified Oswestry Disability

Index (ODI) were compared between the two groups.
Results: There was no significant difference between age and gender in the two groups. Most common level was L4–5 in both groups followed by L5–S1. Patients in both groups had significant pain relief post-surgery evident in VAS scores for leg pain (improvement from mean of 7.2 to 2.5 in UBE group and 6.8 to 2.2 in MLD group) although the difference was not statistically significant. Operation time in UBE group was longer (mean of 75 minutes) compared to MLD group (50 minutes, $p<0.05$) which can be explained by initial learning curve phase for the surgeon. Modified ODI score improved significantly in both groups with no difference between the groups. Length of hospital stay and cost was also comparable between the groups. Both groups had one dural tear each and no recurrence, discitis or neurological deficits in both the groups.
Conclusions: UBE technique is a promising new method to perform discectomy. The outcomes are comparable to the gold standard MLD technique except the operating time which can improve over the period of learning curve. Being minimally invasive, it provides operational flexibility with a clear surgical field and reduced infection risk thereby making it a safe and effective alternative to other techniques.

F098

Tandem spinal stenosis: a 845 multiracial Asian patients' prevalence and risk factor analysis

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Background: Tandem spinal stenosis (TSS), characterized by stenosis occurring concurrently in the cervical and lumbar spinal regions, presents variably in the literature, with prevalence rates ranging from 5% to 60%. This study seeks to elucidate the incidence of TSS and identify associated risk factors in a large, multiracial Asian population.
Methods: We retrospectively analyzed 845 adult patients who underwent T2-weighted magnetic resonance imaging of the entire spine in 2008 at a university hospital. Patients with malignancies, fractures, or infections were excluded. Demographic information was collected, and patients were categorized by age and race. Canal measurements were taken at various vertebral levels and disc levels for cervical and lumbar spine. Using a 10-mm cut-off, stenosis prevalence was determined for both cervical and lumbar regions. Statistical analyses, including *t*-tests, analysis of variance, and multivariate logistic regression, were employed.
Results: The cohort comprised 458 males (54.2%) and 387 females (45.8%) with a mean age of 48 years. The majority were Chinese (544 patients). Mean midsagittal diameter measurements differed across cervical and lumbar segments. Cervical stenosis was identified in 40.5% and lumbar stenosis in 58.8% of participants, using the 10-mm cut-off. TSS was found in 26.7% of patients. Notably, reduced measurements at C3/4, C4/5, C5/6, C6/7, L4/5, and L5/S1 disc levels were significant risk factors for tandem stenosis. The data revealed that each level of cervical stenosis carried an odds ratio of 1.33, while each level of lumbar stenosis presented an odds ratio of 1.52.
Conclusions: In conclusion, this study identified a significant incidence of TSS at 26.7% in a multiracial Asian population. These findings underscore the importance of thorough spinal assessment in patients presenting with stenotic symptoms and the need for further research into the mechanisms and management of TSS.

F100

To assess role of three-dimentional printed model in preoperation planning and outcome of kyphectomy

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Background: Fifteen percent of patients with open neural tube defects develop severe kyphosis requiring kyphectomy, a high-risk surgery. In 50% of cases, nonunion and implant failure occur. We present an unreported cause of non-union at the rudimentary L5–S1 disc following a kyphectomy. Additionally, we describe preoperative planning using a three-dimensional (3D) printed spine model of the patient.
Methods: A 10-year-old girl, who previously underwent meningomyelocele closure at 6 months of age, presented with a non-healing ulcer at the apex of lumbar

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kyphosis. She has had no neurological function below T9 since birth. She underwent a cordectomy at the T9 level, and 1 month later, she underwent a kyphectomy from L1 to L4, with docking of T12 over L5 and posterior fusion from T7 to the pelvis. The surgery was planned using a real-size 3D printed model of her spine.

Results: At 3 months, a postoperative computed tomography scan showed union at the kyphectomy site. At 6 months after surgery, she had kyphosis recurrence and failure of bilateral iliac screws. Progressive widening of the rudimentary L5–S1 disc was identified as the cause of the failure. The pseudarthrosis was repaired, and revised iliac screws were augmented with modified Dunn-McCarthy rods. The rods for this fixation were pre-contoured on the 3D printed model and autoclaved preoperatively for use during the surgery. At the 2-year follow-up, a computed tomography scan showed complete fusion at the nonunion site without any wound problems.

Conclusions: Nonunion at adjacent disc levels is known following kyphectomy. We present an unusual cause of nonunion at the rudimentary L5–S1 disc (S1 sacralized). During surgery, special attention should be given to the fusion of all disc levels, including rudimentary discs that lie within the fixation levels. A 3D printed model is of enormous help in planning this complex surgery.

F103

Long-term follow-up rotational changes after direct vertebral rotation in adolescent idiopathic scoliosis

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Background: Direct vertebral rotation (DVR) using thoracic pedicle screws, a rotational corrective maneuver used in the surgical treatment of adolescent idiopathic scoliosis (AIS), was introduced in 2004. Although DVR is considered to be the main axial corrective maneuver, the long-term rotational changes of vertebrae are still unknown in AIS. Therefore, this study is to evaluate long-term rotational changes of vertebra in AIS patients who underwent DVR.

Methods: A total of 135 vertebrae that underwent DVR using thoracic pedicle screws with a minimum 5-year follow-up were retrospectively assessed for the vertebral rotation angle. Vertebral rotation of the apical vertebra (AV), and distal end vertebra (EV) was evaluated using the Nash-Moe scale, the rotational angle to the sacrum (RAsac), and the Aaro and Dahlborn method.

Results: The mean Nash-Moe scale of distal EV showed statistically significant differences between preoperative and postoperative values (p=0.034) and no statistically significant difference between postoperative and last follow-up values (p=1.000), in a Bonferroni post-hoc analysis. The last follow-up RAsac of AV did not differ significantly from the preoperative RAsac of AV (p=0.515). The last follow-up RAsac of distal EV was significantly lower than the preoperative RAsac of distal EV (p=0.001). Pearson's correlation analysis showed that the last follow-up RAsac of distal EV was correlated with Cobb angle of the main curve (r=0.459, p=0.004), loss of correction (r=0.541, p=0.001), and LIV tilt angle (r=0.504, p=0.001).

Conclusions: The rotation regression phenomenon in AV and rotation maintenance in distal EV were observed after DVR for a 10-year follow-up. These findings suggest that the DVR in the surgical treatment of AIS has a positive long-term effect on the stabilization of distal EV from the point of view of axial rotation.

F104

The safety of full endoscopic spine surgery (uniportal endoscopy) from the perspective of the amount of infusion fluid and magnetic resonance imaging scan

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Background: Full endoscopic spine surgery (FESS) has been performed for several years, and its effectiveness is well known; however, no study on its inflow and outflow of infusion fluid has been published. The authors

surveyed the change of the amounts of infusion fluid according to operation time and measured postoperative muscle edema in multifidus muscle (MFM) using magnetic resonance imaging (MRI) images.

Methods: This study included 51 patients who underwent FESS by a single surgeon at a single medical institution from May 2023 to November 2023. Endoscopic laminotomy were performed in all cases with or without discectomy. Twenty-seven patients were lumbar disc herniation patients, and 24 were spinal stenosis patients. During surgery, inflow and outflow amounts (g) were measured every 15 minutes. The hydro pressure for infusion was fixed at 35 mm Hg throughout the operation time by the infusion pump same as arthroscopic device. The degree of muscle edema was compared by measuring the signal intensity of MFM and psoas muscle on both sides in pre- and postoperative T2-weighted MRI images. Statistical methods used were *t*-test and analysis of variance.

Results: The average total amount of inflow was 8,484.6 g, and that of outflow was 8,419.5 g. The mean duration of operation time was 52.9 minutes. There was no difference in the amount of inflow and outflow every 15 minutes. However, the amount of water entering was greater up to 15 minutes, and the amount of water coming out was greater after 30 minutes and 45 minutes. Additionally, the amount of water re-entered was greater until 60 minutes had elapsed. This showed statistical significance ($p<0.05$). The change in signal intensity of MFM in T2-weighted MRI scans taken before operation and those within 1 hour after surgery did not show statistical significance ($p>0.05$).

Conclusions: The average quantitative amount of absorbed water measured during FESS is approximately 14.7 g, and the muscle edema of the MFM at the operated site has no statistical difference. Therefore, FESS may be considered a potentially safe surgical technique that rarely causes neurological symptoms and soft tissue injury due to hydro pressure.

F109

Learning powered axial vertebral rotation analysis for adolescent idiopathic scoliosis: technology development and clinical validation

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Background: Adolescent idiopathic scoliosis (AIS) is a prevalent three-dimensional skeletal deformity that involves axial rotation and coronal curvature. The evaluation of apical vertebral rotation (AVR) within the curved spine is critical to developing effective treatment strategies. However, an appropriate artificial intelligence model that can accurately identify the apical vertebra and quantify AVR is currently lacking.

Methods: From June 2019 to October 2022, we recruited 2,473 AIS patients for biplanar imaging across two centers. The image dataset was split into training and testing sets at a 4:1 ratio. SpineHRNet+ was trained to predict Nash-Moe AVR grades. Linear regression analysis and confusion matrices were performed to compare the performance of SpineHRNet+ against the ground truth (GT) annotated by experienced surgeons. Linear regression analysis was also performed to assess the correlation between AVR and sagittal spinopelvic parameters for clinical validation.

Results: A total of 2,473 patients were ultimately included in this study. Of these, 2,043 were used for the training and validation of SpineHRNet+, while 430 patients were used to assess the accuracy of SpineHRNet+'s AVR predictions. The distribution of patients with varying degrees of scoliosis indicated that 620 patients (25.1%) had mild scoliosis (Cobb angle: 10°–20°), 1,494 (60.4%) had moderate scoliosis (Cobb angle: 20°–40°), and 360 (14.6%) had severe scoliosis (Cobb angle >40°). Patients with double or multiple curves accounted for 1,501 cases (59.1%). A total of 4,158 curvatures were identified, with thoracic, thoracolumbar, and lumbar curves counting 2,335 (56.2%), 873 (21.0%), and 949 (22.8%), respectively. Nash-Moe classification revealed

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2,141 patients (51.5%) with grade 1, 1,842 (44.3%) with grade 2, 134 (3.22%) with grade 3, and 41 (0.99%) with grade 4 AVR. Compared to the GT in model performance analysis, SpineHRNet+ accurately identified the position of the apical vertebra in 97.0% of cases and accurately predicted the grade of AVR in 81.4% of cases, with a Pearson correlation coefficient of 0.89 (p<0.001). AVR predicted by both SpineHRNet+ and GT showed a statistically significant correlation with the Cobb angle of the corresponding curve (p<0.001, by Pearson correlation).

Conclusions: The Enhanced SpineHRNet+ model was trained and clinically validated, which can provide a significant advancement in the automated prediction of AVR in AIS patients. This model was underscored by the high accuracy in apical vertebrae identification and Nash-Moe grading of AVR. The precision of automatic AVR measurement significantly enhances the clinical efficiency and provides a standardized measurement approach.

F110

Deep learning driven rapid diagnosis system for pedicle dysplasia with preliminary validation

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Background: Pedicle dysplasia is commonly encountered in scoliosis. During spinal surgery, the presence of a dysplastic pedicle poses challenges in screw insertion and increases the risk of complications. In clinical practice, X-ray and computed tomography (CT) scans are commonly employed for the assessment of pedicle dysplasia. However, the examination of radiological images, such as CT scans, necessitates meticulous layer-by-layer observation, which can be laborious and time-consuming. Furthermore, variations in interpretations among different physicians may potentially introduce discrepancies. Therefore, it is of great clinical significance to develop a system that can rapidly diagnose pedicle dysplasia from radiographic images.

Methods: We developed a deep learning model for the diagnosis of pedicle dysplasia and collected CT scans from 248 patients. A CT scan contains 17 vertebrae from T1 to L5, which was further segmented into multiple sub-sequences, each consisting of only one vertebra. The pedicle dysplasia was graded from A to D, whereby A represents the normal pedicle and D represents the most severe dysplasia. The Lenke classification was used to classify the subtype of scoliosis. One hundred and eighty patients were utilized for deep learning model training, 34 patients for validation, and 34 patients for testing. Our deep learning model was designed on the convolutional neural network. The accuracy, sensitivity, and specificity are calculated to evaluate the model's performance.

Results: In this study, the numbers of patients with the Lenke curve type of 1–6 were 113, 60, 10, 7, 35, and 23, respectively. All patients had a major Cobb angle greater than 45°, with a minimum value of 46° and a maximum value of 142°. There were 3,217 grade A pedicles (49.0% in thoracic and 51.0% in lumbar region), 3,327 grade B pedicles (79.1% in thoracic and 21.9% in lumbar region), 1,630 grade C pedicles (89.3% in thoracic and 10.7% in lumbar region), and 348 grade D pedicles (95.4% in thoracic and 4.6% in lumbar region). The deep learning model developed in this study achieved an average accuracy of 0.71, a sensitivity of 0.7, and a specificity of 0.73 in diagnosing pedicle dysplasia. Additionally, the proposed model in this study has an average diagnosis time of less than 5 seconds for one CT scan.

Conclusions: In this study, we developed a deep learning model for detecting and grading pedicle dysplasia from a total of 248 spine CT scans. The experimental results demonstrate that this method can provide a rapid diagnosis of pedicle dysplasia in scoliosis with acceptable accuracy and reliability. Future clinical studies would be needed to investigate the application of this method in clinical practice.

F113

Instrumented fusion of strategic vertebrae provides optimum outcome with minimum instrumentation in adolescent idiopathic scoliosis

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Background: The all-pedicle screw instrumentation method of posterior-only approach arthrodesis, which fuses strategically located vertebrae, avoids metal and implant-related problems and has a correction rate comparable to other methods. It is also reasonably priced and cost-effective for patients in our setup.
Methods: With minimal instrumentation, we selectively fused certain vertebrae to treat 175 patients with severe adolescent idiopathic scoliosis, whose mean age was 17.5 years. The average scoliosis curve measured 86° Cobb. The same senior surgeon handled every case, using both free-hand and C-arm-guided techniques along with intraoperative neurophysiologic monitoring.
Results: Following surgery, the mean scoliosis curve was 37° Cobb. The average follow-up period was 2 years. At the follow-up, it was noted that three patients experienced surgical site infections, two had postoperative neurological deterioration, and three had postoperative curve progression.
Conclusions: Posterior instrumented fusion by minimum level pedicle screw insertion addressing the strategic vertebrae is a good and effective method for stable correction of adolescent idiopathic scoliosis.

F115

Outcome of expansion duraplasty in transverse myelitis

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Background: Transverse myelitis is currently treated by neurologists with medication and plasmapheresis with some success. For patients in whom medical treatment is unsuccessful, no other treatment options are available. We performed expansion duraplasty on this subset of patients.
Methods: A pilot study was carried out after institutional review board approval on compassionate grounds. Fifteen patients (12 males and three females) with a mean age of 34 years (range, 26–42 years) underwent expansion duraplasty at the affected spinal cord levels. We are presenting 6-month data on this subset of patients. Outcome was determined by improvement in neurological status, sphincter control, and dysesthetic pain control.
Results: Preoperatively, 11 patients had grade 1 motor power in both lower extremities, and four patients had grade 2 motor power in both lower extremities. Postoperatively, no patient experienced a worsening in preoperative neurological status. Eleven patients showed improvement in neurological function (motor power 4±5) with a return of sphincter control. Four patients showed no improvement in neurological function at a 6-month follow-up. The only statistically significant difference between the two groups was the time interval between the onset of symptoms and surgical intervention, with a shorter time interval showing better outcomes.
Conclusions: Expansion duraplasty shows promising results in our pilot study of patients with transverse myelitis who had unsuccessful medical management. A larger study and long-term follow-up are required to establish the efficacy of this treatment modality.

F116

Upper rib cage in patients with adolescent idiopathic scoliosis: corrective surgery influences the shoulder balance via the upper ribs

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Background: Shoulder imbalance results in dissatisfaction among adolescent idiopathic scoliosis (AIS) patients, regardless of successful correction of coronal and sagittal balance; however, this complication has been reported to occur in up to 25% or more of cases. The rib cage can restrict rib migration and present unique movements due to corrective surgery, as it consists of

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ribs, the vertebral column, and the sternum. However, there are no reports investigating the three-dimensional (3D) changes of the rib cage and the relationship between the rib cage and shoulder balance.

Methods: Twenty patients with Lenke type 1 and 2 AIS who underwent corrective surgery between 2017 and 2022 were included. The 3D coordinates of the rearmost point on the first to fourth ribs were identified using DICOM data and 3D Medical Image Processing Software. The reference point was placed at the cranial center of the sternum, and the axis was defined as X: left-right, Y: front-back, Z: cranial-caudal (Fig. 1). We measured the 3D coordinates before and 1 week after correction. We also evaluated multiple radiographic parameters.

Results: Postoperatively, the right shoulder height (RSH) and clavicle angle (CA) significantly changed, indicating elevation of the left shoulder. T1 tilt showed no significant change. The preoperative and postoperative coordinates are summarized in Table 1. At the convex side, the X-coordinates significantly decreased in positive coordinates, and the Z-coordinates significantly increased postoperatively ($p<0.05$). At the concave side, the X-coordinates also significantly decreased in negative coordinates, and the Y-coordinates significantly decreased postoperatively ($p<0.05$). The postoperative RSH and CA significantly correlated with the difference in Y-coordinates between the convex and concave sides. The postoperative T1 tilt significantly correlated with the difference in Z-coordinates between the convex and concave sides.

Conclusions: The position of the upper ribs changed after corrective surgery, resulting in cranial migration of the upper ribs on the convex side and forward migration on the concave side. Changes on the convex side correlated with RSH and CA, while changes on the concave side correlated with T1 tilt. These findings indicate that the rib cage may have an impact on postoperative shoulder imbalance.

F125

Surgical and functional outcomes of biportal posterolateral endoscopic lumbar interbody fusion via percutaneous pedicle screw incisional wounds: case series

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Background: We exclusively utilized the biportal endoscopic transforaminal lumbar interbody fusion (BE-TLIF) surgical technique in this study, employing pedicle screw incisions to obviate the need for additional incisions. The percutaneous pedicle screw incisions align more closely with physiological considerations and better suit the design of pedicle screws. BE-TLIF represents a significant advancement in minimally invasive spine surgery, characterized by advantages including diminished intraoperative blood loss, mitigated early postoperative pain, abbreviated hospital stays, and expedited early functional recovery. This preliminary study aims to evaluate both the surgical and functional outcomes of biportal posterolateral endoscopic lumbar interbody fusion via percutaneous pedicle screw incisional wounds.

Methods: From October 2019 to June 2023, 21 patients diagnosed with degenerative disc disease, spondylolisthesis, or facet cysts underwent BE-TLIF via facet-sacrificing posterolateral approach. Demographic data, surgical outcomes, functional outcomes, and complications were assessed perioperatively and at follow-ups.

Results: The mean perioperative hemoglobin level change was -1.02 gm/dL. The mean length of hospital stay was 5 days. The fusion rate at final follow-up was 87%. The subsidence rate at final follow-up was 13%. The mean Visual Analog Scale (VAS) score for back pain was 5.19 preoperatively and 2.12 at final follow-up.

The mean VAS score for leg pain was 6.38 preoperatively and 2.59 at final follow-up. The mean Oswestry Disability Index score was 71% preoperatively and 7% at final follow-up. The mean EuroQoL-5 Dimensions VAS score was 48.57 preoperatively and 93.33 at final follow-up. The mean MacNab score was 4.18 at final follow-up. Postoperative complications were reported in three cases, with one case subsequently undergoing reoperation.

Conclusions: BE-TLIF provides good surgical outcomes and allows for highly visualized and targeted disc preparation, potentially decreasing durotomy rates. There are additional training requirements for surgeons due to the specialized nature of the procedure, and the costs associated with the required equipment could be considerable. BE-TLIF surgery is considered an effective intervention for lumbar spine issues, demonstrating positive functional outcomes with minimal complications. Compared to traditional methods, BE-TLIF through percutaneous pedicle screw incisions reduces incisional wounds and minimizes complications in surgical procedures. This technique is poised to become more prevalent in future practice, and an increasing number of studies focusing on this approach should be expected as part of the ongoing trend towards minimally invasive procedures.

F126

Impact of increased signal intensity of the spinal cord at the vertebral body level in patients with cervical myelopathy

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Background: Increased signal intensity (ISI) is usually recognized at the disc level of the responsible lesion in patients with cervical myelopathy. However, it is occasionally seen at the vertebral body level, below the level of compression. We aimed to investigate the clinical significance and radiographic characteristics of ISI at the vertebral body level.

Methods: This retrospective study included 135 patients with cervical spondylotic myelopathy who underwent surgery and had local ISI. We measured the local and C2–7 angle at flexion, neutral, and extension. We also evaluated the local range of motion (ROM) and C2–7 ROM. The patients were classified into group D (ISI at the disc level) and group B (ISI at the vertebral body level).

Results: The prevalence was 80.7% (109/135) and 19.3% (26/135) for groups D and B, respectively. The local angle at flexion and neutral were more kyphotic in group B than in group D. The local ROM was larger in group B than in group D. Moreover, the C2–7 angle at flexion, neutral, and extension were more kyphotic in group B than in group D. There was no significant difference in clinical outcomes 2 years postoperatively between both groups.

Conclusions: Group B was associated with kyphotic alignment and greater local ROM compared to group D. As the spinal cord is withdrawn in flexion, the ISI lesion at the vertebral body might be displaced towards the disc level, which is impacted by the anterior components of the vertebrae. This should be different from the conventionally held pincer-mechanism concept.

F127

Mid to long-term outcomes of thoracoscopic anterior selective thoracic fusion in adolescent idiopathic scoliosis for in Lenke 1 & 2 curves: a minimum 2-year follow-up review

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Background: Thoracoscopic anterior selective fusion (T-ASF) is a minimally invasive alternative method of scoliosis correction compared to posterior spinal fusion. Advantages of ASF include decreased blood loss, shorter instrumentation, and sparing of spinal musculature. However, there is a paucity of literature on the long-term outcomes of this surgical technique. This study reviews the mid- to long-term outcomes of T-ASF in treating adolescent idiopathic scoliosis.

Methods: Clinical, operative, and radiographic data on all female patients with Lenke 1 & 2 curves, aged 11–20 years old, who underwent T-ASF between January 2000

and December 2013 at our institute were reviewed. Patients with underlying musculoskeletal disease, prior spinal surgeries, and a follow-up duration of less than 2 years were excluded.

Results: A total of 122 patients were identified with an average follow-up of 8.8±3.4 years (range, 2–20.4 years). The average age was 14.2±1.9 years with a median Risser score of 3 (range, 0–5), and 7.7±0.6 levels were fused with estimated blood loss of 313±270 mL. The average main thoracic (MT) curve was 49.6°±8.9° preoperative, which corrected to 11.2°±5.7° postoperative with a correction of 77.3%±10.5%. The average thoracolumbar (TL) curve was 30.0°±7.9°, which corrected spontaneously to 9.6°±5.0° postoperative with a correction of 62.5%±18.1%. At final follow-up, MT was 12.9°±8.3° and TL was 8.9°±6.4°. Twenty-three patients (17.9%) experienced a >5° loss of correction in any coronal curvature at final follow-up due to adding on (n=12), superior screw pull-out (n=9), and/or implant breakage (n=2). Three patients (2.3%) underwent revision to a posterior construct for adding-on, and an additional one patient (0.7%) underwent rod exchange for rod breakage.

Conclusions: Overall, the long-term outcomes of T-ASF are satisfactory with good and durable postoperative curve correction and comparable long-term complication rates to posterior fusion surgeries.

F129

Review of the perioperative outcomes of 123 adult idiopathic scoliosis patients underwent posterior spinal fusion

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Background: There has been growing advancement in corrective surgeries for adult idiopathic scoliosis (AdIS) patients in recent years. Few studies have reported on perioperative outcomes and complications among the AdIS population. The objective of this study is to evaluate perioperative outcomes and determine the prevalence of major and minor complications following single-stage posterior spinal fusion (PSF) in AdIS patients.

Methods: One hundred twenty-three AdIS patients, aged over 18 years, who underwent surgery between 2020 and 2022 using a dual attending surgeon strategy were retrospectively recruited. Outcome measures included operative time, intraoperative blood loss, allogeneic blood transfusion rate, length of postoperative hospital stay, complication rate, and mean reduction in hemoglobin level. Additionally, the number of fusion levels, screw density, and postoperative radiographic parameters were recorded.

Results: The study cohort comprised 112 female and 11 male AdIS patients. The majority had Lenke 1 curve type (47.2%). The mean age was 24.9±5.5 years, with a mean body mass index of 19.4±2.7 kg/m^2. The mean operative time was 134.0±35.6 minutes, and the average intraoperative blood loss was 665.4±281.6 mL, with no allogeneic blood transfusions. The mean number of screws used was 14.0±2.7. The average hospital stay after surgery was 3.2±0.5 days. The mean correction rate was 61.2%±9.0%. The overall complication rate was 1.6%, with both cases being mild superficial surgical site infections successfully treated with antibiotics.

Conclusions: Single-stage PSF using a pedicle screw construct has good perioperative outcomes with an overall complication rate of 1.6% and an average hospital stay of 3.2 days. No major complications were reported.

F130

Clinical and radiographic predictors of deterioration in mild cervical spondylotic myelopathy: a systematic review

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Background: The natural progression of mild cervical spondylotic myelopathy (CSM) has not been clear, and

there are no definitive recommendations regarding the need for surgery for its management. The decision to proceed with surgery remains a topic of debate within the medical community. Therefore, early detection of patients with progression and those who will benefit from early surgery is paramount. This study aims to determine the clinical and imaging factors predicting deterioration in patients with mild CSM.

Methods: This study followed the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) Guidelines and reviewed published articles (including cohort studies, cross-sectional studies, case controls, and previous systematic reviews if available) from 2000 to 2023 that involved adult patients with asymptomatic spondylotic cord compression to mild CSM who underwent conservative management. The search was conducted in Medline via PubMed, Cochrane Central Register of Controlled Trials, Herding Plus, Embase, and Google Scholar. Patient demographics, neurologic outcome, clinical and imaging predictors were examined. Quality assessment was done using the Newcastle-Ottawa Scale for observational studies. Descriptive statistics for all studies were reported as presented in the articles. We reported the raw data and calculated relative risks or odds ratio and their 95% confidence intervals if not provided by the authors. Conduction of meta-analysis was not possible due to heterogeneity among studies. Thus, a qualitative synthesis was done.

Results: Twelve studies were included in the review consisting of 910 patients. We noted several findings. Symptom improvement was observed to correlate with shorter disease duration in conservatively managed patients. The results also indicated that a higher rate of improvement was linked to rigorous conservative treatment measures. Cervical radiculopathy, electrophysiological (electromyography, sensory evoked potential, motor evoked potential) abnormalities, decreased Torg-Pavlov ratio, and cervical instability, slippage (>2 mm) or segmental kyphosis, were significantly associated with myelopathy progression. Cervical range of motion of >50° was an adverse prognostic factor in mild CSM patients. T2 hyperintensity vaguely correlated with poor outcomes. Nevertheless, it has been associated with delayed development of myelopathy. Additionally, CSF column diameter, circumferential cord compression, T1 angular deformity of the cord, cross-sectional area <70 mm^2 and cord compression ratio <0.4 were independent predictors of developing myelopathy. Focal disc herniation was also associated with worsening than diffuse type.

Conclusions: Conservative management has a significant role and is still the primary treatment of mild CSM, particularly in patients with shorter symptom duration. Implementing rigorous conservative treatment measures is fundamental in reducing the risk of progression. Early recognition of clinical features such as myelopathy with radiculopathy and electrophysiologic abnormalities and imaging predictors of deterioration such as segmental instability, decreased Torg-Pavlov ratio, circumferential cord compression, CSF column diameter, and angular deformity on T1 may guide us to do early surgery in these patients. In myelopathy brought by disc pathology, early surgery should be considered in patients with focal disc herniation compared to the diffuse type. Early identification of these predictors can assist clinicians in determining the optimal timing for early surgical intervention.

F133

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

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Background: Delay in diagnosis and treatment is associated with poorer outcomes in patients with symptomatic metastatic epidural spinal cord compression (MESCC). Staging computed tomography (CT) scans are performed routinely, but high-grade MESCC is often underdiagnosed. We previously developed and validated a deep learning model (DLM) to automate the detection of high-grade (Bilsky 2/Bilsky 3) MESCC. We aim to assess the utility of a DLM in detecting high-grade MESCC and its potential to reduce diagnostic delays.

Methods: This is a retrospective review of 140 patients with high-grade MESCC between C7 and L2 who underwent surgical decompression and stabilization for MESCC between January 2015 and January 2022. Prior staging CT up to 4 months before diagnostic magnetic resonance imaging (MRI) was reviewed by a consultant musculoskeletal radiologist (J.H.) and a consultant

spinal surgeon (J.T.), and classified based on the grade of MESCC. The DLM was then used to classify these scans. The above findings were compared to the original radiologist reports. Potential decrease in diagnostic delay was calculated in days from screening CT to MRI scan diagnosing high-grade MESCC.

Results: Of the 140 patients, 95 (67.8%) had available preoperative CT scans. High-grade MESCC was identified in 84 out of 95 (88.4%) of the preoperative CT scans by both JH and JT. High-grade MESCC was reported in only 32 out of 95 (33.7%) of preoperative scans by the original radiologist. There was almost perfect agreement between JH and JT (kappa=0.947; 95% confidence interval [CI], 0.893–1.000; $p<0.001$), JH and DLM (kappa=0.891; 95% CI, 0.816–0.967; $p<0.001$), and JT and DLM (kappa=0.891; 95% CI, 0.816–0.967; $p<0.001$). There was poor interobserver agreement between the original radiologist and all other readers. There was a mean potential reduction in diagnostic delay of 19 days.

Conclusions: The DLM had an almost perfect interobserver agreement with both reviewers. This is the first clinical study to demonstrate its potential for reducing diagnostic delays.

F138

Defining surgical indication for instability in spinal tuberculosis: validation analysis of Tuberculosis Spine Instability Score

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Background: In the absence of neurological deficits, surgical decisions for spinal tuberculosis (STB) depend on the individual experiences of surgeons, which may vary widely. No universal consensus has been reached on an objective definition of instability in the tuberculosis spine. The Tuberculosis Spine Instability Score (TSIS) was developed to discriminate between stable and unstable spines in STB. In the current study, we attempt to analyze the reliability, responsiveness, and construct validity of TSIS to define clear guidelines in tuberculosis spine management.

Methods: STB patients (n=162) were evaluated for the quality assessment of TSIS. It was tested for validity, reproducibility, and responsiveness. Construct validity was expressed as the Pearson correlation coefficient. Intra-observer test-retest reliability and inter-observer reliability were expressed by the intraclass correlation coefficient (ICC). Longitudinal validity was assessed through responsiveness and effect size calculations.

Results: The mean age of patients was 33.39±16.58 years, with 98 females. TSIS showed good construct validity with a substantial correlation with the Spinal Instability Neoplastic Score (Pearson coefficient=0.827). Near-perfect inter-observer and intra-observer reliability were obtained with ICC values of 0.941 and 0.985, respectively. Longitudinal validity evaluation was conducted on 64 patients 6 months apart. With SDC smaller than MIC, the instrument was found to be responsive. The effect size over 6 months was 1.039.

Conclusions: TSIS is an excellent discriminative scoring tool with good validity, reliability, responsiveness, and high specificity. It can differentiate between a stable and unstable spine, which will aid in establishing objective surgical decisions for spine surgeons.

F139

Statistical comparison of two radiographic classifications for adult idiopathic scoliosis patients based on supine versus supine side-bending radiographs

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Background: Most adult idiopathic scoliosis (AdIS) patients were untreated adolescent idiopathic scoliosis (AIS) patients who progressed into adulthood after attaining maturity. Classification of AdIS patients based on the Lenke AIS classification may be limited as degenerative elements should be considered among this adult population. In 2021, Lin and his colleagues proposed a new radiographic classification as an expansion of the previous Lenke AIS classification by incorporating lumbosacral curve and global alignment parameters. This new radiographic classification

adopted a different cut-off value for structural criteria than the Lenke AIS classification. Moreover, this classification was based on supine radiographs instead of the commonly applied side-bending radiographs in the Lenke AIS classification. Therefore, our study aimed to report on the prevalence of each curve type, lumbosacral modifier, and global alignment modifiers based on the new AdIS radiographic classification by Lin and his colleagues, as well as to evaluate the difference in curve types compared to the Lenke AIS classification.

Methods: We retrospectively analyzed 117 AdIS patients who underwent posterior spinal fusion surgeries between 2021 and 2022. All patients were classified using both the Lenke AIS classification and the new AdIS classification. Structural criteria in defining Lenke curve types differed in this new classification as they were based on supine radiographs. This classification adopted ≥35° as the cut-off value for structural criteria in proximal thoracic (PT), main thoracic (MT), and thoracolumbar/lumbar (TL/L) supine Cobb angle, as well as kyphosis ≥20° for PT (T2–T5), MT, or TL/L (T10–L2). Lumbosacral modifiers (structural versus non-structural) and global alignment modifiers (aligned, sagittal malalignment, coronal malalignment, or a combination of both) were included.

Results: The mean age was 25.2±5.3 years. Classification based on the Lenke AIS curve types indicated that most cases were Lenke 1 (45.3%), followed by Lenke 2 (22.2%), Lenke 6 (17.9%), Lenke 5 (12.0%), Lenke 4 (1.7%), and Lenke 3 (0.9%). Meanwhile, curve types based on the new AdIS classification demonstrated predominance in type 1 (35.0%), followed by type 6 (20.5%), type 2 (19.7%), type 3 (9.4%), type 5 (9.4%), and type 4 (6.0%). There was a significant difference in curve types between these two classifications (p<0.001). The majority of the patients had a non-structural lumbosacral modifier (87.2%) and an aligned global alignment modifier (94.0%).

Conclusions: The new AdIS classification demonstrated a significant difference in curve type stratification compared to the Lenke classification while additionally offering information on lumbosacral and global alignment modifiers.

F140

A dedicated spine team approach maintained a consistent operating theatre efficiency and perioperative outcomes in posterior spinal fusion surgery for adolescent idiopathic scoliosis patients

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Background: Amidst the current setting of inflation and rising healthcare expenditure, corrective surgeries for adolescent idiopathic scoliosis (AIS) patients can be very costly. Operating theatre (OT) inefficiency, an unnecessary healthcare expense, ultimately translates to the high hospital costs incurred by patients. Therefore, implementing a dedicated surgical team was one of the interventions established to improve OT efficiency. Nevertheless, the perioperative outcomes of AIS patients operated on with such enhanced OT efficiency are not well-established in the current literature. Thus, we aimed to report on the OT efficiency and perioperative outcomes of AIS patients operated on by a dedicated spine team approach, in a consecutive case operation list.

Methods: We recruited all AIS patients who were listed for surgery on three consecutive surgery days (8:00 AM to 8:00 PM) and operated on by a dedicated surgical team from 2021 to 2022. The team comprised three senior spine consultants who employed a dual attending surgeon strategy, an anesthetic consultant, dedicated surgical scrub nurses, anesthesiology nurses, radiographers, and neuromonitoring technicians. All recruited patients were classified based on the sequence of the operation list. Case 1 was the first case, case 2 was the second case, and case 3 was the last case of the day. OT efficiency (preoperative time, operative time, postoperative time, total OT time, and turnover time) and perioperative outcomes across all three groups were evaluated.

Results: A total of 102 cases were analyzed. The mean major Cobb angle was 63.3°±15.5°. On average, case 1

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started at 8:38 AM, whereas case 3 ended by 5:54 PM of the same day. OT efficiency was consistent between case 1, case 2, and case 3 with comparable OT times in all five stages (p>0.05). The mean turnover time was 15.1±13.5 minutes and the mean operative time was 123.0±28.1 minutes. Intraoperative blood loss and blood transfusion requirements were comparable between groups (p>0.05). The mean intraoperative blood loss was 638.2±252.5 mL (p=0.832), and none of the patients required allogeneic blood transfusion. The complication rate was 2.0%, with two cases of superficial surgical site infection.

Conclusions: Enhanced OT efficiency with the dedicated spine team did not compromise patient safety, as all three cases in the consecutive list had consistent perioperative outcomes.

F141

Deriving a favorable intraoperative lowest instrumented vertebra tilt angle using preoperative left supine side-bending radiographs for Lenke type 1 and 2 (non-AR curves) adolescent idiopathic scoliosis patients

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Background: Overcorrection of the spinal curves in scoliosis corrective surgery could result in postoperative spinal decompensation and coronal imbalance. It was hypothesized that distal adding-on (AO) phenomenon could be a compensatory mechanism for the overcorrection of curves. We postulated that by achieving a favorable intraoperative lowest instrumented vertebra (LIV) tilt angle, the residual unfused lumbar curve could balance the fused spine. Thus, we aimed to derive a mathematical calculation for a favorable LIV tilt angle using preoperative left supine side-bending (LSB) radiographs in Lenke type 1 and 2 (non-AR curves) adolescent idiopathic scoliosis (AIS) patients. We also purposed to report the clinical and radiological outcomes of these patients operated with the calculated LIV tilt angle.

Methods: Part I of the study primarily validated and defined the adjusted LSB LIV tilt angle (α) (when the LIV was presumptively centralized at the central sacral line as the sum of preoperative LSB LIV tilt angle [x] and preoperative LSB LIV translation angle [y]; [$\alpha=x+y$]). In part II, the clinical and radiological outcomes of 50 Lenke type 1 and 2 (non-AR curves) AIS patients, operated between 2018 and 2021, using the α angle were analyzed. The difference between intraoperative LIV tilt angle (β) and α was determined (ΔLIV tilt angle=$\beta-\alpha$).

Results: Part I reported excellent mean intraclass correlation coefficients for both inter-rater and intra-rater reliability tests for α (0.982 and 0.907) and x (0.992 and 0.970), respectively. In part II, 42 patients had positive ΔLIV tilt angle while eight patients had negative ΔLIV tilt angle. The overall incidence of distal AO was 10.0% (n=5/50). Patients with negative ΔLIV tilt angle had higher incidence of distal AO (n=4/8, 50.0%) than patients with positive ΔLIV tilt angle (n=1/42, 2.4%) (p<0.001). LIV disc angle improved significantly at final follow-up (0.0° [-1.3° to 2.0°]) despite not levelling the intraoperative LIV tilt angle at 0°. Upon final follow-up, six patients had coronal imbalance (≥20 mm), two patients had distal junctional kyphosis, and none had proximal junctional kyphosis. The average scores for Scoliosis Research Society-22 domains improved significantly at final follow-up except for the pain domain.

Conclusions: Achieving an intraoperative LIV tilt angle (β) greater than or equal to the adjusted LSB LIV tilt angle (α) derived ($\beta\geq\alpha$) could be a favorable way to avoid distal AO.

F143

Perioperative outcome of severe adolescent idiopathic scoliosis patients with Cobb angle ≥100°: the feasibility of single-stage posterior spinal fusion with radical facetectomies

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Background: Corrective surgeries for severe scoliosis are challenging as they necessitate extensive approaches such as combined anterior and posterior procedures and osteotomies to achieve optimal results. This could lead to an increase in surgical duration, blood loss, higher rate of complications, increased overall cost and prolonged hospital stay. FOCOS (Foundation of Orthopedics and Complex Spine) spine research group in 2021 reported satisfactory outcomes by utilizing preoperative halo gravity traction and one-stage multiple posterior osteotomies and fusion in severe scoliosis patients. The objective of this study is to assess perioperative outcomes severe adolescent idiopathic scoliosis (AIS) patients with Cobb angle ≥100° undergoing single-staged posterior spinal fusion (PSF) with radical facetectomies (without any major osteotomy and preoperative halo traction).
Methods: Retrospective study whereby 35 severe AIS patients with Cobb angle ≥100° who underwent single-staged PSF without any osteotomies from 2019 to 2023 in a single tertiary center were recruited. Dual attending surgeon strategy was employed with low-density alternate-level pedicle screw construct. Outcomes were measured via operative time, intraoperative blood loss, need for allogenic blood transfusion, correction rate, length of hospital stay, and complication rate. Data were analyzed using IBM SPSS ver. 27.0 and descriptive statistics were reported in mean (±standard deviation) for numerical variables meanwhile categorical variables were presented via number (%).
Results: Mean operative time was 212.6±67 minutes. Mean intraoperative blood loss was 1,121.3±435.2 mL. Only 14.3% of patients required allogenic blood transfusion. Average fusion level was 13.2±0.9 and screw density was 1.3±0.1. Mean correction rate achieved was 52.6%±11.2%. Total hospital stay was only 4.5±0.9 days. Our study cohort experienced a total complication rate of 8.6%. Two patients developed pleural effusion while one patient had superficial surgical site infection.
Conclusions: Single-stage PSF with radical facetectomies is a feasible treatment strategy for severe AIS patients with Cobb angle ≥100°. By avoiding major osteotomies, this strategy could lower the overall complication rate and lead to a shorter hospital stay.

F144

A novel approach: utilization of medial pedicle wall referencing extra-pedicular screw insertion technique in narrow dysplastic pedicles in adolescent idiopathic scoliosis patients

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Background: Conventional extra-pedicular (EP) screw technique has a high medial convergence angle which increases the difficulty of entry into the vertebral body, increasing the risk of anterior perforations. The lateral entry point requires more extensive dissection. A lateral starting point leads to malalignment of the screw heads when placed next to intra-pedicular screws. The objective of this study was (1) to describe a novel technique of medial pedicle wall referencing EP screw insertion method that is inserted along the pedicle axis; (2) to compare EP chord length of this technique with the conventional technique; and (3) to report the accuracy of the technique based on computed tomography (CT) assessment.
Methods: Retrospective study whereby 103 patients underwent posterior spinal fusion from 2018 to 2023 were recruited. A total of 2,472 thoracic pedicles were analyzed on preoperative CT scan and classified based on the classification by Chiu and his colleagues. EP

chord length of both techniques was measured for narrow dysplastic pedicles (type C and D). A postoperative CT scan was used to assess medial perforations using Gertzbein and Robbins classification modified by Rao and his colleagues. Anterior perforations were classified using the grading by Hansen-Algenstaedt and his colleagues.

Results: The prevalence of thoracic narrow dysplastic pedicles was 31.3%. 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 contrast, when the trajectory was planned using the medial pedicle wall referencing technique, it was 38.6±3.2 mm and 38.3±3.2 mm, respectively (p<0.001). A total of 434 EP screws were inserted using this novel technique in narrow dysplastic pedicles. Of these, 11.3% had medial grade 1 perforation, and 4.1% had anterior grade 1 perforation. Grade 2 perforations accounted for only 0.7% (0.2% medial, 0.5% anterior). None of the perforations were symptomatic, and no grade 3 perforations were noted.

Conclusions: The medial pedicle wall referencing EP screw insertion technique is a safe alternative method, especially in narrow dysplastic pedicles. This technique has a shorter chord length and a less convergent trajectory with a low anterior perforation rate.

F145

The feasibility of rapid recovery protocol in severe adolescent idiopathic scoliosis patients (Cobb angle ≥90°) following posterior spinal fusion

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Background: Corrective surgeries in severe adolescent idiopathic scoliosis (AIS) patients entails a higher risk of prolonged operation, excessive bleeding, extended hospital stays, and higher complication rates compared to non-severe AIS patients. Implementation of rapid recovery protocol (RRP) among severe AIS patients has not been reported. The objective of this study was designed to assess the feasibility and outcome of RRP in severe AIS patients with Cobb angle ≥90° underwent single-staged posterior spinal fusion (PSF).

Methods: Retrospective study whereby 37 severe AIS patients who underwent single-staged PSF surgery from 2019 to 2022 were recruited. The RRP consisted of a preoperative regime and counselling, intraoperative strategies to reduce operation duration and blood loss, and an accelerated postoperative rehabilitation pathway. Outcome measures were operative time, blood loss, postoperative pain scores, patient-controlled analgesia (PCA) morphine usage, length of hospital stay, and recovery milestones of patients. Data were analyzed using IBM SPSS ver. 27.0 and descriptive statistics were reported in mean (±standard deviation) for numerical data whereas categorical data were presented in number (%).

Results: The mean operation duration was 173.5±39.4 minutes and the mean blood loss was 1,064.6±473.3 mL. The mean length of postoperative hospital stay was 3.2±0.6 days. The pain score 12 hours post-operation was 4.0±2.0 and reduced to 3.9±1.6 at 48 hours. And 78.4% of patients discontinued their PCA at 48 hours. First liquid intake was at 6.3±8.5 hours whereas solid food consumption was initiated at 23.4±14.2 hours. The urinary catheter was removed at 17.8±7.6 hours. Patients started ambulation at 24±12.7 hours, first passed flatus at 37.7±20.4 hours, and had first bowel movement at 122.1±41.7 hours. Three complications (8.1%) were reported. There were two superficial wound healing problems and one skin thermal injury.

Conclusions: The implementation of the RRP following PSF in severe AIS patients was feasible and resulted in a short postoperative hospital stay of 3.2 days without increasing the risk of major complications, readmissions, and reoperations.

F146

Outcomes of pregnancy and childbirth following posterior spinal fusion in adolescent idiopathic scoliosis: a retrospective cohort study

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Background: Adolescent idiopathic scoliosis (AIS) is more prevalent among females, and research indicates that women who undergo corrective surgeries for scoliosis often experience a higher frequency of low back pain and an increased likelihood of needing a caesarean section. Notably, the majority of these studies have been conducted within the Caucasian population. This study seeks to contribute to the existing literature by exploring whether females with AIS, treated specifically with spinal fusion surgery, exhibit distinct outcomes in pregnancy and childbirth, particularly in terms of caesarean section rates and the use of epidural anesthesia.
Methods: Conducted as a retrospective matched cohort study, the research utilized a single tertiary center's database spanning from 2004 to 2018. A total of 21 females who underwent surgical treatment for AIS within this period were recruited. Inclusion criteria specified that participants must be at least 20 years old, have undergone posterior spinal fusion (PSF), possess sufficient clinical and radiological parameters, carry a primary diagnosis of AIS, and experience a singleton pregnancy with a cephalic presentation. The comprehensive data collection encompassed patients' demographics, anthropometric parameters, number of pregnancies, and the number of live births. For each live birth, detailed information was gathered, including the mother's age at delivery, baby's birth weight, gender, duration of pregnancy, complications during delivery, type of delivery, use of epidural analgesia, pain relief methods during labor, duration of labor, type of anesthesia during caesarean section, consultation with spine surgeons before delivery, and the severity of low back pain during and after pregnancy.
Results: The study included 21 patients with a mean age of 32.2±3.2 years, and the mean postoperative period was 9.5±3.5 years. The Lenke distribution showed variation, with Lenke 1 being the most common (57.1%), followed by Lenke 2 (4.8%), Lenke 3 (4.8%), Lenke 5 (19.0%), and Lenke 6 (14.3%). The LIV distribution was T11 (14.3%), T12 (14.3%), L1 (23.8%), L2 (19.0%), L3 (14.3%), and L4 (14.3%). On average, 9.4±1.8 levels were fused. The mean birth weight of the first child was 2.7±0.4 kg. Of the participants, 66.7% had one child, while 33.3% had two. Caesarean section was performed in 28.6% of cases, 52.4% underwent spontaneous vaginal delivery, and 19.0% experienced induced vaginal delivery. Epidural anesthesia was administered to 19.0% of patients during the delivery of their first child. The mean Oswestry Disability Index scores during the first pregnancy were 15.6%±13.3%, decreasing to 7.1%±8.2% after the first pregnancy.
Conclusions: In conclusion, the study reveals that a significant portion of females with AIS post-PSF can successfully conceive and give birth. The childbirth outcomes include a diverse distribution of delivery methods and pain relief strategies, emphasizing the need for personalized care in this population.

F147

Prediction of the optimal upper instrumented vertebra tilt angle based on the preoperative erect radiograph for Lenke type 1 and 2 adolescent idiopathic scoliosis patients

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Background: An optimal upper instrumented vertebra (UIV) tilt angle with is associated with good medial and neck balance following posterior spinal fusion (PSF). The physician-supervised cervical supine side bending (CSSB) films was generally used to calculate UIV tilt angle. The objective of this study is to explore the feasibility of utilizing the radiological parameters measured from the preoperative erect whole spine radiograph to derive a predictive formula for the optimal UIV tilt angle.

Methods: The postoperative UIV tilt angle (at minimum 2-year follow-up) in 133 adolescent idiopathic scoliosis patients who had good radiological medial shoulder balance (T1 tilt between -3° and +3°) was considered the optimal UIV tilt angle. The predictive factors in the univariate analysis including preoperative clavicle angle, cervical axis, coronal balance, T1 tilt angle, UIV tilt angle, UIV level, Cobb angle, side-bending Cobb angle, and flexibility rate. Independent predictive factors with $p<0.05$ from multivariate regression analysis were used to generate the regression formula for the predicted optimal UIV tilt angle.
Results: There were 99 Lenke 1 patients and 34 Lenke 2 patients. The significant predictors from the preoperative erect radiograph were preoperative UIV tilt angle (β=0.396, $p<0.001$) and preoperative T1 tilt angle (β=-0.349, $p<0.001$). The regression formula for predicted optimal UIV tilt angle was [(0.396×preoperative UIV tilt angle)–(0.349×preoperative T1 tilt angle)–0.871] (R^2 value=0.583). When we compared the predicted (using preoperative erect radiograph) vs. the conventional (using CSSB films) measurements for the optimal UIV tilt angle, 61.7%, and 99.3% had the predicted measurements of <2°, and ≤5° from the actual measurements, respectively. Only one patient (0.7%) had a difference of >5°.
Conclusions: The optimal UIV tilt angle can be predicted with the formula: [(0.396×preoperative UIV tilt angle)–(0.349×preoperative T1 tilt angle)–0.871] and had a R^2 value of 0.583. This formula can be used to predict the actual measurement for the optimal UIV tilt angle preoperatively with acceptable accuracy.

F149

Postoperative medial shoulder, lateral shoulder, and neck imbalance among 120 Lenke 1 and 2 adolescent idiopathic scoliosis patients with a minimum of 5-year follow-up

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Background: Shoulder and neck imbalance following adolescent idiopathic scoliosis (AIS) surgery can cause patient dissatisfaction. However, the postoperative evolution of shoulder and neck imbalance over time is unclear. We aimed to investigate the postoperative medial shoulder, lateral shoulder, and neck imbalance among Lenke 1 and 2 AIS patients to determine if they would improve over a period of 5 years.
Methods: We retrospectively reviewed 120 Lenke 1 and 2 AIS patients. "Medial shoulder balance (MSB)" was represented by T1 tilt and was defined as "balanced" (MB) when -3°≤ T1 tilt ≤3°. T1 tilt >3° was defined as medial shoulder imbalanced positive (MI+ve). T1 tilt <-3° was defined as MI-ve. "Lateral shoulder balance (LSB)" was represented by clavicle angle (Cla-A) and was defined as "balanced" (LB) when -2°≤ Cla-A ≤2°. LI+ve was Cla-A >2°; LI-ve was Cla-A <-2°. Cervical axis (CA) represented "neck balance" and was defined as "balanced" (NB) if -3°≤ CA ≤3°. NI+ve was CA >3° and NI-ve was CA <-3°. Shoulder and neck balance were compared at 6-month follow-up (FU) and at 5-year FU.
Results: At 6-month FU, 51.7% achieved MB, 35.8% had MI+ve, and 12.5% reported MI-ve. Among the MB group, 87.1% remained MB at 5-year FU; 65.1% of patients with MI+ve remained MI+ve at 5-year FU; and 86.7% of MI-ve patients remained MI-ve at 5-year FU. For LSB, 68.3% achieved LB, 24.2% had LI+ve, and 7.5% had LI-ve at 6-month FU. 72.4% of LI+ve patients achieved LB at 5-year FU. At 6-month FU, 65.8% achieved NB, 28.3% had NI+ve, and 5.9% had NI-ve; 89.9% of patients who had NB remained NB at 5-year FU. However, 50% of those with NI+ve remained NI+ve, while the other half achieved NB at 5-year FU. Among patients with MI+ve and LI+ve who achieved good balance at the final FU, there was a significant change in the distal disc angulation but not the T1-UIV angle.
Conclusions: At 5-year FU, most patients with MI+ve and MI-ve remained imbalanced. The majority of patients achieved LB regardless of the LSB pattern at 6-month FU. 50% of NI+ve patients remained NI+ve. Distal disc angulation led to improvement in MSB/LSB. However, the T1-UIV angle remained relatively stable at the 5-year follow-up.

F150

All-pedicle construct selective thoracic fusion in adolescent idiopathic scoliosis: clinical and radiological outcomes at 5-year follow-up for Lenke 1b, 1c, 2b, and 2c curves

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Background: The potential benefits of selective thoracic fusion (STF) include better perioperative outcomes with shorter operating times, less blood loss, and lower operative risks. However, postoperative coronal decompensation and adding-on phenomena are known adverse radiological outcomes, despite strict selection criteria for STF. The study aimed to evaluate the long term clinical and radiological outcomes of adolescent idiopathic scoliosis (AIS) patients with Lenke 1B, 1C, 2B, and 2C treated with STF with all pedicle screw construct.

Methods: This is a retrospective study included AIS patients with Lenke 1B, 1C, 2B, and 2C who underwent single-staged STF with pedicle screws construct with minimum 5-year follow-up. Radiological parameters and Scoliosis Research Society-22 (SRS-22) revised were assessed. Unsatisfactory results such as adding-on, coronal decompensation, and junctional kyphosis were reported.

Results: Thirty-eight AIS patients with a mean age of 14.5±2.8 years and an average follow-up of 5.4 (5.0–7.6) years were recruited. The lowest instrumented level was L2. The preoperative main thoracic (MT) curve was 65.1°±12.0° while the lumbar curve was 44.1°±60°. The average MT to thoracolumbar/lumbar ratio was 1.5±0.3. The average MT correction was 61.9%±10.2% at the final follow-up, demonstrating stable correction from immediate postoperative. Spontaneous correction at the non-instrumented lumbar curve was observed with a correction rate of 52.2%±16.8% at the immediate postoperative period. Notably, the spontaneous correction progressively improved to 59.6%±15.2% at the final follow-up (p<0.05). Patients reported significant improvement in overall SRS-22 score, function domain and image domain (p<0.05). The incidence of adding-on phenomenon and coronal decompensation were 7.9% and 5.3%, respectively. No cases of junctional kyphosis or revision surgery were encountered.

Conclusions: Patients who underwent STF and had a minimum 5-year follow-up had good radiological and clinical outcomes. The prevalence of adding on phenomenon and coronal decompensation were 7.9% and 5.3%, respectively.

F151

Zonal differences in distribution of dysplastic pedicles in severe (Cobb angle ≥90°) idiopathic scoliosis: a computed tomography study of 2,652 pedicles using the zonal classification

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Background: Patients with idiopathic scoliosis (IS) have higher prevalence of abnormal or dysplastic pedicles. This study is to investigate the prevalence and distribution of dysplastic pedicle among IS patients with severe scoliosis (Cobb angle ≥90°), according to the zonal classification. Currently there was none similar study in this specific scoliosis group in English literature.

Methods: This a retrospective study. The scoliosis curves were divided into eight zones. Computed tomography scans were used to measure the pedicle width, then classified into type A: cancellous channel >4 mm; type B: cancellous channel 2 to 4 mm; type C, cortical channel of 2 to 4 mm; and type D, cortical or cancellous channel of less than 2 mm. Type B, C, and D were dysplastic pedicles while type C and D were narrow dysplastic pedicles.

Results: The mean patient age was 16±3.9 years old, 10 (12.8%) female patients and 68 (87.2%) male patients. Out of which, 10 (12.8%) are Lenke 1 curves; 37 Lenke 2 curves (47.4%); seven Lenke 3 curves (9%); nine Lenke 4 curves (11.5%); and 15 Lenke 6 curves (19.2%). The mean Cobb angle for main thoracic (MT) curves is 106°±11.7° and 100.7°±7.0° for lumbar (L) curves. The prevalence of type A pedicles is 738 (27.8%); type

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B, 907 (34.2%); type C, 830 (31.3%); and type D, 177 (6.7%). The prevalence of dysplastic pedicles (sum of type B, C, and D) was 1,914 pedicles (72.2%) and narrow dysplastic pedicles (sum of type C and D) was 1,007 pedicles (38.0%). The concave proximal thoracic (PT) zone has the highest prevalence of dysplastic pedicles (100%), closely followed by the transitional PT/MT zone (94.0%), and concave MT (88.4%). Similar pattern shown for narrow dysplastic pedicles, highest in concave PT zone (83.7%), transitional PT/MT zone (75.8%), and concave MT (58.5%). Zones with fewer narrow dysplastic pedicles include transitional MT/L zone (18.6%) and convex L zone (18.4%).

Conclusions: Overall prevalence of dysplastic and narrow dysplastic pedicles in severe IS patient (Cobb angle ≥90°) is 72.2% and 38% respectively. The concave PT zone has the highest prevalence of dysplastic pedicles and narrow dysplastic pedicles (100% and 83.7%), followed by the transitional PT/MT zone (99.1% and 75.8%) and concave MT zone (85.4% and 58.5%).

F152

Factors associated with moderate and severe pulmonary impairment in preoperative adolescent idiopathic scoliosis patients

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Background: Moderate and severe pulmonary impairment (MSPI) among adolescent idiopathic scoliosis (AIS) patients were reported to be clinically relevant. To date, only limited literature investigated both clinical and radiological predictive factors for MSPI in AIS. This study aimed to identify predictive factors for MSPI in preoperative AIS patients.

Methods: Preoperative pulmonary function tests of 102 AIS patients, operated between 2015 and 2020 were reviewed. All patients were categorized into two groups based on predicted forced vital capacity (FVC) and forced expiratory volume in one second (FEV1), respectively. Group 1 had normal/mild pulmonary impairment (FVC or FEV1 >65% predicted) whereas group 2 had MSPI (FVC or FEV1 ≤65% predicted). Multivariate logistic regression analysis was performed to determine the independent predictive factors for MSPI. Receiver operating characteristic (ROC) curve analysis was conducted to evaluate main thoracic (MT) Cobb angle in predicting MSPI.

Results: Of the total patients, 41.2% and 52.0% were categorized into group 2 (MSPI) based on predicted FVC and FEV1, respectively. In general, group 2 (both predicted FVC and FEV1) had more patients with a major MT curve, a larger MT curve with lower MT flexibility, a larger MT apical vertebra translation (MT-AVT), and a smaller thoracolumbar-lumbar (TL/L) AVT (p<0.05). Based on predicted FVC, group 2 had a lower body mass index (BMI) (17.5±3.8 kg/m^2) compared to group 1 (19.3±3.4 kg/m^2) (p=0.014). MSPI was evident when MT Cobb angle exceeded 70°. Multivariate logistic regression demonstrated MT Cobb angle (for every 10° increment, FVC: adjusted odds ratio [aOR], 1.7; FEV1: aOR, 1.8; p<0.001) and BMI (FVC: aOR, 0.8; FEV1: aOR, 0.9; p<0.05) as significant independent predictive factors for MSPI. ROC curve analysis identified MT Cobb angle of 64.5° has the highest Youden Index (FVC: 0.481; FEV1: 0.476) in predicting MSPI (FVC: sensitivity, 71.4%; specificity, 76.7%; area under the curve [AUC], 0.751; FEV1: sensitivity, 66.0%; specificity, 81.6%; AUC, 0.767; p<0.001).

Conclusions: MSPI was evident when MT Cobb angle exceeded 70°. MT Cobb angle and BMI were the significant independent predictive factors for MSPI in AIS patients.

F156

Predictive value of supine radiographs for postoperative curve correction in adult idiopathic scoliosis patients

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Background: Preoperative supine radiographs are man-

datory in the new adult idiopathic scoliosis (AdIS) classification (the classification by Lin and his colleagues). Supine radiographs are easily reproducible and highly predictive of side bending (SB) radiographs. However, the use of supine radiographs in predicting postoperative curve correction in AdIS patients after posterior spinal fusion (PSF) has not been well-studied. The objective of this study was to investigate the feasibility of predicting the postoperative curve correction based on the supine radiographs.

Methods: A total of 95 AdIS patients who underwent PSF between 2022 and 2023 were included. Subjects were divided into two groups based on the AdIS classification, namely main thoracic (MT) (type 1, type 2, type 3, and type 4 curves) and lumbar (L) (type 5 and type 6 curves). Pearson correlation analysis was used to determine correlations and relationships between variables.

Results: A total of 95 subjects were included in our study with a median age of 23.5 years and comprised 82 females (86.3%). Preoperative supine Cobb angle (r=0.839, r=0.878, r=0.716, p<0.001) and preoperative SB Cobb angle (r=0.814, r=0.873, r=0.805, p<0.001) showed similar strong positive correlation with postoperative proximal thoracic (PT), MT, and L Cobb angle, but preoperative supine Cobb angle had slightly stronger correlation in PT and MT, whereas preoperative SB Cobb angle had stronger correlation in L curve. Using the derived predictive formulae, there was a significant, strong, positive correlation between the predicted value and actual value of postoperative standing Cobb angle, (r=0.851, p<0.001), with 70.5% of the patients had predicted postoperative Cobb angle from the supine radiographs within 5° of the actual value.

Conclusions: Both supine radiographs and SB radiographs had strong predictability of the postoperative Cobb angle for PT, MT, and L curves. In 70.5% of patients, the actual postoperative Cobb angle was within 5° of the predicted postoperative Cobb angles using the regression formulae.

F157

Description of a novel proximal hyperkyphotic rod contouring technique to redistribute thoracic kyphosis among adolescent idiopathic scoliosis patients: a study of 58 Lenke type 1 and 2 adolescent idiopathic scoliosis patients

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Background: Restoration of thoracic kyphosis among adolescent idiopathic scoliosis (AIS) patients is important to restore cervical lordosis and lumbar lordosis. The conventional differential rod-contouring technique may lead to thoracic hypokyphosis and proximal junctional kyphosis postoperatively. We hypothesize that the proximal hyperkyphotic rod-contouring technique redistributes thoracic kyphosis proximally while maintaining global thoracic kyphosis.

Methods: In the proposed technique, the titanium rods were contoured to be hyperkyphotic compared to the intraoperative kyphosis at the proximal thoracic region to redistribute the thoracic kyphosis. All Lenke 1 and 2 AIS patients who underwent posterior spinal fusion (PSF) surgery with the proximal hyperkyphotic rod-contouring technique between 2018 and 2020 in a single tertiary center were recruited retrospectively. The preoperative and minimum 2-year postoperative radiographs were measured for sagittal vertical axis, C2–C7 angle; T1 slope angle; lumbar lordosis angle; T1–T5, T2–T5, T1–T12, T2–T12, T5–T12 and upper instrumented vertebra-T12 kyphotic angles. The data were analyzed to determine changes in the sagittal measurements in pre- and final follow-up radiographs.

Results: Fifty-eight AIS patients were recruited, consisting of 44 (75.9%) Lenke 1 patients and 14 (25.1%) Lenke 2 patients. Postoperatively, the mean T1–T5 and T2–T5 kyphotic angles were increased by 4.7°±9.0° (p<0.001) and 4.4°±8.3° (p<0.001), respectively while the mean T5–T12 kyphotic angle was reduced by 5.8°±10.7° (p<0.001). The global kyphosis (T1–T12) averaged 30.6°±10.0°. The mean C2–C7 angle improved

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by 2.1°±11.9° (p=0.181) while the T1 slope angle increased by 1.3°±6.2° (p=0.110).
Conclusions: PSF with the proposed novel proximal hyperkyphotic rod-contouring technique significantly increased the thoracic kyphosis proximally at T1–T5, T2–T5 region and maintained the global kyphosis. The cervical lordosis and T1 slope were also improved; however, they were not statistically significant.

F158

Long-term functional outcome, health-related quality of life, and sports participation among adolescent idiopathic scoliosis patients more than 10 years after posterior spinal fusion surgery: a study of 128 adolescent idiopathic scoliosis patients

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Background: The long-term functional outcomes and quality of life among adolescent idiopathic scoliosis (AIS) patients more than 10 years post-posterior spinal fusion (PSF) are not fully understood. Most studies have reported on short-term postoperative outcomes in AIS patients up to 2 years after surgery, but literature on long-term functional outcomes is limited and often involves only small populations. We hypothesize that PSF surgery for AIS can achieve good long-term function, satisfactory quality of life, and low disability scores after more than 10 years.
Methods: AIS patients who underwent PSF surgery in a single center between 2000 and 2013 were recruited retrospectively. The patients completed questionnaire regarding their employment and marital status, participation in sports, and patient-reported outcome questionnaires including Scoliosis Research Society-22 (SRS-22), Oswestry Disability Index (ODI), Roland-Morris Disability Questionnaire (RMDQ), and Trunk Appearance Perception Scale (TAPS). The questionnaires were further analyzed to assess the patient's functionality in key areas of activities of daily living (ADL).
Results: We enrolled 128 patients (19 males, 109 females) with a mean current age of 28.5±4.2 years and a mean postoperative follow-up period of 12.8±2.9 years. There were 64 Lenke 1 (50.8%), 18 Lenke 2 (14.1%), seven Lenke 3 (5.5%), eight Lenke 4 (6.3%), 19 Lenke 5 (14.8%), and 11 Lenke 6 (8.6%) patients. A total of 126 patients (98.4%) were employed while only 2 (1.6%) were unable to work due to back reasons. 59 (46.1%) were single, 34 (26.6%) were in a relationship, and 35 patients (27.3%) were married. There were 74 patients (57.2%) actively participating in sports, 40 (30.2%) were uninterested in sports while 14 (10.9%) avoided sports due to scoliosis-related issues. The mean SRS-22 total score was 4.2±0.4, ODI 7.0%±1.8%, RMDQ 2.0±2.4, and TAPS 2.0±0.4. Most AIS patients were able to carry out key ADLs without any restrictions including walking (93%), climbing several flights of stairs (84%) and personal care (94%).
Conclusions: PSF surgery for AIS led to excellent long-term function and active lifestyles, as evidenced by good patient-reported outcomes and low disability scores.

F160

Comparison between medial and lateral pedicle wall thickness in Asian adolescent idiopathic scoliosis with major thoracic curves

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Background: The widths of medial and lateral pedicle walls in the normal spine of middle age and elderly adults had been investigated and these studies found that medial pedicle wall was thicker than lateral pedicle wall. However, none had evaluated the widths of medial and lateral pedicle walls in adolescent idiopathic scoliosis (AIS) patients. Aim of this study is to identify the distribution and variations of medial and lateral pedicle wall widths throughout the different vertebral levels of the scoliotic spine and its differences according

to age, gender, body mass index, maturity, curve types, and curve severity in AIS patients with major thoracic curves.

Methods: Retrospective analysis of computed tomography (CT) images. All AIS patients with major thoracic curves who had CT scans prior to corrective spine surgery from 2015 to 2020 were retrospectively included in this study. Medial and lateral pedicle wall widths were measured in the axial slices of CT scans from T1 to L5 vertebrae.

Results: A total of 6,230 pedicles (right: 3,064, left: 3,166) from 191 patients were analyzed with 264 (right: 183, left: 81) fully corticalized pedicles excluded from analysis. Right sided medial pedicle wall widths were narrower from T4–T10 (0.75±0.23 mm) compared to T1–T3 (0.89±0.28 mm) and T11–L5 (0.92±0.30 mm). Left medial pedicle wall widths were narrower from T4–T7 (0.76±0.24 mm) compared to T1–T3 (0.88±0.26 mm) and T8–L5 (0.90±0.27 mm). Medial cortical wall widths were significantly thicker compared to lateral cortical wall widths for all vertebrae from T1 to L5 (right medial 0.85±0.28 mm vs. lateral 0.64±0.26 mm (p<0.001), left medial 0.86±0.26 mm vs. lateral 0.64±0.26 mm (p<0.001). The left medial pedicle wall widths were significantly thicker (p<0.001) than right side (right medial 0.85±0.28 mm vs. left medial 0.86±0.26 mm). The main notable significant differences were located at the periapical region of the thoracic curve between T7 to T10 with left concave medial pedicle width being thicker than right convex medial pedicle width. The right concave T7 (0.73±0.24 mm) and T8 (0.73±0.23 mm) have the thinnest medial pedicle wall width.

Conclusions: The medial pedicle wall widths were significantly thicker than lateral pedicle wall widths in AIS patients with major thoracic curves. The right concave periapical region had the thinnest medial pedicle walls.

F163

Medial wall glide technique: a novel technique for pedicle screw insertion in non-dysplastic pedicles among adolescent idiopathic scoliosis patients

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Background: Pedicle screw malposition is a serious complication in adolescent idiopathic scoliosis (AIS) surgeries. To address this issue, the authors introduced a novel medial wall glide technique for pedicle screw insertion in non-dysplastic pedicles in AIS surgeries. In this study, we aimed to determine the safety and accuracy of this technique using computed tomography (CT) analysis.

Methods: A total of 157 AIS patients who underwent posterior spinal fusion surgeries were reviewed. The medical wall glide technique was used for non-dysplastic pedicles. A pedicle probe was used to palpate the medial wall of the pedicle. The probe was advanced up to 15–20 mm deep. A gliding maneuver along the medial wall of the pedicle was used to create a channel for screw insertion. A pedicle sound was used to palpate all cortices to ensure pedicle integrity. The screw was inserted along the same trajectory. Dysplastic pedicles of types C and D were excluded. CT scan was used to evaluate screw perforation at 4–6 months postoperatively. Screw perforation was classified into grade 0 (no violation), grade 1 (<2 mm perforation), grade 2 (2–4 mm), and grade 3 (>4 mm). Anterior perforations were classified into grade 0 (no violation), grade 1 (<4 mm perforation), grade 2 (4–6 mm), and grade 3 (>6 mm).

Results: A total of 1,595 screws were analyzed. When the lateral perforations of T1–T12 region were excluded, the overall perforation was 11.3% with 10.3% grade 1, 0.9% grade 2, and 0.1% grade 3 perforations. Critical perforation (i.e., grade 2 and 3 perforations) rate was only 1.0% (15 perforations). There was only one grade 3 perforation which was a medial perforation at T9 level. Medial, anterior, and inferior perforation rates were 6.8%, 2.2%, and 0.1%, respectively. Highest perforation rate was found at L1–L2 regions (22.4% and 20.8%, respectively). No neurologic complications nor abutment

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to vital structures were observed.
Conclusions: The medial wall glide technique for pedicle screw insertion among AIS patients resulted in an overall perforation rate of 11.3%. The highest perforation rate was found in the L1–L2 region. The critical perforation rate was 1.0%.

F165

A GPT-based question-and-answer chatbot on osteoporosis and phantom-less quantitative computed tomography bone mineral density measurement system for osteoporosis

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Background: Bone health attracts more attention recently and an intelligent question and answer (QA) chatbot for osteoporosis is helpful for science popularization. With generative pretrained transformer (GPT) technology developing, we build an osteoporosis corpus dataset and then fine-tune LLaMA, a famous open-source GPT foundation large language model (LLM), on our self-constructed osteoporosis corpus. Evaluated by clinical orthopedic experts, our fine-tuned model outperforms vanilla LLaMA on osteoporosis QA task in Chinese. Three-dimensional quantitative computed tomography (QCT) measured bone mineral density (BMD) is considered as more accurate than dual-energy X-ray absorptiometry for BMD measurement in recent years. We develop an automatic Phantom-less QCT (PL-QCT) that is more efficient for BMD measurement since no need of an external phantom for calibration. Combined with LLM on osteoporosis, our PL-QCT provides efficient and accurate BMD measurement for our chatbot users.
Methods: We build a novel osteoporosis corpus containing about 30,000 Chinese literatures whose titles are related to osteoporosis. The whole process is done automatically, including crawling literatures in .pdf format, localizing text/figure/table region by layout segmentation algorithm and recognizing text by OCR algorithm. We train our model by continuous pre-training with Low-Rank Adaptation (rank=10) technology to adapt LLaMA-7B model to osteoporosis domain, whose basic principle is to mask the next word in the text and make the model predict that word. The loss function is defined as cross-entropy between the predicted and ground-truth word. Experiment is implemented on single NVIDIA A800 GPU for 15 days. Our automatic PL-QCT BMD measurement adopt artificial intelligence-associated region-of-interest (ROI) generation algorithm for localizing vertebrae-parallel cylinder in cancellous bone. Due to no phantom for BMD calibration, we calculate ROI BMD by CT-BMD of personal muscle and fat.
Results: Clinical orthopedic experts are invited to design five osteoporosis questions in Chinese, evaluating performance of vanilla LLaMA and our fine-tuned model. Our model outperforms LLaMA on over 80% of these questions, understanding "expert consensus on osteoporosis," "QCT for osteoporosis diagnosis," and "effect of age on osteoporosis." Detailed results are shown in Appendix. Future work may be done by training a larger LLM on the whole orthopedics with more high-quality domain data, or a multi-modal GPT combining and understanding X-ray and medical text for orthopedic computer-aided-diagnosis. However, GPT model gives unexpected outputs sometimes, such as repetitive text or seemingly normal but wrong answer (called "hallucination"). Even though GPT give correct answers, it cannot be considered as valid clinical diagnoses instead of clinical doctors. The PL-QCT BMD system provided by Bone's QCT (Bone's Technology Limited, Shenzhen, China) achieves 0.1448 mg/cm^2 (spine) and 0.0002 mg/cm^2 (hip) mean absolute error and linear correlation coefficient R^2=0.9970 (spine) and R^2=0.9991 (hip) (compared to QCT-Pro [Mindways]) on 155 patients in three-center clinical trial in Guangzhou.
Conclusions: This study builds a Chinese osteoporosis corpus and develops a fine-tuned and domain-adapted LLM as well as a PL-QCT BMD measurement system. Our fine-tuned GPT model shows better capability than LLaMA model on most testing questions on osteoporosis. Combined with our PL-QCT BMD system, we are looking forward to providing science popularization and early morning screening for potential osteoporotic patients.

F167

The long-term natural history of degenerative lumbar spinal stenosis

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Background: Long-term data on the natural history of degenerative lumbar spinal stenosis (LSS) remain limited as management has increasingly favored surgical intervention. Here, we sought to characterize the prevalence of clinical deterioration upon long-term follow-up as well as to identify risk and protective factors.
Methods: We identified 215 patients aged 65–75 years attending the spinal disorders clinic who were suffering from neurogenic claudication and possessed compatible findings of central and/or lateral recess stenosis on lumbosacral magnetic resonance imaging (MRI). At disease presentation, we determined symptomatology, ambulatory status, walking tolerance, and medical comorbidities (hypertension, diabetes mellitus, hyperlipidemia, and spinal stenosis over non-lumbar regions). We excluded patients with less than 2 years of follow-up and those suffering predominantly from axial back pain or sciatica. From standing lumbar X-rays, we assessed the presence and severity of spondylolisthesis (slip distance in mm and Meyerding classification), while from MRIs, we assessed the dural sac area (mm^2) at the most stenotic level, the number of stenotic levels, developmental lumbar stenosis, Schizas grading, and Pfirrmann grading. Clinical deterioration upon follow-up was defined as one or more of the following: (1) decrease in walking tolerance to ≤10 minutes due to neurogenic claudication, (2) myotomal lower limb weakness, or (3) sphincter disturbance. Receiver operator characteristic curves and Kaplan-Meier survival curves were plotted to determine predictors for clinical deterioration. Missing data were excluded from analysis.
Results: The mean follow-up duration was 117±42.7 months, and 94.0% of patients (202/215) had at least 5 years of follow-up. The mean age at the onset of LSS symptoms was 65.4±4.21 years. The proportion of unaided walkers at the latest follow-up (131/213) was less than that at initial presentation with symptoms of LSS (178/204, $p<0.001$). Clinical deterioration occurred by the latest follow-up in 40/215 (18.6%) patients, at 7.05±4.24 years after symptom onset. Among those with deterioration, 37 (90.2%) reported reduced walking tolerance due to neurogenic claudication, 8 (19.5%) exhibited myotomal weakness, and 3 (7.3%) developed sphincter disturbance. While there was a high prevalence of developmental lumbar stenosis (76.1%), none of the 25 patients without developmental stenosis deteriorated by the latest follow-up ($p=0.019$). Dural sac area (DSA) at the most stenotic level was associated with clinical deterioration ($p<0.001$), and a DSA of ≤37.35 mm^2 exhibited an area under the curve of 0.726 in predicting clinical deterioration within 5 years of symptom onset. The correlation between clinical deterioration and medical comorbidities, severity of spondylolisthesis, number of stenotic levels, Schizas grading, and Pfirrmann grading was statistically insignificant.
Conclusions: This work represents the most comprehensive longitudinal cohort assembled to date on the natural history of LSS, which exhibited a benign clinical course in the majority of patients. Dural sac area correlated to deterioration with modest predictive power, while in the absence of developmental lumbar stenosis, patients invariably fared well. These respectively represented risk and protective factors that can help in decision-making towards surgical decompression or conservative therapy. Nevertheless, patients with neurogenic claudication and high functional demand may still benefit most from surgery.

F168

Adherence of *Mycobacterium tuberculosis* on material surface of nano-hydroxyapatite/polyamide 66 composite and long-term results of clinic application to spinal tuberculosis

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Background: To evaluate the adherence ability of *Mycobacterium tuberculosis* in nHA/PA66 and the long-term results of n-HA/PA66 in clinic application to spinal tuberculosis.
Methods: *M. tuberculosis* were cultured with four types of metal segments, smooth or rough surfaced n-HA/PA66, and titanium, respectively. The characteristics

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of adhesion and biofilm formation were observed under scanning electron microscope. There were twenty patients who underwent the debridement and strut graft with n-HA/PA66 cage combined with anterior instrumentations between June 2009 and January 2011 included in this study. There were nine male and 11 female patients with the mean age of 39.81±7.34 years.

Results: The average value of colony forming units of *M. tuberculosis* in smooth or rough surfaced n-HA/PA66 were significantly lower than those in titanium (p<0.01). All patients successfully completed one-stage lesion debridement, the mean operating time was 187.4±44.3 minutes, and intraoperative blood loss was 382.61±89.26 mL. The Visual Analog Scale score was relieved from 7.11±1.75 points before operation to 1.38±0.42 points at the last follow-up. The preoperative kyphosis Cobb angle range was 14° to 82° (32.41°±11.45°), which decreased to 2° to 47° (mean of 19.55°±10.21°) postoperatively. However, at the final follow-up, the mean kyphosis Cobb angle slightly increased to 3° to 57°. Bony fusion was achieved in 12 patients (60%) at 6 months, in 19 patients (95%) at 1 year, and in all patients at 2 years.

Conclusions: Long-term clinical follow-up results have confirmed that this material is an ideal option for anterior column reconstruction following the removal of thoracolumbar tuberculosis focus.

F169

A comparison of anterior reconstruction of spinal defect using nano-hydroxyapatite/polyamide 66 cage and autologous iliac bone for thoracolumbar tuberculosis: a stepwise propensity score matching analysis

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Background: Previous studies have confirmed the advantages and disadvantages of autogenous iliac bone and nano-hydroxyapatite/polyamide 66 (n-HA/PA66) cage. However, there is no conclusive comparison between the efficacy of the two implant materials in spinal tuberculosis bone graft fusion. The aim of this study was to analyze the mid- to long-term clinical and radiologic outcomes between n-HA/PA66 cage and autogenous iliac bone for anterior reconstruction application of spinal defect for thoracolumbar tuberculosis.

Methods: We retrospectively reviewed all patients who underwent anterior debridement and strut graft with n-HA/PA66 cage or iliac bone combined with anterior instrumentations between June 2009 and June 2014. One-to-one nearest-neighbor propensity score matching (PSM) was used to match patients who underwent n-HA/PA66 cage to those who underwent iliac bone. Clinical outcomes were assessed using the Japanese Orthopaedic Association (JOA) and Visual Analog Scale (VAS) score. Radiographic evaluations included cage subsidence and segmental angle.

Results: At the end of the PSM analysis, 16 patients from n-HA/PA66 cage group were matched to 16 patients in Iliac bone group. The C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) values in the n-HA/PA66 group decreased significantly from 33.19±10.89 and 46.63±15.65 preoperatively, to 6.56±2.48 and 9.31±3.34 at the final follow-up, respectively (p<0.001). There were no significant differences in the CRP and ESR values between the two groups at the final follow-up. The VAS and JOA scores in the iliac bone and n-HA/PA66 group were significantly improved at the 3-month follow-up postoperatively (both p<0.001). Then, improvements of VAS and JOA scores continue long at final follow-up. However, there were no significant differences in the VAS and JOA scores at any time point between the two groups (p>0.05). Although the SA significantly increased after surgery in both groups, there was no significant difference at any time point after surgery (p>0.05). There were no significant differences in the cage subsidence and fusion time between the two groups.

Conclusions: Overall, our data suggest that the n-HA/PA66 cage outcomes are comparable to those in the autogenous iliac bone, with a similar high fusion rate as autogenous iliac bone.

F171

S1 vertebral bone quality score independently predicts pedicle screw loosening following surgery in patients with adult degenerative scoliosis

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Background: Magnetic resonance imaging (MRI)-based vertebral bone quality (VBQ) score is an effective predictor of pedicle screw loosening after lumbar fusion surgery and has been recognized as a valuable tool for assessing preoperative bone quality. Due to the lateral curvature of lumbar spine of degenerative scoliosis, accurate measurement of VBQ score by conventional measurement methods that capture MRI signal intensity at L1–4 may be limited under certain conditions. To this end, a new simplified S1 VBQ score method has been proposed, which is comparable to the previous L1–4 VBQ score or S1 Hounsfield unit value, and has high accuracy and reliability. This retrospective single-center cohort aimed to evaluate the predictive value of MRI-based S1 VBQ score for pedicle screw loosening following surgery for adult degenerative scoliosis (ADS).

Methods: A total of 92 patients who underwent posterior lumbar interbody fusion (PLIF) with pedicle screw fixation for ADS were enrolled in the study between January 2017 and January 2020. The association between the S1 VBQ score and pedicle screw loosening following surgery for ADS was measured. We retrospectively reviewed the records of all patients who underwent PLIF between January 2017 and January 2020. The clear zone around pedicle screws ≥1 mm was identified as screw loosening. The S1 VBQ score was calculated from the S1 central-based non-contrast T1-weighted MRI. The signal intensity of the cerebrospinal fluid was then measured using region-of-interest placed at the L3 level to normalize the results. Multivariate logistic regression analysis was performed to identify independent risk factors for screw loosening. Then, a receiver operating characteristic (ROC) curve was constructed, and the threshold (cut-off) of the VBQ score with high sensitivity and specificity was determined based on the Youden index.

Results: A total of 92 patients were included, including 34 males and 58 females. The mean age of the patients was 61.23±1.23 years old. At 1-year follow-up, the screw loosening rate was 56.5% (52/92). The age and levels of fixation were higher in the loosening group than in the non-loosening group (p=0.036, p=0.025). Patients in the loosening group had a greater VBQ score compared to patients in the non-loosening group (3.31±0.41 vs. 3.01±0.28, p=0.001). Multivariate logistic regression analysis showed that advanced age (odds ratio [OR], 1.090; 95% confidence interval [CI], 1.005–1.183; p=0.039) and higher VBQ score (OR, 5.778; 95% CI, 2.889–16.177; p=0.001) were independent risk factors for screw loosening. In addition, the ROC curve was created to assess the role of VBQ score as predictors of screw loosening with a diagnostic accuracy of 74.6% (95% CI, 64.2%–85.1%). The most suitable threshold for the VBQ score as determined by the Youden Index was 3.175 (sensitivity: 76.0%, specificity: 83.3%).

Conclusions: Higher S1 VBQ score was significantly associated with pedicle screw loosening following surgery for ADS. The S1 VBQ score can be used as an effective preoperative predictor, which has the potential clinical application.

F172

Magnetic resonance imaging-based endplate bone quality score as a predictor of cage subsidence following oblique lumbar interbody fusion

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Background: To compare the predictive value of quantitative computed tomography (QCT)-volumetric bone mineral density (vBMD) and magnetic resonance imaging (MRI)-based vertebral bone quality (VBQ) and endplate bone quality (EBQ) scores for cage subsidence (CS) following oblique lumbar interbody fusion combined with anterolateral single-rod screw fixation (OLIF-AF).

Methods: Clinical data of 149 patients with single-level lumbar degenerative disease treated with OLIF-AF from February 2019 to October 2021 were retrospectively analyzed. There were 54 males and 95 females with an average age of 58.82±7.28 years. VBQ score and EBQ score were measured by preoperative T1-weighted MRI. CS was measured on lumbar X-rays at

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final follow-up and patients were divided into subsidence and non-subsidence groups. Univariate analysis was performed on age, sex, body mass index (BMI), previous medical history, Charlson comorbidity index, surgical level, Modic change, and cage parameters and perioperative radiographic data to preliminarily screen the influencing factors of CS. Cage parameters include cage length and cage height. Perioperative radiographic data included preoperative disc height, immediate postoperative disc height, change of disc height, L1/2 QCT-vBMD, VBQ score, and EBQ score. Multivariate logistic regression analysis was performed to screen independent risk factors for CS. Receiver operating characteristic (ROC) curves of independent risk factors were drawn, area under the curves (AUC) were calculated, and differences of AUC of independent risk factors were evaluated by ROC curve comparison analysis. ROC curves were also used to determine the most appropriate threshold (cut-off) for EBQ with higher sensitivity and specificity.

Results: A total of 149 patients were included in the final analysis (54 males, 95 females; mean age, 58.82±7.28 years; mean BMI, 25.93±4.85 kg/m^2; mean follow-up, 23.77±4.18 months). During follow-up, the incidence of CS was 30.2% (45/149). VBQ and EBQ score measurements showed good intra-observer and inter-observer reliability (intraclass correlation coefficient >0.80). Both VBQ and EBQ score were significantly higher in the subsidence group than in the non-subsidence group (3.71±0.58 vs. 3.09±0.46, 5.16±0.46 vs. 4.47±0.46; both p<0.001). L1/2 QCT-vBMD was lower in the subsidence group compared with the non-subsidence group (110.50±22.88 vs. 136.96±19.20, p<0.001). Multivariate regression analysis showed lower L1/2 QCT-vBMD (odds ratio [OR], 0.917; 95% confidence interval [CI], 0.878–0.959; p<0.001); higher VBQ score (OR, 3.569; 95% CI, 3.110–5.202; p=0.001) and higher EBQ score (OR, 5.720; 95% CI, 4.124–7.645; p<0.001) were independently associated with CS. ROC curves showed EBQ score had the highest predictive value, and L1/2 QCT-vBMD and VBQ had similar predictive value. The predictive value AUC of EBQ score as CS was 0.855, its sensitivity was 85.6% and specificity was 67.7%, and its most appropriate threshold was 4.745.

Conclusions: MRI-based EBQ score was independent predictors of CS following OLIF-AF, and higher EBQ score was significantly associated with an increased risk of CS. EBQ scores showed higher predictive value for CS following OLIF-AF than L1/2 QCT-vBMD and VBQ score.

F174

Long-term quality of life in patients with severe thoracic ossification of the ligamentum flavum treated with posterior laminectomy: a clinic follow-up study with a mean of 70.8 months

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Background: There is a lack of studies on the long-term quality of life (QoL) after posterior laminectomy in patients with severe thoracic ossification of the ligamentum flavum (TOLF), and risk factors associated with poor prognosis remain controversial. Therefore, the present study conducted to illustrate the long-term QoL for the severe TOLF patients after surgery and determine its relationship with their demographic, surgery-related, clinical characteristics, and imaging data.

Methods: A total of 118 patients diagnosed with thoracic myelopathy because of TOLF were enrolled in this retrospective study. They all underwent posterior decompressive laminectomy from August 2010 to January 2021. The QoL was evaluated based on the EuroQol five-dimension five-level (EQ-5D-5L). We collected data on gender, age, number of operations, compressed segments, Frankel grade, complications, body mass index (BMI), symptoms and duration, modified Japanese Orthopaedic Association (mJOA) score (preoperative), follow-up time, type of ossification, increased signal on sagittal T2-weighted images (ISST2I), and occupancy rate. The data were then analyzed using the Mann-Whitney U test, Kruskal-Wallis test, chi-square test, and logistic regression tests.

Results: The average follow-up was 70.8 months. The mean age of the patients was 59.74±9.81 years. At the final follow-up, the mean QoL score based on the EQ-5D-5L was 0.71±0.28, and the mean Visual Analog Scale (VAS) score was 78.88±10.21. Moderate to severe pain/discomfort was reported by 22.0% of the patients, while 24.6% and 30.4% reported moderate to severe problems with mobility and usual activities, respectively. The mean QoL and VAS scores were significantly higher in patients with mild to moderate neurological impairment, normal BMI, age below 60 years, no dural tears, symptom relief at hospital discharge, unilateral or bilateral ossification on axial computed tomography

(CT) scan, ≤50% spinal canal occupancy on CT and magnetic resonance imaging, and none or fuzzy findings on ISST2I.
Conclusions: Long-term QoL after posterior laminectomy in severe TOLF patients is generally satisfactory compared to preoperative levels. Preoperative mJOA score, age, comorbid diabetes, the major symptom is activity limitation, BMI, ISST2I, intraoperative dural tears, and spinal canal occupancy rate correlate significantly with the corresponding dimensions and are predictive. Age, spinal canal occupancy rate, ISST2I, preoperative mJOA score, and BMI are significantly associated with and have predictive value for overall postoperative QoL.

F176

Two-level anterior cervical corpectomy and fusion versus posterior open-door laminoplasty for the treatment of cervical ossification of posterior longitudinal ligament: a comparison of the clinical impact on the occipito-atlantoaxial complex

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Background: Both two-level anterior cervical corpectomy and fusion (t-ACCF) and posterior open-door laminoplasty (ODLP) are effective surgical procedures for the treatment of ossification of the posterior longitudinal ligament (OPLL). The cervical spine is divided into the upper and the subaxial cervical spine (UCS, SCS), due to its different anatomical structure leads to considerable mechanical differences. At the same time, the corresponding changes produced by the UCS and SCS cause some compensatory responses that have some effect on the structure and function of the cervical spine. previous studies have identified different effects of different surgical procedures on the UCS and SCS; however, there are no studies on the effects of t-ACCF and ODLP on the occipito-atlantoaxial complex. Therefore, the purpose of this study is to compare the changes in sagittal parameters and range of motion (ROM) of the occipito-atlantoaxial complex in OPLL patients treated with t-ACCF and ODLP.
Methods: This was a retrospective study that included 74 patients who underwent t-ACCF or ODLP for the treatment of OPLL from January 2012 to August 2022 at our institution. Preoperative, 3-month, and 1-year postoperative cervical neutral, flexion-extension, and lateral flexion radiographs were taken. Sagittal parameters including Cobb angle of C2–7, C0–2, C0–1, C1–2, C2 slope, and the ROM were measured. The clinical outcome was assessed using the Japanese Orthopaedic Association, Visual Analog Scale, and Neck Disability Index scores preoperatively and at 3 and 12 months postoperatively.
Results: In the ODLP group, the SCS (C2–7) Cobb angle was significantly reduced (12.9±10.0 to 7.7±11.27, $p<0.05$), and the UCS (C0–2) Cobb angle was significantly compensated for at 1 year postoperatively compared with the t-ACCF group (2.1±5.09 vs. 0.8±5.62, $p<0.01$). The SCS and lateral flexion ROM of the ODLP group was better maintained than t-ACCF (14.5±6.00 vs. 10.7±3.79; 6.9±4.56 vs. 3.8±1.67; $p<0.01$), and the compensatory increase in C0–2, C0–1, and C1–2 ROM was more pronounced.
Conclusions: The loss of SCS Cobb angle was more pronounced in ODLP relative to t-ACCF, resulting in a significant compensatory increase in UCS and atlantoaxial Cobb angle. The ROM of the UCS, atlantooccipital, and atlantoaxial joints was significantly increased in ODLP group, this may accelerate degenerative changes in the occipital-atlantoaxial complex, leading to poorer outcomes in the long-term. In contrast, t-ACCF better maintains normal curvature of the SCS and occipito-atlantoaxial complex but loses more ROM.

F177

The novel cervical vertebral bone quality score can independently predict cage subsidence after anterior cervical corpectomy and fusion

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Background: To optimize cervical vertebral bone quality (C-VBQ) score and explore its effectiveness in predicting cage subsidence in anterior cervical corpectomy and fusion (ACCF) and identify a new method for

evaluating subsidence without different equipment and image scale interference.

Methods: We collected demographic, imaging, and surgery-related information. Cage subsidence was measured using a new method. Multifactorial logistic regression was used to identify risk factors associated with subsidence. Pearson's correlation was employed to determine the relationship between C-VBQ and computed tomography Hounsfield units (HU). The receiver operating characteristic curve was used to assess the predictive ability of C-VBQ. Correlations between demographics and C-VBQ scores were analyzed using linear regression models.

Results: A total of 92 patients were included in this study. Among them, 36 (39.1%) showed subsidence with a C-VBQ value of 2.05±0.45, while the no-subsidence group had a C-VBQ value of 3.25±0.76. Multifactorial logistic regression showed that C-VBQ is an independent predictor of cage subsidence with a predictive accuracy of 93.4%. Pearson's correlation analysis showed a negative correlation between C-VBQ and HU. Linear regression analysis showed a positive correlation between C-VBQ and cage subsidence. Univariate analyses showed that only age was associated with C-VBQ.

Conclusions: The C-VBQ values obtained using the new measurements independently predicted postoperative cage subsidence after ACCF and showed a negative correlation with HU. By adding the measurement of non-operated vertebral heights as a control standard, the results of cage subsidence measured by the ratio method are likely to be more robust, perhaps can exclude unavoidable errors caused by different equipment and proportional.

F178

A novel magnetic resonance imaging-based cervical endplate bone quality score independently predicts cage subsidence after anterior cervical diskectomy and fusion

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Background: Postoperative cage subsidence after anterior cervical discectomy and fusion (ACDF) often has adverse clinical consequences and is closely related to bone mineral density (BMD). Previous studies have shown that cage subsidence can be better predicted by measuring site-specific bone density. Magnetic resonance imaging (MRI)-based endplate bone quality (EBQ) scoring effectively predicts cage subsidence after lumbar interbody fusion. However, there is still a lack of studies on the practical application of EBQ scoring in the cervical spine. The purpose of this study is to create a similar MRI-based scoring system for cervical-EBQ (C-EBQ) and to assess the correlation of the C-EBQ with endplate computed tomography Hounsfield units (HU) and the ability of this scoring system to independently predict cage subsidence after ACDF, comparing the predictive ability of the C-EBQ with the cervical vertebral bone quality (C-VBQ) score.

Methods: A total of 161 patients who underwent single-level ACDF for degenerative cervical spondylosis at our institution from 2012 to 2022 were included. Demographics, procedure-related data, and radiological data were collected, and Pearson's correlation test was used to determine the correlation between C-EBQ and endplate HU values. Cage subsidence was defined as fusion segment height loss of ≥3 mm. Receiver operating characteristic analysis and area under the curve values were used to assess the predictive ability of C-EBQ and C-VBQ. A multivariate logistic regression model was developed to identify potential risk factors associated with subsidence.

Results: Cage subsidence was present in 65 (40.4%) out of 161 patients. The mean C-EBQ score was 1.81±0.35 in the group without subsidence and 2.59±0.58 in the group with subsidence (p<0.001). Multivariate analysis revealed that a higher C-EBQ score was significantly associated with subsidence (odds ratio [OR], 5.700; 95% confidence interval [CI], 3.435–8.193; p<0.001). It was identified as the sole independent predictor of cage subsidence after ACDF and demonstrated a predictive accuracy of 93.7%, which surpassed that of the C-VBQ score (89.2%). Furthermore, it exhibited a significantly negative correlation with the end-plate HU value (r=-0.58, p<0.001).

Conclusions: Higher C-EBQ scores were significantly associated with postoperative cage subsidence after ACDF. There was a significant negative correlation between C-EBQ and Endplate HU values. The C-EBQ score may be a promising tool for assessing preoperative bone quality and postoperative cage subsidence and is superior to the C-VBQ.

F182

Magnetic resonance imaging-based cervical vertebral bone quality score and the quality of paravertebral muscle are novel predictors of the loss of cervical lordosis after open-door laminoplasty

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Background: Open-door laminoplasty (ODLP) is commonly employed in treating cervical spondylotic myelopathy (CSM). Maintaining the normal curvature and sagittal balance of the cervical spine post-surgery is crucial for achieving favorable clinical outcomes. However, ODLP inevitably damages posterior cervical structures, often resulting in loss of cervical lordosis (LCL) and sagittal imbalance during the postoperative period. The risk factors associated with LCL are unclear. Preoperative conditions of cervical vertebral bone quality and the relative cross-sectional area of paraspinal muscles have been shown to correlate with LCL after ODLP. However, the relationship between the novel magnetic resonance imaging (MRI)-based cervical vertebral bone quality (C-VBQ) score and the degree of fat infiltration (DFF) in paraspinal muscles with LCL remains unknown.

Methods: We conducted a retrospective analysis of patient data to assess the relationship between C-VBQ score, the degree of DFF of the paraspinal muscle with LCL. Lateral radiographs of the cervical spine were collected to measure cervical sagittal parameters and range of motion (ROM). Computed tomography Hounsfield unit (CT-HU) values of cervical vertebrae were obtained in axial and sagittal positions on cervical CT scans. C-VBQ scores were calculated based on preoperative T1-weighted MRI images. Image J software was used to measure the degree of DFF of the paraspinal muscle. Pearson correlation analysis and Spearman correlation analysis were used to assess the correlation between LCL and relevant parameters. Multivariate logistic regression analyses and Receiver operating characteristic curve were used to investigate the risk factors for predicting LCL.

Results: A total of 182 patients (mean age: 52.31±8.12 years) were included in the analysis, with an average follow-up of 24.3 months. Among them, 87 patients (47.8%) with LCL >5° at the 1-year follow-up were classified into the LCL group. Patients in the LCL group had significantly lower Japanese Orthopaedic Association (JOA) scores at the last follow-up compared to those in the non-LCL group (13.21±0.54 vs. 14.56±0.62), and the mean JOA recovery rate was significantly negatively correlated with LCL (r=-0.376, p=0.01). Furthermore, preoperative C2 slope (C2S), T1 slope (T1S), flexion/extension ROM, C-VBQ scores, and the DFF of paravertebral muscles were significantly and positively correlated with LCL. Multivariate analysis revealed that C2S, T1S, flexion/extension ROM, C-VBQ scores, and DFF of paraspinal muscles were risk factors for LCL.

Conclusions: This study is the first to reveal a significant positive correlation between the C-VBQ score, DFF of paravertebral muscles, and LCL. The C-VBQ score and DFF of paravertebral muscles are novel predictors of LCL, with very important clinical applications.

F185

Effect of different intraoperative neck positions on postoperative dysphagia after anterior cervical discectomy and fusion: a double-blind, prospective, randomized controlled trial

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Background: Dysphagia is a frequent complication after anterior cervical discectomy and fusion (ACDF), which can hinder the early recovery of patients. The Smith-Robinson approach to ACDF is a commonly performed surgical procedure for the treatment of degenerative cervical spondylosis. Current surgical position choices include neck hyperextension, neutral positioning, and neck hyperextension rotated 30° to the contralateral side. While numerous studies have identified some risk factors for postoperative dysphagia after ACDF, the impact of intraoperative neck positions on postoperative dysphagia remains unclear.

Methods: A total of 98 patients (aged 54.3±9.8 years) with degenerative cervical spondylosis were randomized into two groups. In the experimental group, the surgical neck position of choice was cervical hyper-

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extension with a 30° rotation to the contralateral side, while in the control group, the surgical neck position of choice was cervical hyperextension in a neutral position. All surgeries were performed by a single surgeon with a senior title. Bazaz dysphagia score and Visual Analog Scale (VAS) scores for arm and neck pain were collected at 1 day, 3 days, 1 week, 3 months, and 6 months postoperatively. The modified Japanese Orthopaedic Association (mJOA) score and the degree of prevertebral soft tissue swelling (PSTS) were measured preoperatively and 1 week postoperatively.

Results: In patients undergoing multi-segmental ACDF (2–3 segments), the Bazaz scores were significantly higher in the experimental group compared with the control group at 1 day, 3 days, and 1 week postoperatively ($p<0.001$, $p<0.001$, and $p=0.012$, respectively). However, at 3 and 6 months, there were no significant differences in Bazaz scores between the two groups. Similarly, at 1 and 3 days, the VAS scores were significantly higher in the experimental group compared to the control group after multi-segmental ACDF ($p<0.001$ and $p<0.001$, respectively). However, there were no significant differences in VAS scores between the two groups at 1 week, 3 months, and 6 months. No significant differences in Bazaz scores and VAS scores were observed between the two groups in single-segment ACDF. Additionally, there were no significant differences in PSTS and mJOA scores preoperatively and 1 week postoperatively.

Conclusions: In multi-segment ACDF, the intraoperative cervical hyperextension with neutral position can reduce dysphagia and neck pain in the early postoperative period, and for single-segment ACDF, there is little difference between the effects of the two positions on dysphagia and neck pain in the early postoperative period.

F186

Clinical outcomes of coplanar-hybrid techniques for restoring thoracic kyphosis in patients with idiopathic scoliosis: synergy between convex uniplanar screws and hybrid constructs on the concave side

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Background: Coplanar alignment for idiopathic scoliosis (IS) is a technique rooted in the concept of anatomically aligning vertebral axes into a single plane. However, sagittal plane correction relies on the pull-in force between screws and rods, as well as the distraction force among screws, raising uncertainties about its effectiveness in restoring thoracic kyphosis (TK). Therefore, we hypothesized that a combination of convex coplanar correction and hybrid constructs with multi-sublaminar bands on the concave side (Coplanar-Hybrid techniques) could potentially demonstrate a synergistic effect in IS correction, particularly for restoring TK. The aim of this study is to reveal the clinical efficacies of these techniques through short-term follow-up.

Methods: We retrospectively evaluated a consecutive series of 50 postoperative patients with Lenke type 1 or 2 IS, aged 25 years or younger, who underwent posterior spinal fusion with a minimum 2-year follow-up. The patients were divided into two groups: those treated with Coplanar-Hybrid techniques (26 cases: group CH) and those treated with other techniques (24 cases: group PS). Radiographic parameters were compared between the two groups.

Results: In the CH group, the mean Cobb angles (pre/latest/correction rate) were 55.9°/17.4°/69.0%, while in the PS group, they were 58.5°/22.5°/61.9%. Additionally, the T5–T12 TK angles (pre/latest) were 15.5°/26.0° in the CH group and 17.1°/21.8° in the PS group, respectively. The postoperative TK gain was significantly higher in the CH group (10.4° vs. 4.7°, $p<0.05$).

Conclusions: In the Coplanar-Hybrid techniques, the utilization of coplanar tubes on the convex uniplanar screws facilitates substantial coronal and rotational correction independently. By integrating hybrid constructs on the concave side, including multi-sublaminar bands,

it applies a pull-in force in the sagittal plane during TK correction, enabling a more ideal three-dimensional correction. The insertion of pedicle screws on the concave side of the thoracic curve can pose challenges due to the narrow pedicle width, proximity to the spinal cord, and major blood vessels. In such cases, the merits of the Coplanar-Hybrid techniques are deemed significant. This study demonstrates that the Coplanar-Hybrid techniques could potentially exhibit a synergistic effect in both restoring TK and achieving coronal correction in IS.

F187

Single versus double index screws in thoracolumbar burst fractures: a comparative retrospective study

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Background: With the advent of modern implants and instrumentation, short-segment fixation with index screws in the fractured vertebra became the standard surgical method for treating thoracolumbar burst fractures. However, there is no clear consensus on whether a single or double index screw is ideal for the management of thoracolumbar burst fractures. Thus, the current study aims to assess the radiological and clinical outcomes of patients who had thoracolumbar burst fractures and underwent posterior stabilization with a single index screw (SIS) or double index screws (DIS) at the fractured vertebra.

Methods: This study involved a retrospective analysis of all cases undergoing short-segment posterior-only stabilization with SIS or DIS for thoracolumbar burst fractures from 2018 to 2021. Patients with pathological fractures, osteoporotic fractures, more than two vertebral fractures, thoracolumbar injury classification and severity less than 4, load-sharing classification score less than 6, less than 2 years of follow-up, and AO type C injury were excluded. A total of 87 patients met our criteria and were included in our study. Among these, 38 had DIS fixation, and 49 had single index screw fixation. Plain radiographs were assessed for Cobb's angle (CA), vertebral wedge angle (VWA), and vertebral body compression ratio (VBCR) in the neutral lateral view. The occupancy rate of the pedicle screw within the vertebral body was calculated using postoperative computed tomography (CT) scans. Clinical outcomes were assessed using the Visual Analog Scale (VAS) for back pain and the Oswestry Disability Index (ODI) at the final follow-up visit.

Results: The mean age in the DIS group was 48.5 years (range, 17–55 years) and in the SIS group was 43.7 years (range, 19–58 years). All patients had more than 2 years of follow-up, with a mean follow-up of 29.6 months (range, 24–96 months). At the latest follow-up, CA in the SIS and DIS groups was found to be 8.7° (range, 5.7°–12.2°) and 6.9° (range, 4.8°–10.2°), with a loss of 2.4° (range, 1.2°–4.1°) and 1.7° (range, 0.8°–3.4°). VWA in the SIS and DIS groups was 11.8° (range, 8.3°–14.4°) and 8.0° (range, 5.8°–11.2°), with a loss of 2.3° (range, 1.8°–4.8°) and 1.2° (range, 0.8°–3.7°) in the SIS and DIS groups at their latest follow-up. VBCR had a loss of 9% (range, 6.5%–13.7%) in the SIS group and 5.2% (range, 4.2%–7.6%) in the DIS group, as noted. The pedicle screw occupancy rate (PSOR) in the final follow-up CT scan was higher in the DIS group (135 mm^3 vs. 270 mm^3). At the final follow-up, in the SIS group, the mean VAS for back pain was 2.5 (range, 1–5) and the mean ODI was 15.4% (range, 10.3%–26%). In the DIS group, the mean VAS for back pain was 1.4 (rang, 1–3) and the mean ODI was 12.5% (range, 10%–23.5%).

Conclusions: Fixation of unstable thoracolumbar fractures with short-segment posterior stabilization with DIS in the fractured vertebra resulted in radiologically better maintenance of CA, VWA, VBCR, and increased PSOR compared to single index screw, with increased hospital costs in the DIS group. Though the VAS and ODI were better in the DIS group, they were statistically insignificant.

F201

The meaning and clinical application of facet fluid effusion found on magnetic resonance imaging in patients with cervical degenerative spondylolisthesis

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Background: Cervical degenerative spondylolisthe-

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sis (CDS) has become more common, along with the growing prevalence of cervical spondylosis in the recent decade, an era of smartphones and 3C products. However, unlike the well-established connection between the excised facet fluid on the magnetic resonance (MR) image and the instability secondary to lumbar degenerative spondylolisthesis, similar findings over the cervical levels still lack definitive confirmation from current literature. Therefore, this study aims to investigate the association between cervical facet fluid findings on MR images and clinical instability indicating immobilization levels in CDS diagnosed on plain film radiography.
Methods: From 2010 to 2020, patients diagnosed with CDS by plain film and followed by magnetic resonance imaging in a medical center were enrolled. The baseline demographics and radiologic parameters were collected after being verified by the institutional review board. The Facet Fluid Index (FFI) (ratio of facet fluid width and facet joint width), a modified measurement originating from the lumbar spine, was applied to assess the subaxial cervical spine (C3–C7). The parameters of CDS levels and non-CDS levels were recorded separately. The clinical presentation, including Visual Analog Scale, modified Japanese Orthopaedic Association score, and Neck Disability Index, were traced along the observative duration and analyzed, respectively. Multivariate logistic regression was conducted to analyze the relationship between the baseline parameters and the presence of CDS. Also, the cut-off points of FFI, predicting the deterioration of cervical instability after observation for a year, were identified by the receiver operating characteristic (ROC) curve and verified by the area under the ROC curve analysis.
Results: A total of 185 patients with 242 levels of CDS and 498 levels of non-CDS were enrolled. The mean FFI was significantly higher in the CDS group than in the non-CDS group (0.25±0.08 vs. 0.19±0.10, $p<0.05$). In addition, both fluid width ($p<0.001$) and facet width ($p<0.05$) were significantly larger in the CDS group than in the non-CDS group. The larger FFI (odds ratio [OR], 22.88; 95% confidence interval [CI], 18.38–30.26), wider local range of motion (OR, 1.52; 95% CI, 1.03–1.84), shorter disc height (OR, 0.89; 95% CI, 0.72–0.99), existing cord signal change (OR, 3.51; 95% CI, 2.03–6.77), and disc bulging (OR, 4.82; 95% CI, 3.52–8.00) at the same level were found independent predictor of CDS under the regression model. The identified cut-off point, 0.225, was verified to provide good accuracy (0.8–0.9) on predicting the deterioration of cervical instability and functional outcomes.
Conclusions: Several predictors, including the most dominant FFI, were associated with the presence of CDS. After verifying the FFI threshed associated with the rapid progression of cervical instability, spine surgeons could identify candidate patients indicating proper fixation despite relatively mild symptoms.

F202

Analysis of midterm clinical and functional outcomes following sacrectomy for primary malignant sacral tumors: a single tertiary care center study on posterior-only approach without reconstruction

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Background: Sacrectomy is a primary intervention for high-grade sarcomas and aggressive benign bone tumors. Previous studies have advocated for a combined anterior and posterior approach with spinopelvic fixation, contributing to prolonged surgical duration and increased wound complications. This study aims to analyze perioperative and functional outcomes following sacrectomy using a posterior-only approach without reconstruction.
Methods: Between 2018 and 2021, 26 patients underwent sacrectomy for primary malignant tumors. Perioperative outcomes were evaluated during hospitalization, with subsequent assessments conducted at 2 weeks, 6 weeks, 3 months, and every 6 months thereafter. Final functional outcomes were appraised following a minimum follow-up period of 24 months.
Results: Among the patients, six underwent total sacrectomy, 14 had high partial sacrectomy preserving the S1 body, and six had sacrectomy below S2. The overall final Musculoskeletal Tumor Society (MSTS) score averaged 23 (range, 16 to 28), with 24 patients walking unaided, one using a cane, and one requiring a walker. Prophylactic colostomy was performed in 12 patients due to tumor proximity to the rectum. The average surgery duration was 236 minutes, with a blood loss of 2,645 mL. Hemodynamic instability necessitating vasoactive drugs occurred in eight patients postoperatively.

Complications included intraoperative ureter injury (one patient), sciatic nerve sacrifice (four patients), rectum injury (one patient), and vaginal injury (one patient). Postoperative wound complications required repeat debridement in four patients. Additionally, urinary incontinence was observed in five patients, bowel incontinence in one patient, and tumor recurrence in two patients. No spinopelvic migration was detected on the final X-ray at 24 months.

Conclusions: This pilot study suggests that, even without spinopelvic reconstruction, patients undergoing total sacrectomy with a posterior-only approach can achieve good MSTS scores and experience limited perioperative complications. This study sets the stage for further research and evaluation in this field.

F211

Correction rigid and severe spinal deformity in a resource constant environment by single stage posterior vertebral column resection

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Background: Treating a severe and rigid kyphotic deformity, regardless of its cause, is always challenging for the spine surgeon. Nevertheless, vertebral column resection (VCR) has evolved over the past century to become a viable last resort for correcting the most challenging spinal deformities through a single, posterior approach.

Methods: This is a prospective case series of 28 patients either with a severe (Cobb angle >60°) or rigid kyphotic deformity who underwent treated for correction of deformity by a single stage posterior vertebral column resection (PVCR) from July 2016 to June 2022.

Results: Mean age of the patient was 30.2 years with a mean follow-up time 27 months. Average operating time was 420 minutes (range, 320–760 minutes). Overall final postoperative kyphotic Cobb angles correction ranged from 30.4° to 55.9°. Oswestry Disability Index improved from 58.6±6.5 to 10.5±3.2. Visual Analog Scale was improved from 6.7±0.5 to 1.7±0.8. Most frequent complications observed in our series were massive blood loss with a mean of 740 mL (range, 560–1,380 mL), dural tear (8%), thoracic root pain (4%), and neurological deterioration (four cases: three transient and one late onset). Mean recovery period for neurological recovery was 3 months. Surgical site infection rates range from 2.9% to 3.7%

Conclusions: Although the PVCR is a highly technically demanding, exhaustingly lengthy, and associated with a variety of complications but can be performed safely with proper training and patience for correcting these deformities with a satisfactory outcome in a resource constrained environment like us.

F213

Evaluation of accuracy of thoracolumbar pedicle screw placement assisted by artificial intelligence preoperative planning

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Background: Based on the three-dimensional U-Net network, segment the thoracolumbar computed tomography images and use deep learning to build an artificial intelligence model for planning thoracolumbar pedicle screw placement. It has been verified to be feasible through retrospective research and the model is used for preoperative planning of thoracolumbar pedicle screw placement, and further comparison of the safety and accuracy of thoracolumbar pedicle screw placement assisted by artificial intelligence preoperative planning and traditional manual pedicle screw placement.

Methods: A total of 80 patients who visited Beijing Tongren Hospital Affiliated to Capital Medical University from December 2022 to December 2023 were divided into two groups: the artificial intelligence preoperative planning-assisted nail placement group (AIG) and the traditional manual placement group at a ratio of 1:1 nail group (HG). The main outcome measure was the evaluation of the accuracy of pedicle screw placement according to the modified Gertzbein and Robbins grading scale, in which grades A and B (pedicle screw damage to the vertebral cortical layer <2 mm) are considered clinical acceptable, grades C, D, and E (pedicle screws destroying the vertebral cortical layer ≥2 mm) are considered to have significant deviations from the

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predetermined trajectory. Other parameters include: proximal facet joint invasion, operation time, intraoperative blood loss, number of intraoperative radiations, postoperative hospitalization time, and so forth.

Results: A total of 499 pedicle screws were placed in 80 patients (251 pedicle screws were placed in 40 patients at AIG and 248 pedicle screws were placed in 40 patients at HG). In AIG, 95.22% of the inserted screws were considered clinically acceptable (86.85% of them were grade A and 8.37% were grade B), and the remaining screw grades were grade C (2.79%), grade D (1.20%), and E. level (0.80%). In HG, 88.31% of the inserted screws were considered clinically acceptable (79.84% of them were grade A and 8.47% were grade B), and the remaining screw grades were grade C (7.66%), grade D (2.82%), and grade E level (1.21%). And the difference is significant (p=0.005, <0.05). In addition, six screws in AIG had facet joint invasion, while 21 screws in HG had facet joint invasion, which was a significant difference (p=0.003, <0.05). Among the secondary observation indicators, the average operation time, intraoperative blood loss, and postoperative hospitalization time required by AIG were less than those of HG, but the difference was not significant. Postoperative examination analysis of the two groups of patients showed that no serious nerve root damage was found in any of the patients. In HG, three screws were poorly positioned and entered the spinal canal but no obvious symptoms were found. The same situation did not occur in AIG.

Conclusions: Artificial intelligence preoperative planning-assisted thoracolumbar pedicle screw placement is safer and more accurate than traditional manual pedicle screw placement. However, the impact on operation time, intraoperative blood loss, etc. still needs further study.

F218

Postoperative analgesic efficacy of intersemispinal plane block in posterior cervical laminectomy: a prospective randomized controlled study

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Background: Postoperative pain following posterior cervical laminectomy is often severe due to extensive soft tissue dissection involved. Though multimodal analgesia has been the standard for managing postoperative pain in posterior cervical laminectomy, the role of the interfascial plane block has been explored in recent years. One among them is the intersemispinal plane block (ISPB) which acts on the dorsal rami of the cervical spinal nerves providing significant postoperative pain relief. The study aims to assess the safety and efficacy of ultrasound-guided ISPB for postoperative analgesia in posterior cervical laminectomy.

Methods: This is a prospective, randomized controlled, double-blinded study. Eighty-eight patients requiring posterior cervical laminectomy were randomized into two groups. After anesthesia and prone position, ISPB group patients received ultrasound-guided ISPB at the C5 level using 15 mL of 0.25% bupivacaine and 8mg dexamethasone bilaterally along with multimodal anesthesia while the control group patients received only standard postoperative multimodal analgesia. Demographic and surgical data (blood loss, duration of surgery, perioperative total opioid consumption, muscle relaxants used) were assessed. Postoperatively, the surgical site pain, alertness scale, satisfaction score, time to mobilization, and complications were recorded.

Results: There were 44 patients in each group; the two groups were identical in demographic and surgical profile. The total opioid consumption (128.41±39.65 mcg vs. 284.09±140.92 mcg, p<0.001), muscle relaxant usage (46.14±6.18 mg vs. 59.32±3.97 mg, p<0.001), surgical duration (128.61±26.08 minutes vs. 160.23±30.99 minutes, p<0.01), and intraoperative blood loss (233.18±66.08 mL vs. 409.77±115.41 mL, p<0.01) were significantly less in the ISPB group. In the postoperative period, the control group's pain score was significantly higher (p<0.001). The Modified Observer Alertness/Sedation Score (MOASS) score and satisfaction scores also showed significant differences between the two groups, where the ISPB patients had better MOASS and satisfaction scores (p<0.001). The mean time required to ambulate was significantly less in ISPB (4.30±1.64 hours) when compared to controls (9.48±3.07 hours) (p<0.001).

Conclusions: In patients undergoing posterior cervical laminectomy, ISPB is a safe and effective technique with better outcomes than standard multi-modal analgesia alone, in terms of reduced intraoperative opioid requirements and blood loss, better postoperative analgesia, and early mobilization. It can be utilized as an additional arm of multimodal analgesia, particularly for elderly patients with cervical myelopathy who are more susceptible to opioid side effects.

F219

Risk predictive score and cord morphology classification for intraoperative neuromonitoring alerts in kyphosis surgery

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Background: Intraoperative neuromonitoring (IONM) alert is one of the worrying events of kyphosis corrective surgery, which can result in a postoperative neurological deficit. To our knowledge, there is no risk prediction score to predict such events in patients undergoing kyphosis surgery. We aim to develop a new preoperative magnetic resonance imaging (MRI)-based cord morphology classification (CMC) and risk prediction score for predicting IONM alerts in patients with kyphotic deformity.
Methods: Kyphotic deformity patients undergoing posterior spinal fusion were retrospectively reviewed. Based on the morphology of the spinal cord and surrounding cerebrospinal fluid (CSF) in MRI, there are five cord types: type 1 (normal cord): circular cord with surrounding visible CSF between the cord and the apex; type 2 (flattened cord): cord with <50% distortion at the apex with obliteration of the anterior CSF; type 3 (deformed cord): cord with >50% distortion at the apex with complete obliteration of the surrounding CSF; type 4 (stretched cord): the cord is stretched and atrophied over the apex of the curve; and type 5 (translated cord): horizontal translation of the cord at the apex with buckling collapse of the vertebral column. Preoperative radiographs were used to measure the preoperative sagittal Cobbs' angle, sagittal deformity angular ratio (S-DAR), sagittal vertical axis, apex of the curve, and type of kyphosis. Clinical data like the duration of symptoms, clinical signs of myelopathy, neurological status (adolescent idiopathic scoliosis grade), grade of myelopathy using the modified Japanese Orthopaedic Association (mJOA) score, and type of osteotomy were documented. Multivariate logistic regression was used to determine the risk factors for IONM alerts and the risk prediction score was developed which was validated with a new cohort of 30 patients.
Results: A total of 114 patients met the inclusion criteria. IONM alerts were documented in 33 patients (28.9%), with full recovery of the signal in 25 patients and a postoperative deficit in eight patients. Rate of IONM alerts was significantly higher in type 5 (66%), followed by type 4 (50%), type 3 (21.1%), type 2 (11.1%), and type 1 (11.1%) (p<0.001). Based on multiple logistic regression, seven factors, namely preoperative neurological status, mJOA score <6, presence of signs of myelopathy, apex of the curve above T5, preoperative sagittal Cobbs, S-DAR, and MRI-based CMC, were identified as risk predictors. The value for the risk factors varies from 0 to 4, and the maximum total risk score was 13. The cut-off value of 6 had good sensitivity (84.9%) and specificity (77.8%) indicating a high risk for IONM alerts. The area under the receiver operating characteristic curve of the predictive model was 0.92, indicating excellent discriminative ability.
Conclusions: We developed and validated a risk predictive score that clearly identifies patients at risk of IONM alerts during kyphosis surgery. Identification of such high-risk patients (risk score >6) helps in proper evaluation and preoperative counseling and helps in providing a proper evidence-based reference for treatment strategies.

F222

Does the gut microbiome influence disc health and disease?: the interplay between dysbiosis, pathobionts, and disc inflammation

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Background: Gut microbiome alterations resulting in inflammatory responses have been implicated in many distant effects on different organs. However, its influence on disc health is still not fully investigated.
Methods: We analyzed 16S V3–V4 ribosomal RNA gut metagenome from 20 healthy volunteers (HV) and compared the top signature genera from 40 patients with disc degeneration (DG) across Modic and non-

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Modic groups. Plasma proteome with liquid chromatography coupled to tandem mass spectrometry and immunoturbidometric analysis, measured serum C-reactive protein (CRP), and plasma fatty acid binding protein 5 (FABP5) were measured.

Results: We observed significant gut dysbiosis between HV and DG and also between Modic and non-Modic groups. In the Modic group, commensals *Bifidobacterium* and *Ruminococcus* were significantly depleted while pathobionts *Streptococcus*, *Prevotella*, and *Butyrivibrio* were enriched. *Firmicutes*/*Bacteroidetes* ratio was decreased in DG (Modic: 0.62, non-Modic: 0.43) compared to the HV (0.70). Bacteria-producing beneficial short-chain fatty acids (SCFAs) were also depleted in DG. Elevated serum CRP and increased FABP5 were observed in DG.

Conclusions: The study revealed gut dysbiosis, altered *Firmicutes*/*Bacteroidetes* ratio, reduced SCFAs-producing bacteria, and increased systemic and local inflammation in association with disc disease, especially in Modic changes. The findings have considerable importance in our understanding, and prevention of disc degeneration.

F223

An algorithm for the posterior only surgical correction of kyphosis in thoracic and thoracolumbar spinal tuberculosis

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Background: Spinal tuberculosis (TB) is one of the most common causes of kyphotic deformity in the world. Though, there is clear consensus for surgical decision-making in patients with neurological involvement or instability due to spinal TB, no such protocol exists in the treatment of kyphotic deformity in spinal TB. The aim of our study is to analyze the clinical and radiological outcomes of deformity correction and to propose a treatment algorithm for guiding the decision-making in the management of kyphotic deformities in thoracic and thoracolumbar spinal TB.

Methods: This study is a retrospective analysis of prospectively collected data of patients with thoracic and thoracolumbar spinal tuberculosis (active and healed), operated in our institute with kyphotic Cobb's angle >30° who underwent surgical management. Patients were categorized into group A (active spinal TB) and group B (healed spinal TB). Data collection was performed using the hospital information system, operative registry, and Picture Archiving and Communication System. This included patient demographic data, and radiological data including pre- and postoperative radiographs, computed tomography scans, magnetic resonance imaging scans, and surgical data. In all patients, level of involvement, the number of vertebrae involved, and the magnitude of deformity were noted. In healed cases, additional data including flexibility of the deformity (using dynamic radiographs), and coronal and sagittal balance (using full-length standing radiographs) were also assessed. Pre-, postoperative, and follow-up kyphotic angles were calculated in lateral X-rays by the method described by Konstam and Blesovsky. Clinical outcomes were assessed using Frankel grading and Visual Analog Scale (VAS) at final follow-up.

Results: A total of 52 patients with a minimum 2-year follow-up were included (group A: 25 patients, group B: 27 patients). The mean preoperative kyphosis was 39.5° (31.2°–53.7°) for group A and 85° (44.2°–125.2°) for group B. According to the kyphosis classification, group A had 19 patients with type IIIA and six patients with type IIA. Group B had 18 patients with type IIIB, five with type IIIC, three with type IIA, and one with type IIIA. All surgeries were performed via the posterior approach. In group A, all patients underwent instrumented decompression with posterior column shortening (Smith-Peterson osteotomy), and 14 patients also had additional anterior column reconstruction. In group B, one patient had a pedicle subtraction osteotomy, two had a disc-bone osteotomy, 18 had a closing-opening wedge osteotomy, and six had a halo followed by vertebral column resection. The mean kyphosis at the 2-year follow-up was 20.8° (11.2°–32.8°) in group A and 53.5° (8.1°–96.4°) in group B. The VAS score improved in both groups at the final follow-up.

Conclusions: Correction of kyphosis in spinal tuberculosis involves completely different strategies in active and healed disease. Based on our experience, we have proposed an algorithm for the surgical correction of kyphosis deformity in spine TB patients.

F225

Radiation-free three-dimensional spine curve synthesis based on biplanar optical unclothed back images for spine alignment analysis

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Background: Adolescent idiopathic scoliosis (AIS) is a complex three-dimensional spinal abnormality, impacting the well-being of young individuals. Early detection is crucial for effective AIS management. Traditional monitoring techniques such as physical examinations and radiography are either subjective or expose patients to harmful radiation. In this study, we have developed an innovative and radiation-free pipeline that utilizes optical images of the patient's unclothed back to accurately assess scoliosis severity. Our approach has the potential in early scoliosis detection, promising a significant step forward in the safe and effective screening and monitoring of AIS.

Methods: Between October 9, 2019, and December 13, 2023, a total number of 3,983 AIS patients attending two local scoliosis clinics were recruited to form a comprehensive dataset. Patients were excluded if they had psychological and/or systematic neural disorders that could influence the study's compliance and/or the patient's mobility. For each patient, we collected the posterior-anterior (PA) and lateral (LAT) optical images of the patient's unclothed back captured via an optical camera and the PA and LAT biplanar radiographs. Biplanar radiographs served as the reference for accurately determining the spine curve for each patient. A deep generative network method was developed and optimized to synthesize the spine curve only based on PA and LAT optical images of the patient's unclothed back. The resulting PA and LAT spine curves could be used to calculate three-dimensional spine curves and analyze spine alignment. Dice similarity was used to evaluate the spine curve synthesis performance. Confusion matrix analysis was adopted to assess the model performance on AIS severity grading.

Results: Among the 3,203 patients (67% female; mean±standard deviation age, 15.96±1.63), data from 2,320 patients were used for model development and training, 581 for model evaluation, and 302 for prospective testing. Regarding spine curve synthesis, the models showed a Dice similarity coefficient of 0.71 in the generation of spine curves, indicating higher precision. For severity grading, the prediction achieved a sensitivity and a negative prediction value (NPV) of over 0.857 and 0.86 among all three severity levels (normal-mild: sensitivity=0.915, NPV=0.86; moderate: sensitivity=0.857, NPV=0.942; severe: sensitivity=0.857, NPV=0.986).

Conclusions: This study introduces an innovative non-radiative method for evaluating spinal alignment in a three-dimensional space. The proposed approach investigates the technical feasibility and stability of assessing spinal alignment utilizing optical sensing and deep learning techniques. This has the potential to facilitate early detection and diagnosis of AIS, consequently leading to more timely and effective treatment strategies. Moreover, the non-invasive nature of the system minimizes risks related to recurrent radiation exposure, thereby augmenting patient safety. The results of this study indicate that our method serves as a potential and viable alternative for routine AIS screening and follow-up, that avoids the risks associated with ionizing radiation.

F226

A retrospective comparative study of single bolus versus bolus followed by continuous infusion with similar total tranexamic acid dosage on surgical blood loss in scoliosis surgery

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Background: Tranexamic acid (TXA) is commonly used in adolescent idiopathic scoliosis (AIS) corrective surgeries to reduce intraoperative blood loss. Various range of dosages have been used as there is no universal protocol for TXA dosage in AIS surgery. The aim of this study is to compare total surgical blood loss between

two methods of TXA administration with similar total dosage in AIS patients undergoing posterior spinal fusion (PSF) surgery: single intravenous bolus versus bolus followed by continuous infusion.

Methods: This retrospective observational study involved analysis of AIS patient data who underwent single-stage PSF surgery in a tertiary university hospital from March 2020 to March 2022. Patients were categorized based on dosage of TXA given intraoperatively into either group A (single bolus of 30 mg/kg) or group B (bolus of 20 mg/kg followed by continuous infusion of 5 mg/kg/hr). Data on patient demographics, operative data, estimated blood loss, blood transfusion rate, and complications were retrieved. Hemoglobin and hematocrit levels were obtained at three perioperative time frames: T1 (preoperative), T2 (0-hour postoperative), and T3 (48 hours postoperative). Predictors of total surgical blood loss were also determined.

Results: A total of 172 patients, 86 in each group were included and analyzed. Demographic data and total TXA doses were similar between the two groups. The median duration of surgery was 115 minutes (range, 100–135 minutes). The mean estimated total surgical blood loss was not significantly different between both groups (group A: 748.29±290.71 mL; group B: 751.76±278.79 mL; p=0.936). The total surgical blood loss, postoperative drainage, and total blood loss per hour and per fused spinal level were similar between the groups. None of the patients in both groups received allogenic blood transfusion. No perioperative complications including seizure and thrombotic events were observed. Duration of surgery and Cobb angle were the independent predictors of blood loss. The decrease in hemoglobin levels between T1 and T3 for both groups were not significant.

Conclusions: Comparable total dosage of TXA given either as a single bolus or bolus followed by continuous infusion is associated with comparable estimated total surgical blood loss in AIS patients undergoing PSF surgery.

F227

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

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Background: Allogeneic blood transfusion (ABT) is the current standard of blood replenishment for metastatic spine tumor 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. The current literature lacks the long-term outcomes of SBT in MSTS patients. We aimed to conduct a prospective clinical study to ascertain the long-term clinical outcomes of intraoperative cell salvage in MSTS by running a prospective non-randomized cohort study over a period of time to get 4-years outcome.

Methods: Our prospective study included 98 patients who underwent MSTS from 2014–2017. Patients were divided into three groups based on their blood transfusion (BT) type: no blood transfusion (NBT), ABT, and SBT. Primary outcomes assessed were overall survival (OS) and tumor progression (TP), that was evaluated using RECIST (ver. 1.1; https://recist.eortc.org/recist-1-1-2/) employing follow-up radiological investigations at 6, 12, 24, 36, and 48 months. The primary tumors of metastatic spinal disease were also subgrouped based on vascularity and analyzed.

Results: Our study had a total of 98 patients (53 male and 45 female patients) with a mean age of 60 years old at the time of surgery. All three BT groups were comparable for demographics and tumor characteristics (p=0.215). Overall median blood loss was 400 mL (interquartile range [IQR], 200–900 mL) and overall median BT was 620 mL (IQR, 110–1,600 mL) for patients receiving BT. Of the patients, 33 (33.7%) received SBT, 39 (39.8%) received ABT, and 26 (26.5%) received NBT. Comparison of total blood loss among the three groups

revealed no significant difference between SBT and ABT (p=0.052). There was also no significant difference between the OS of patients who underwent ABT or SBT, as compared to NBT (p=0.136). However, OS was better in SBT than in ABT group, represented by our adjusted survival curve. Subgroup analysis with the vascularity of the primary tumors also showed a significant association with risk of death on the adjusted survival curve. On multivariate analysis, SBT did not show any increase in 4-year tumor progression (adjusted hazard ratio [HR], 0.57; 95% confidence interval [CI], 0.14–2.22; p=0.423). Total blood loss was also not associated with tumor progression (adjusted HR, 0.51; 95% CI, 0.15–1.65; p=0.26).

Conclusions: MSTS patients whom had SBT were associated with a decreased risk of death compared to ABT and NBT. Improved OS for SBT compared to ABT can be attributed to ABT-related immunosuppression which increases the likelihood of postoperative complications. Dividing the primary tumor into subgroups based on their vascularity also showed tumor vascularity to be a significant factor in OS, with highly vascular tumors showing significant increase in risk of death. However, our study did not find any factor that had significant association with TP. This may due to TP being determined by inherent primary tumor characteristics, instead of factors discussed in our paper. This will be the first long-term prospective study to report on the clinical outcomes of SBT in comparison with control groups in MSTS and affirms the clinical role of SBT in MSTS.

F228

Implant and construct decision making in metastatic spine tumor surgery

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Background: Metastatic Spine Tumour Surgery (MSTS) is an important treatment modality of metastatic spinal disease (MSD). Increase in MSTS has been due to improvements in our oncological treatment, as patients have increased longevity and even those with poorer comorbidities or more extensive disease are now being considered for surgery. However, there is currently no consensus on how MSTS surgeons should select the appropriate levels to instrument and which type of implants should be utilized. In our review, we aim to review the literature and highlight personal experiences from our own unit and senior authors regarding the various crucial factors that should be considered in decision-making for the implant and construct in MSTS.

Methods: The current literature on MSTS was reviewed to study implant and construct decision making factors by using PubMed, Medical Literature Analysis and Retrieval System Online (MEDLINE), the Cochrane Library, and Scopus databases through 27 March 2023. All studies that were related to instrumentation in MSTS were included to create the guideline and algorithm. The concept of our instrumentation decision-making algorithm was done as an expert opinion by the two senior spine surgeons in this manuscript, with experiences from treating and observing patients with MSTS.

Results: A total of 58 studies were included in this review. We discussed a new decision-making model that should be taken into account when planning for surgery in patients undergoing MSTS. These factors include the quality of bone for instrumentation, the extent of the construct required for MSTS patients, the use of cement augmentation, and the choice of implant. Various studies have advocated for the use of these modalities and demonstrated better outcomes in MSTS patients when used appropriately.

Conclusions: Our proposed stepwise decision-making algorithm involves first considering MSD patients' fitness for surgery, to determine if MSTS should be undertaken. This can be done through generic tumor surviving scoring systems to assess for the extent of disease in MSTS patients, and the frailty of these patients should be assessed through internationally validated performance scores such as the Eastern Cooperative Oncology Group and Karnofsky. If MSTS patients are fit for surgery, the various factors affecting instrumentation choice should be deliberated on preoperatively prior to surgery itself to ensure optimal outcomes for MSD patients. However, if they are not fit for surgery, either radiotherapy or palliative care should be discussed with them. For patients with an intermediate Spinal Instability Neoplastic Score (SINS), the decision for surgery should be individualized, taking into account their primary tumor subtype and pre-existing comorbidities. There is a higher frequency of surgery in patients with a SINS greater than 10. In this review, our team will be the first to establish new decision-making

algorithms for patients undergoing MSTS. These algorithms serve as an important guide for surgeons treating MSD with MSTS, allowing for the standardization of care amid the continuous evolution of our treatment capacity in MSD.

F229

Does three-dimensional printing affect material properties of polyether ether ketone composites? a detailed compositional and optimized mechanical analysis of pre- and post-manufacturing

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Background: Polyether ether ketone (PEEK) is an emerging alternative implant material (Young's Modulus 3.6 GPa, compared to cortical bone's 17–21 GPa) that is highly researched for manufacturing orthopedic implants. While PEEK is highly compatible, it lacks the potential for osteointegration and has mechanical properties that are only compatible for screw and rod fabrication. Three-dimensional (3D) printing technology is being introduced to enhance the properties of PEEK to increase and improve its clinical applications. There is some evidence that PEEK with hydroxyapatite (HA) and Mg_2SiO_4 composition would increase bioactivity, promote bone tissue integration, and optimize mechanical properties for clinical use. Our aim is to investigate whether PEEK with HA and Mg_2SiO_4 compositions are 3D-printable and to explore the manufacturing challenges using 3D printing technology. We also investigated the material properties of this composite before and after 3D printing, with rigorous evaluation of its mechanical properties.

Methods: A comprehensive materials investigation included the analysis of surface attributes, thermal properties, structural characteristics, and chemical compositions. Surface attributes were scrutinized using scanning electron microscopy (SEM) and energy-dispersive X-ray spectrometry, offering detailed insights into the material's surface structure and elemental composition. Thermogravimetric analysis was employed for thermal property analysis, providing a thorough understanding of melting and glass transition temperature changes. X-ray diffraction elucidated structural characteristics, identifying crystalline phases. Fourier transform infrared spectroscopy was used for chemical composition analysis, revealing functional groups and molecular bonds. Mechanical properties were assessed through meticulous tensile and flexural tests adhering to American Society for Testing and Materials standards, ensuring reliable results. Suitable equipment was selected for enhanced precision to provide a holistic understanding of the material's behavior under tension and bending forces.

Results: We studied a composite comprising 75% PEEK, 20% HA, and 5% Mg_2SiO_4, which was utilized for 3D printing through twin-screw extrusion and fused deposition modeling. SEM surface analysis of pre-printing revealed irregular structures, attributing irregular spherical particles to HA and Mg, suggesting uneven dispersion during extrusion. Post-printing, an improvement in uniformity was observed, crucial for effective osseointegration in cell adhesion. Thermal analysis showcased PEEK's stability up to 530°C, with subsequent weight loss due to oxidation until 637°C. The presence of HA and Mg_2SiO_4 did not affect crystallization, likely due to their high melting points. X-ray diffractograms confirmed characteristic peaks without impurity. However, differences in peak intensities and widths were noted between pre- and post-printed materials.

Conclusions: The mechanical properties, particularly tensile strength, decreased in the 3D-printed composite PEEK, which could be attributed to differences in bonding between layers and voids. Yet, flexural strength in 3D-printed PEEK exceeded composite PEEK filament due to the covalent bonding inherent in the composite. This study highlights the intricacies of material dispersion, thermal stability, and mechanical alterations in 3D-printed composite PEEK. The analysis of pre- and post-3D printed composite PEEK marks the first comprehensive materials assessment of such composite filament and 3D-printed PEEK materials, showcasing improvement in compositional distribution of the material components. This analysis will exploit possibilities of improvement in mechanical properties, hence affecting future spine implant production.

F230

Novel material processing printing method for novel polyether ether ketone-hydroxyapatite-Mg_2SiO_4 composite material for spine implants

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Background: The current "gold standard" (titanium) for manufacturing spine implants has a high Young's modulus, which causes stress shielding and generates imaging artifacts. Standard polyether ether ketone (PEEK) material is bioinert with low tensile strength and Young's modulus. These materials do not address all the mechanical properties posed by osteoporotic and metastatic spines. We aim to develop a novel material processing method for PEEK-hydroxyapatite (HA)-magnesium orthosilicate (Mg_2SiO_4) composite material with enhanced properties for potential use in tumors, osteoporosis, and other spinal conditions. We also aim to evaluate the biocompatibility and imaging compatibility of the material.

Methods: Materials were prepared in three different compositions, namely, composite A (75-weight % PEEK, 20-weight % HA, 5-weight % Mg_2SiO_4), composite B (70-weight % PEEK, 25-weight % HA, 5-weight % Mg_2SiO_4), and composite C (65-weight % PEEK, 30-weight % HA, 5-weight % Mg_2SiO_4). The materials were processed to obtain three-dimensional (3D) printable filament. Biomechanical properties were analyzed as per American Society for Testing and Materials standards, and the biocompatibility of the novel material was evaluated using indirect and direct cell cytotoxicity tests. A three-point bending test was conducted to evaluate the flexural properties of the biocomposites. Cell viability of the novel material was compared to PEEK and PEEK-HA materials. The novel material was used to 3D print a standard spine cage by ARBURG plastic free-forming. Furthermore, the computed tomography (CT) and magnetic resonance (MR) imaging compatibility of the novel material cage vs. PEEK and PEEK-HA cages were evaluated using a phantom setup.

Results: Composite A resulted in optimal material processing to obtain a 3D printable filament, while composites B & C resulted in non-optimal processing. Our biocomposites exhibited linear elastic characteristics under bending load. The composite material showed a flexural strength of 2.89±0.2 GPa, which is significantly higher than the flexural strength of individual components. Linear flexural strain was observed with increasing flexural stress, but it did not affect the elastic characteristics of the PEEK biocomposite. Composite A enhanced cell viability up to approximately 20% compared to PEEK and PEEK-HA materials. The enhancement in cell viability displayed could possibly be due to the favorable mechanism of magnesium and silicate ion release that enhances cell growth. Our material induces bioactivity, thus avoiding the risk of delamination. Our material is hypothesized to have a Young's modulus closer to that of cortical bone, resulting in optimal load sharing between bone and implant. The composite A cage generated minimal/no artifacts on CT & MR imaging, and the images were comparable to those of PEEK and PEEK-HA cages. This facilitates improved radiotherapy planning and delivery.

Conclusions: Composite A demonstrated superior bioactivity compared to PEEK and PEEK-HA materials and comparable imaging compatibility compared to PEEK and PEEK-HA. Our biocomposite has a Young's modulus comparable to that of cortical bone, facilitating a reduction in stress shielding. Therefore, our material displays excellent potential to manufacture spine implants with enhanced mechanical and bioactive properties. This novel method and material are predicted to improve production, osseointegration, and reduce the chances of construct loosening or implant failure in spinal conditions, especially MSTS and osteoporotic fixations.

F238

Expandable cages for transforaminal lumbar interbody fusion: 1-year radiological outcomes of lumbar lordosis, vertebral foramen height, anterior and posterior disc height

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Background: Expandable interbody cages are being increasingly used as they expand inside the disc space and increase the surface area for fusion using a mini-

mally invasive corridor. The need for distraction and compression is also less as we can achieve good intervertebral height without compromising the vertebral endplate integrity. There are very few studies observing the radiological parameters after using expandable interbody cages—particularly in minimally invasive spine surgery (MISS) transforaminal lumbar interbody fusion (TLIF). This study is designed to observe radiographic outcomes—lumbar lordosis (LL), vertebral foramen height (VFH), anterior disc height (ADH), posterior disc height (PDH), and Oswestry Disability Index (ODI) Scores after performing TLIF in single and double level cases of lumbar canal stenosis and intervertebral disc prolapse.

Methods: A prospective interventional study was conducted from March 2020 to March 2022, including 30 patients with a mean age of 55 years and a minimum follow-up of 1 year. Patients with up to two levels of lumbar canal stenosis or intervertebral disc prolapse and a minimum follow-up of 1 year were included. Patients with infectious pathologies and those lost to follow-up were excluded. All patients included were operated on at the same center by a single surgeon. All patients underwent either open or MISS TLIF procedures using expandable cages. Preoperative and 1-year postoperative computed tomography scans and ODI scores were calculated for each patient. Preoperative and 1-year postoperative LL, VFH, ADH, and PDH were calculated, respectively. Clinical analysis was conducted using ODI scores preoperatively and at 1 year postoperatively, recorded in electronic health record software. Statistical analysis was performed using SPSS software.

Results: Average surgical time was 128 minutes, and blood loss was 340 mL. There was one case of cage backout and one case of surgical site infection. The average preoperative and 1-year postoperative LL were 38° and 40°, respectively. The average preoperative and 1-year postoperative ADH were 13.2 mm and 15.4 mm, respectively. The average preoperative and 1-year postoperative PDH were 7.3 mm and 9.8 mm, respectively. The average preoperative and 1-year postoperative VFH were 16.8 mm and 18.3 mm, respectively. The average preoperative and 1-year postoperative ODI scores were 35 and 82, respectively. All results were statistically significant at $p<0.05$.

Conclusions: TLIF using expandable interbody cages is a reliable and simple technique that avoids extensive dissection of the posterior longitudinal ligament and annulus, with the advantages of increased surface area for fusion. Extensive distraction and compression maneuvers are also not necessary, which might reduce blood loss and surgical time, particularly in MISS TLIF. With the added advantages of a statistically significant increase in PDH, ADH, TFH, and ODI scores and a mild but statistically significant increase in LL, this appears to be a promising technical advancement in spine surgery for the future.

F243

Back pain questionnaire in adolescent idiopathic scoliosis: an insight into pain characteristics and its relationship with health-related quality of life

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Background: Experiencing back pain by patients with adolescent idiopathic scoliosis (AIS) is not uncommon. In order to establish an effective pain management protocol, detailed information regarding back pain is required. There is a lack of questionnaires specifically inquiring about different aspects of pain, especially in static motion-induced or dynamic movement-induced back pain related to posture and muscles. Whether dynamic or static motion-related back pain relates to health-related quality of life (HRQoL) remains unknown. The objectives of this study are: to evaluate the prevalence of recent back pain, static motion-related or dynamic motion-related back pain using a customized questionnaire, and to investigate the relationships between these back pains and HRQoL.

Methods: Patients diagnosed with AIS, aged between 10 and 18 years, were consecutively recruited at the scoliosis specialist clinic from July to December 2023. Patients were asked to fill out the refined Scoliosis Research Society-22 (SRS-22r) questionnaire, EuroQoL Five-Dimension Youth Five-Level (EQ-5D-Y-5L), and the customized self-reported Back Pain Questionnaire. The Back Pain Questionnaire was constructed by a panel of orthopedic healthcare professionals, inquiring about the following aspects of pain: location, severity (Visual Analog Scale [VAS]: 0 [no pain] to 10 [worst]), dynamic-static motions with back pain, activity levels, and relieving factors. Data collection included patient demographics, Cobb angles, and curve types from

spine radiographs. The relationships between HRQoL measures and the presence of back pain were tested, while HRQoL scores were compared in patients with and without back pain.

Results: A total of 188 patients (73.9% girls) were studied. There were 53.7% (n=101) with lumbar curves with a major Cobb angle of 29.1°±9.9°, and 46.3% with thoracic curves at 29.8°±10.2°. Most patients (70.2%) were under observation. Back pain occurred in 44.1% (n=83) of patients in the previous 6 months, with a VAS of 3.0±1.8 (16.7% had VAS ≥5). Recent 1-month back pain occurred in 38.3% (n=72) of the patients with a VAS of 2.9±1.6 (15.9% had VAS ≥5). Patients experienced back pain more in the lumbar spine (25.5% vs. thoracic: 13.3%) and lower back. Among those with recent 1-month pain, patients experienced back pain more with static motion (during: 56.9%, after: 30.5%) than dynamic motion (during: 15.3%, after: 25.0%). For relieving back pain, 23.6% of patients always/frequently changed postures, while 18.1% performed stretching exercises. The presence of recent 1-month pain negatively correlated with SRS-22r pain domain (rpb=-0.615) and total (rpb=-0.489) scores, EQ utility score (rpb=-0.531), and EQ-VAS (rpb=-0.312), all at $p<0.001$. Patients with recent back pain had a lower SRS total score versus those without (4.06±0.40 vs. 4.47±0.32, $p<0.001$). The presence of back pain during or after static or dynamic motion all correlated with SRS-22r total score, EQ scores, and EQ-VAS ($p<0.05$), with the strongest relationship demonstrated by pain after static motion and SRS total score (rpb=-0.438, $p<0.001$). Patients with these motion-related pains had significantly lower SRS total scores and EQ scores.

Conclusions: Patients with recent back pain, and pain during or after static/dynamic motions had worse HRQoL. Our findings provide a better understanding of back pain characteristics in AIS, and these can form the foundation for developing effective pain management strategies tailored to the specific needs of these patients.

F249

The use of novel H-bar in intraoperative assessment of alignment for patients with adolescent idiopathic scoliosis receiving posterior fusion surgery

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Background: Achieving satisfactory coronal and shoulder balance is essential in scoliosis surgery. Important parameters to measure with reference to the central sacral vertical line (CSVL) include upper instrumented vertebra tilt, horizontal offset at T1, T1 tilt, and radiographic shoulder height difference (RSHD). Cross bar techniques have been described in the literature. However, it lacks a horizontal reference to accurately assess the T1 endplate, and it is impossible to assess the lateral shoulder balance. A novel device was developed that incorporated another mobile transverse bar cranially, with a longitudinal component telescoping into the original longitudinal limb of the cross bar. The accuracy of the device was evaluated.

Methods: Adolescent idiopathic scoliosis patients receiving posterior spinal fusion surgery were recruited. Exclusion criteria included non-idiopathic scoliosis, revision surgery, and those with pre-existing shoulder girdle deformity. Demographic information including age, sex, height, body weight, and skeletal maturity using the Thumb Ossification Composite Index were recorded. The curves were classified according to the Lenke Classification, and the Cobb angle before and immediately after the operation were measured. During the operation, a sterile H-bar was placed onto the patient to assess the intraoperative alignment after fixation of two rods. The lower longitudinal component of the "H" should be leveled with both iliac crests unless one is higher than the other in standing films. The transverse component represents the CSVL. The upper longitudinal component of the "H" is adjusted to the upper instrumented vertebra and then to T1 to measure the degree of tilting and the amount of truncal shift.

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Any difference in radiographic shoulder height was also measured. Postoperative standing EOS alignment films were taken, and the same parameters measured during the operation were assessed. Student *t*-test was used to compare two groups of data, and a *p*-value <0.05 was considered statistically significant.

Results: From May 2023 to December 2023, the H-bar was used in 20 patients. Sixteen of them were male, and four were female. Significant corrections of scoliosis (p=0.000) were observed for all three curves, with the percentages of corrections being 63%, 69%, and 64% for the proximal thoracic, main thoracic, and thoracolumbar/lumbar curve, respectively. Satisfactory truncal balance (CSVL less than 20 mm from T1) was observed in 90% (n=18) of the patients, and good lateral shoulder balance (RSHD <2 cm) was seen in 95% (n=19) of the patients. No statistically significant differences were observed for all intraoperative measurement parameters using the H-bar when compared with postoperative X-rays.

Conclusions: The novel H-bar is a useful and accurate tool to assess intraoperatively the important alignment parameters for patients undergoing posterior fusion surgery for adolescent idiopathic scoliosis.

F252

Resection of hemivertebra in congenital scoliosis using ultrasonic bone cutter under computerized navigation

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Background: Hemivertebra excision is the treatment of choice for congenital scoliosis with progressive or significant deformity. The traditional single posterior approach is a high-risk procedure, largely related to significant bleeding or pseudoarthrosis at the osteotomy site and neurovascular injury. With recent advancements in adopting a computer-assisted approach using navigation and the invention of a new instrument—a bone cutter based on ultrasonic oscillation—in spinal deformity surgery, our team has combined the two technologies into the "navigated ultrasonic bone cutter" for hemivertebra excision, which has not been described in the literature. It is advantageous to provide safe and precise bone removal with reduced risks of bleeding and injury to surrounding tissues, including the dura and neurovascular structures.

Methods: From January 2022 to October 2023, we reported a case series of three patients with hemivertebra presenting with significant or progressive deformities. The surgical workflow was described as follows: (1) Preoperative computed tomography was performed, and the three-dimensional images were transferred to the Stryker Navi III machine for osteotomy planning. (2) A single posterior approach was adopted. (3) Pedicle screws were inserted under navigation. (4) After laminectomy, osteotomy of the hemivertebra was performed under navigation using the ultrasonic bone cutter (Sonopet, Stryker). (5) Gradual controlled instrumental closure of the osteotomy was performed under intraoperative neuromonitoring. Postoperatively, free mobilization was allowed, and EOS standing posterior-anterior and lateral radiographs were arranged to measure the amount of correction in both the coronal and sagittal planes.

Results: This technique was performed in three patients with a mean age of 14.3 years old. Satisfactory coronal correction for both the main curves (mean correction rate=51.7%) and the compensatory curves (mean correction rate=54.7%) was achieved. Segmental kyphosis was also improved in all curves with a 75% average correction rate. Good shoulder and truncal balance were found in all patients during the last follow-up. There were no dural tears, neurological injuries, or wound complications found in our series.

Conclusions: We reported a novel technique to combine both computerized navigation and an ultrasonic bone cutting instrument for safe and precise excision of hemivertebrae in congenital scoliosis patients, with satisfactory deformity correction and balance achieved.

F273

Prospective validation of multimodal digital exercise therapy for low back pain management

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Background: Low back pain (LBP) refers to acute or chronic pain in the lumbar region. The lifetime prevalence of LBP can reach up to 85% in the population. In the Global Burden of Disease Study published in The Lancet, LBP is consistently ranked as one of the leading causes of disability-adjusted life years, especially in countries and regions with higher levels of healthcare. This study aims to evaluate the effectiveness of a 10-week multimodal digital exercise therapy in office workers with LBP.

Methods: A 10-week longitudinal observational study was conducted among office workers with LBP using multimodal digital exercise therapy accessible through a mobile application. The digital platform was available on both iOS and Android. The primary outcome measure was pain assessed using the Visual Analog Scale (VAS). Secondary outcome measures included the Oswestry Disability Index (ODI), Hospital Anxiety and Depression Scale (HADS), and willingness to undergo surgery in the next year (0–100%).

Results: A total of 432 office workers participated in this study. The three most common job positions were management (managers, directors, and so forth; n=97), professional (analysts, consultants, accountants, and so forth; n=69), and clerical (clerks, administrative staff, secretaries, and so forth; n=42). Due to privacy regulations, the age and gender of the participants were not disclosed. Among them, 57 had acute LBP (duration <3 months, 13.2%) and 166 had chronic LBP (duration >3 months, 38.4%). A total of 93 employees completed at least 5 weeks of digital exercise therapy for LBP (13 with acute LBP, 39 with chronic LBP, and 41 without LBP undergoing preventive digital exercise therapy). Among the 52 participants with acute or chronic LBP, 38 participants (73.0%) showed a decrease in VAS scores between baseline and the last session of digital exercise therapy, with an average improvement of 48.9% (3.94±1.99 to 2.01±2.32, $p<0.001$). Among the secondary outcome measures, 40 participants with acute or chronic LBP (76.9%) showed a decrease in ODI scores, with an average improvement of 45.8% (5.55±3.94 to 3.00±2.94). In terms of HADS scores, 33 participants (64.3%) showed a decrease in anxiety scores, with an average improvement of 13.9% (5.81±4.00 to 5.00±4.72, $p=0.15$), and 26 participants (50%) showed a decrease in depression scores, with an average improvement of 17.8% (4.55±4.16 to 3.74±4.05, $p=0.28$). The average willingness to undergo surgery in the next year decreased by 53.3% among the participants.

Conclusions: This study demonstrates that a 10-week multimodal digital exercise therapy has a significant positive effect on office workers with LBP. The multimodal digital exercise therapy, accessible through a mobile application, including back photo artificial intelligence assessment, LBP education articles, musculoskeletal exercise therapy, and behavioral health support, can significantly reduce pain scores, improve functional disability, decrease anxiety and depression scores, and reduce the inclination for surgery. The results of this longitudinal observational study confirm the effectiveness and scalability of multimodal digital exercise therapy for treating acute and chronic LBP in a diverse real-world population. This study provides strong support for non-surgical treatment options for musculoskeletal pain patients through digital exercise therapy.

Abstracts for Medal Papers E-Poster Papers

E003

Complete intradural interbody cage migration in lumbar spine surgery: a case report and literature review

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Background: Spinal fusion is a common surgery in which vertebrae are fused to restore spinal stability and eliminate pain during movement. The use of an interbody cage facilitates spinal fusion. However, complete cage migration into the dura mater is rare and can be challenging to manage.

Case Report: A 44-year-old man presented to our spine center with a history of incomplete paraplegia and cauda equina syndrome that had lasted for 2 years and 4 months. This condition developed after he underwent six lumbar spine surgeries to address lower back pain and right-sided sciatica. A structural allograft kidney-shaped cage was found completely within the dura at the level of the L3 vertebra. Durotomy, cage retrieval, and pedicle screw fixation from the L2 to L4 vertebrae were performed. Numbness in both lower limbs markedly decreased within several days of the operation. Four months after the surgery, following progressive physical therapy, the patient could partially control both urination and defecation. Five months postoperatively, he could stand with slight assistance.
Conclusions: Complete intradural cage migration is a rare and serious complication. To the best of our knowledge, this is the first reported case of such a condition in the literature. Even if treatment is delayed, surgical intervention may salvage remaining neurologic function and may even lead to partial recovery.

E007

Anterior lumbar interbody fusion as a surgical strategy for lumbar pseudoarthrosis: a systematic review

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Background: Pseudarthrosis is one of the most common complications of lumbar spine surgery. On average, at least 15% of attempted spinal fusions result in pseudarthrosis. It is a known cause of recurrent pain and disability after spinal fusion surgery and is one of the most common indications for revision lumbar surgery. Despite its relatively high prevalence, there is a lack of robust clinical evidence on salvage options for lumbar pseudarthrosis. Anterior lumbar interbody fusion (ALIF) is an attractive option for revision surgery of pseudarthrosis.
Methods: This systematic review aims to determine the current evidence on ALIF as a salvage surgical technique for lumbar pseudarthrosis. PubMed/Medline, Google Scholar, and EMBASE were utilized for the literature search.
Results: In total, 318 studies were identified through database searching and other sources. After applying the inclusion and exclusion criteria, only four studies were analyzed. Patient enrollment spanned from 1984 to 2016, amassing a total of 151 patients with lumbar pseudarthrosis, with a mean age of 54.84 years (range, 30–81 years). The advantages of salvage ALIF include improvements in clinical and radiologic outcomes and a low complication rate after surgery: fusion rates (100%, 95%, 96.6%, 72%); segmental lordosis (6.23° vs. 8.85°) and disc height (12.25 mm vs. 16.94 mm) improvement at final follow-up; overall mean improvements in the Visual Analog Scale (8 to 2.2; 7.25 to 3.1), Oswestry Disability Index (54.5 to 21.2; 56.3 to 30.4), and 12-item Short Form Health Survey (SF-12) scales (SF-12 physical component summary: 32.2 to 41.1; SF-12 mental component summary: 36.6 to 50.9). Reported complications include five vascular, 10 wounds, eight ileus, one hernia, one hematoma, one screw cut-out, one lateral femoral cutaneous neuropraxia, one hematuria, eight pneumonia, nine urinary tract infections, and three cardiac.
Conclusions: In conclusion, this systematic review presented the evidence that ALIF is a useful for salvage surgery to treat lumbar pseudoarthrosis.

E011

Genetics of intervertebral disc degeneration: insights from bibliometric and single-cell transcriptomic analysis

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Background: Intervertebral disc degeneration (IVDD) is a major cause of chronic low back pain, and genetic factors are implicated. Although genetic studies of IVDD exist, scientific econometric analyses are unavailable. We screened the literature for studies on IVDD genetics using Web of Science. We downloaded IVDD single-cell transcriptome sequencing data from a public database. Our aim was to create a knowledge map of countries, institutions, journals, and authors related to research on IVDD genetics.

Methods: We conducted bibliometric analyses on 2,304 papers and visualized the processed data. The IVDD single-cell transcriptome sequencing data included Pfirrmann level 1 (six samples), Pfirrmann level 2 (seven samples), Pfirrmann level 3 (10 samples), Pfirrmann level 4 (six samples), and Pfirrmann level 5 (six samples). In total, 211,747 high-quality cell lines were obtained. We annotated nine cell types, including cartilage progenitor cells, nucleus pulposus progenitor cells, and chondrocytes. We summarized 54 IVDD susceptibility genes and performed enrichment analyses on the IVDD susceptibility gene data. Furthermore, we constructed a protein–protein interaction network of IVDD susceptibility genes and analyzed potential hub genes.
Results: Publication numbers on IVDD have increased annually. Keyword analysis showed that "autophagy," "apoptosis," and "oxidative stress" may be future research hotspots in this field. We found that intervertebral disc (IVD)-structure-related genes differed significantly in expression among the different cell types. Genes related to the IVD structure in cartilage progenitor cells and chondrocytes tended to decrease with disease severity, whereas in nucleus pulposus progenitor cells, such genes tended to increase with disease severity. The hub genes identified included interleukin (IL)-6, IL-1B, matrix metalloproteinase-9, prostaglandin-endoperoxide synthase 2, IL-10, and IL-1A, suggesting that inflammatory factors and immune responses play essential roles in IVDD pathogenesis. Therefore, these genes may be potential therapeutic targets for IVDD.
Conclusions: By revealing therapeutic targets, research hotspots, and trends in IVDD genetics, we provide a reference for future research.

E021

Prevesicular herpes zoster lumbar radiculopathy with transient motor paresis: a case report

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Background: Herpes zoster frequently causes a dermatomal vesicular rash accompanied by severe neuralgia, and reaching a differential diagnosis may be challenging before the appearance of the vesicular rash.
Methods: A 40-year-old male patient visited the emergency department with a complaint of sudden onset motor weakness and ipsilateral radiating neuralgia to the left thigh. He had suffered from chickenpox during childhood. No skin lesion was present at the initial visit. The reverse Straight Leg Raise test was negative. Magnetic resonance imaging showed an asymmetrically swollen dorsal root ganglion with Gadolinium enhancement. The vesicular rash that appeared on the sixth day after the symptom onset led to the diagnosis of herpes zoster.
Results: An antiviral agent, valacyclovir (1,000 mg 3 times a day), was administered for 7 days. The patient recovered from motor weakness by 2 weeks from the onset of the symptom. A mild degree of post-herpetic neuralgia resolved in 2 months.
Conclusions: A high index of suspicion is necessary to differentiate early herpes zoster radiculitis before the appearance of a vesicular rash from compressive radiculopathy. In L2–3 ipsilateral radiating pain along the dermatome or myotome, the absence of a reverse Straight Leg Raise sign may be a possible factor in differentiating herpes zoster radiculitis from compressive radiculopathy.

E022

Cost-effectiveness comparison of lumbar endoscopic discectomy and microscopic discectomy

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Background: Endoscopic discectomy is an increasingly common minimally invasive procedure used in treating lumbar disc herniation and decompressing spinal nerves. The advancement of techniques and equipment has led to improved intraoperative visualization and safety profiles, while maintaining smaller incisions, resulting in better surgical outcomes and shorter hospital stays. This study aims to investigate the cost-effectiveness of lumbar endoscopic discectomy.
Methods: A single-center, multi-surgeon retrospective case series of 24 patients who underwent elective single-level lumbar endoscopic discectomy was

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conducted. A level-matched comparative study was performed against 70 single-level microscope-assisted discectomies, comparing patient demographics (age, gender, body mass index, Charlson comorbidity index, Functional Independence Measure) and 6-month postoperative complications.

Results: No significant difference was found in the baseline demographics between both groups. Two endoscopic cases were complicated by excessive bleeding necessitating conversion to open surgery; no dural tears or wound complications were noted in the endoscopic group. While no significant difference was found in the length of stay and postoperative day 1 ambulation distance, the average operation duration was longer in the endoscopic group (129.4±70.5 minutes vs. 94.6±28.7 minutes, $p<0.001$).

Conclusions: Endoscopic lumbar discectomy offers several advantages as a minimally invasive decompression technique, such as a wider working view and additional posterior and contralateral decompression. However, it is not without its limitations and potential complications. Our study reports comparable patient outcomes and costs, making it a feasible alternative to conventional microscopic discectomy for early decompression without instrumentation. However, it is important to note the learning curve that surgeons need to overcome to become proficient and avoid complications.

E023

Is traumatic disc injury a local kyphosis risk?

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Background: Although there have been many reports on the treatment strategy and surgical indications for fractured vertebrae in spinal trauma, there has been no consensus on the treatment strategy for intervertebral disc injury. In this study, we evaluated the relationship between the progression of postoperative local kyphosis and disc injury in patients with thoracolumbar fractures treated only with posterior instrumentation.

Methods: The subjects were 28 patients (17 males; mean age, 63.5 years) who underwent surgery for thoracolumbar spine fractures from 2015 to 2022, excluding those with fragility fractures and diffuse idiopathic skeletal hyperostosis. The kyphosis progression was measured as the difference between the immediate postoperative period and the last observation (mean 19.3 months). This was assessed as the difference in kyphosis angle between the upper and lower vertebrae of the fractured vertebra including the intervertebral disc (SKA), the difference in anterior vertebral body crush ratio (AVBHR), and the difference in kyphosis angle of the fractured vertebra (VWA). The AO classification and load sharing classification (LSC) were used to evaluate fracture morphology, and the Sander classification was used to evaluate intervertebral disc damage. We compared patients with SKA less than 10° (group C, 6.1°; n=17) and those with SKA more than 10° (group K, 13.3°; n=11). Statistical analyses were conducted using the Mann-Whitney *U*-test and Fisher's exact probability test.

Results: The mean age was 61.5 years in group C and 60.5 years in group K. Body mass index (BMI) was 22.8 kg/m^2 in group C and 23.5 kg/m^2 in group K. AVBHR was 9.6% in group C and 15.8% in group K. VWA was 3.8° in group C and 5.1° in group K. AO classification was A3 or higher in 88.2% of group C and in all patients in group K. The LSC score was 5.6 in group C and 6.2 in group K. The Sander classification of grade 2 or higher for cephalad disc injuries was 47.1% in group C and 72.7% in group K, and 17.6% in group C and 81.8% in group K for caudal disc injuries. There were no significant differences in age, height of injury, duration of observation, BMI, AVBHR, VWA, AO classification, and LSC between the two groups, but disc injuries, especially caudal injuries, were significantly more severe in the K group than in the C group.

Conclusions: In the K group, although vertebral body crush itself progresses, kyphosis does not progress at the vertebral body level. This suggests that kyphosis progresses in the thoracolumbar spine as a whole due to intervertebral disc injury. It is thought that the treatment strategy for vertebral fractures should take into account not only the fractured vertebra but also the intervertebral disc injury.

E024

Recurrence in an aggressive chondroblastoma of the thoracic spine

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Background: Chondroblastoma is a benign cartilaginous neoplasm with a male preponderance, usually arising in the epiphyses of long bones with metaphyseal expansion and cortical thinning. It usually presents in young patients undergoing maturation, and it rarely localizes in the spine. The treatment mainly involves local curettage or resection with a moderate chance of recurrence.

Methods: A 30-year-old male with mid-back pain 9 years ago underwent a biopsy, which was suggestive of isolated parachordoma of D9. Symptoms worsened, and he was lost to follow-up. Repeat biopsy was suggestive of chondroblastoma, and he presented with acute onset paraplegia, which was managed with global decompression and fusion in two stages: anterior and posterior. Histopathology was suggestive of chondroblastoma of D8, D9, and D10 vertebrae as the lesion had progressed.

Results: He did well at the 18-month follow-up; however, he presented with acute onset paraparesis. Metal artifact reduction sequences (MARS) magnetic resonance imaging (MRI) was inconclusive; however, computed tomography (CT) myelogram suggested the recurrence of the lesion at D9/D10. The patient underwent surgery, and thereafter, neurological improvement was seen.

Conclusions: AE1/AE3 positive tumors with a non-metastatic picture should alert a surgeon regarding the possibility of a locally aggressive, yet slow-growing chondroblastoma. Regular follow-up is necessary to monitor disease progression, and the use of CT myelogram is vital in cases of long fusion where MARS MRI is inconclusive to localize the recurrence after clinical evidence of compressive myelopathy.

E028

Vertebroplasty in osteoporotic vertebral compression 82 analysis of 50 patients

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Background: Osteoporotic vertebral compression fractures (VCF) are a very common cause of significant back pain and limitations in activities of daily living. Vertebroplasty is a safe and effective method for the treatment of VCF. It is a minimally invasive procedure that can be performed under local anesthesia (LA) on a day care basis. It provides very good pain relief to patients, allowing them to return to their normal routine activities early.

Methods: We retrospectively analyzed 50 patients who had suffered from osteoporotic VCF and had failed to respond to conservative treatment. Only patients with osteoporotic VCF were included in the study, and those with pathological or traumatic fractures were excluded. All patients were treated with bilateral percutaneous vertebroplasty under C-arm guidance in LA with polymethyl methacrylate with barium sulphate. All patients were assessed pre- and postoperatively for clinical outcomes using the Visual Analog Scale (VAS) for pain. Perioperative metrics such as operation time, cement volume, C-arm duration, and the incidence of complications were also assessed.

Results: In our study, we had 30 (60%) women and 20 (40%) men, with a mean patient age of 67.58±7.66 years. Patients had an average duration of onset of symptoms of 7.98±3.53 weeks. The average follow-up duration was 29.56±8.89 weeks. The mean preoperative VAS for back pain was 79.68±5.86, which significantly improved from the preoperative period to the last follow-up (VAS 20.50±9.07). The average volume of cement injected was 5.32±1.26 mL in each patient, and the mean operative time was 26.82±4.90 minutes. The average use of C-arm in each patient was 33.18±5.36. We observed cement extravasation in two patients, and two patients had persistent back pain. One patient developed paresthesia along the intercostal nerve distribution.

Conclusions: Vertebroplasty is a very safe and cost-effective minimally invasive procedure for the treatment of painful osteoporotic VCF, with a high success rate and very low complication rate, resulting in good patient satisfaction.

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E031

Surgical treatment in recollapse of cement augmented vertebrae after percutaneous vertebroplasty and percutaneous kyphoplasty: report of three cases and literature review

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Background: Recollapse of cement-augmented vertebrae after percutaneous vertebroplasty (PVP) and percutaneous kyphoplasty (PKP) is not uncommon, given the aging population and the increasing number of PVP/PKP procedures. However, there is no standard surgical treatment strategy reported if conservative treatment fails.

Methods: We report three cases of recollapsed vertebrae after PVP/PKP. All three cases were female, aged 55, 69, and 82 years old, respectively. The recollapsed vertebrae were T12 in two cases and L1 in one case. Recollapse occurred at postoperative 1 month (one case) and 2 months (two cases). All cases presented with severe mechanical back pain and kyphosis in the thoracolumbar junction. One case (T12) had thoracic myelopathy due to spinal stenosis at the collapsed level. All cases underwent surgery in the form of posterior column osteotomy (PCO) for kyphosis correction, laminectomy for decompression, and cemented pedicle screw fixation for stabilization and posterolateral fusion. Additionally, systematic anti-osteoporosis treatment was administered after the operation.

Results: According to the literature, risk factors for vertebrae recollapse after PVP/PKP include cement distribution pattern, severe osteoporosis, and thoracolumbar junction fracture. There were no intraoperative adverse events in our three cases. Postoperatively, significant relief in mechanical back pain was observed in all cases, with satisfying kyphosis correction. No implant loosening, adjacent level collapse, or kyphosis recurrence was observed up to the 1-year follow-up.

Conclusions: Our cases demonstrate that surgical intervention in the forms of PCO and cemented pedicle screw fixation and fusion are effective in treating recollapse of cemented vertebrae. However, more cases with longer follow-up are still needed for future studies.

E042

Treatment options in giant sacral Schwannomas: a scoping review of literature

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Background: Giant Schwannomas of the sacrum are rare occurrences, with an incidence of 0.3%–3.2% of all Schwannomas and 0.4 to 15% of all retrorectal tumors. They are slow-growing tumors that are usually detected in an advanced stage of growth. Schwannomas are benign tumors with the potential to become locally aggressive. Complete excision is the treatment of choice. However, in the sacrum, the complex anatomy may make complete excision difficult, if not impossible, without compromising neurologic function or spinal stability. This has led to the exploration of other treatment options for giant sacral Schwannomas.

Purpose: This paper presents a case of a 44-year-old woman diagnosed and treated for a Giant sacral Schwannoma, Klimo type 2, treated with a posterior approach and subtotal resection. This will be followed by a scoping review of the current treatment approaches to giant sacral Schwannomas, with emphasis placed on tumor recurrence, morbidity, and residual function.

Methods: Literature searches using PubMed and Google Scholar databases were performed to identify literature on the treatment and outcomes of benign Giant Sacral Schwannomas by the three authors of this paper.

Results: Surgical resection is the treatment of choice, with the posterior approach being the most common (53/105 [50%]), followed by combined anterior and posterior (30/106 [28%]), and the anterior approach being the least common (23/106 [21%]). Total resection was performed in 45 patients (42%), either as *en bloc* or piecemeal, and subtotal excision in 61 patients (58%). Complications were highest in total *en bloc* excision using the combined approach (3/8 [37.5%]), followed by the posterior approach (2/15 [13%]), and the anterior approach (0/4 [0%]). The recurrence rate was highest for the anterior *en bloc* excision (2/8 [25%]), followed by the posterior (3/15 [20%]) and anterior approaches (0/4 [0%]). As for the partial excision group, the combined approach had the highest complications (4/10 [40%]), followed by the anterior approach (3/12 [25%]), with the posterior approach having the least

complications (5/29 [17.2%]). Other treatment options to accompany excision are radiation, cryotherapy, and preoperative embolization.
Conclusions: Treatment for giant sacral Schwannomas has evolved over the years with the availability of other options such as cryotherapy, radiotherapy, and embolization robotic and laparoscopic surgery. The posterior approach seems to yield the lowest complication rate. Caution should be exercised in interpreting the results due to the heterogeneity of the study population in this study.

E045

Learning curve for percutaneous endoscopic lumbar discectomy

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Background: To study the learning curve of performing percutaneous endoscopic lumbar discectomy of a spine surgeon who has never been exposed to endoscopic spine surgery.
Methods: A total of 78 cases were selected, with the inclusion criteria of percutaneous endoscopic single-segment lumbar discectomy performed under local anesthesia with a follow-up time of more than 1 year. The cases were chronologically and equally divided into two groups, A and B, with 39 cases in each group. The learning curve was comprehensively assessed by comparing and analyzing the length of the procedure, the clinical outcome of the procedure (low back pain Visual Analog Scale [VAS] score, lumbar spine function Oswestry Disability Index [ODI], and Japanese Orthopaedic Association [JOA] scores), and complications.
Results: The duration of percutaneous endoscopy in group A (mean time of 168.46 minutes) was higher than that in group B (mean time of 131.76 minutes) with statistical significance ($p<0.05$). Additionally, the learning curve graph of the procedure duration showed that it steadily shortened as the number of surgical cases increased, displaying a gently decreasing pattern. The postoperative VAS scores for low back pain, ODI, and JOA scores of lumbar spine function of both groups were significantly better than the preoperative ones. There was no significant difference between the two groups regarding the clinical efficacy after surgery, indicating the definitive surgical effectiveness of percutaneous endoscopic lumbar discectomy. In terms of complications, two cases occurred in group A. One case involved an intraoperative slip of the working trocar, resulting in an incorrect surgical segment detected postoperatively, leading to a second percutaneous endoscopic lumbar discectomy. In the other case, disc remnants remained after surgery, causing symptoms and necessitating a secondary open lumbar discectomy. One case in group B also had postoperative disc remnants causing symptoms and underwent a sequential open lumbar discectomy.
Conclusions: With adequate preparation and training, the learning curve of percutaneous endoscopic lumbar discectomy appears to be not steep and relatively manageable.

E046

The prevalence of spinal intradural lesions after microendoscopic lumbar decompression surgery

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Background: Spinal epidural hematoma during the early period following spinal surgery is a common cause of symptomatic neural compression. However, there are few reports regarding the prevalence of spinal intradural hematoma or cyst reported as the extremely rare delayed complication after spinal surgery. We aimed to clarify the prevalence and risk factors of spinal intradural lesions (SIDLs) following microendoscopic lumbar decompression surgery (MEL).
Methods: Totally 117 patients (74 men, 43 women; average age, 68.7±12.1 years) who underwent MEL were retrospectively evaluated in this study. Lumbar magnetic resonance imaging (MRI) was investigated within 1 week postoperatively in all patients, and patients were divided into three groups: the first group with epidural hematoma (E group); the second with intradural lesions (I group), and the third group without any lesions (N group). Comparison of clinical outcomes and the hematological findings were performed among the three groups. We also evaluated risk factors for postoperative SIDLs using logistic regression analysis. *p*-values

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less than 0.05 were considered significant.
Results: There were 59 patients (50.4%) in the E group, 12 patients (10.3%) in the I group, and 46 patients (39.3%) in the N group. Four patients in the E group had neurological symptoms, although none of them required revision surgery. There were 17 patients using antiplatelet or anticoagulant therapy preoperatively, and the percentage of usage for anticoagulant therapy was significantly higher in the I group compared to the other groups (p=0.027). For the hematological findings, there was a tendency that the value of estimated glomerular filtration rate in the I group was lower than the other groups (p=0.075). In the I group, the tendency revealed that the surgical duration was longer than the other groups (p=0.072), and the number of operated levels was higher than the other groups (p=0.098). The perioperative complications were only epidural hematoma and intradural lesions in all groups except the N group. Surgical duration was a significantly independent risk factor for SIDLs (odds ratio, 1.031; 95% confidence interval, 1.002–1.060; p=0.033).
Conclusions: The prevalence of the SIDLs after MEL was 10.3%, without any associated clinical findings. Surgical duration was identified as the risk factor for postoperative SIDLs. While patients underwent MEL are often discharged from the hospital within 1 week, we should take these lesions into consideration on the postoperative MRI in patients with neurological symptoms after surgery.

E051

Dural sealants in spine surgery: a scientometric analysis

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Background: This research aims to systematically and comprehensively evaluate the publication, citation, collaboration, and evolution of topics in dural sealant for cerebrospinal fluid leakage in spine surgery publications.
Methods: This is a scientometric study that systematically mined publications from the Web of Science in January 2023 using the keywords (dural sealant) AND (cerebrospinal fluid) AND (spine surgery). No exclusion criteria were used in the search. The analysis was divided into publication, citation, collaboration, and text-co-occurrence network analysis. R Studio and VOSViewer were used for data management, analysis, and visualization.
Results: A total of 53 documents published between 2002 and 2022 were analyzed. The countries with the most publications were the United States of America (39.62%), Italy (9.43%), and Japan (9.43%). Total citations for all publications were 859, with an overall H-index of 15. Institutions from South Korea, India, China, and the United States of America were found to have previous collaborations on the topic. Additionally, neurosurgery publications had four clusters of co-occurring keywords, which include (1) neurological deficit, polyethylene glycol, efficacy, safety; (2) dural defect, prevention, cerebrospinal fluid (CSF) leak; (3) postoperative CSF leak, dural tear; and (4) prolene, fibrin sealant, watertight closure. In terms of evolution, publications initially focused on the types of sealants but are currently focusing more on the effects of these sealants on different outcomes.
Conclusions: This study provided an overview of the scientific output, trends, and research topics in dural sealant for CSF leakage in spine surgery publications worldwide. More research is still needed using varied designs and more subjects on this topic. Results may serve as a valuable guide for researchers, practitioners, and educators to find the future direction of research agenda and projects about using dural sealant to prevent CSF leak in spine surgeries.

E054

Predicting adequate segmental lordosis correction in lumbar spinal stenosis patients undergoing oblique lumbar interbody fusion: a focus on the discontinuous segment

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Background: The clinical and radiological factors associated with sufficient correction of segmental angle (SA) following minimally invasive oblique lumbar interbody

fusion (MIS-OLIF) remain underexplored. Therefore, this study aimed to identify the preoperative or postoperative radiological factors associated with adequate correction of the SA greater than 10° at each surgical level and to establish a predictive formula for SA correction following MIS-OLIF with percutaneous pedicle screw instrumentation.

Methods: Data from lumbar spinal stenosis patients who underwent single- or two-level MIS-OLIF were reviewed. Segments with adequate correction of the SA >10° after MIS-OLIF were categorized as discontinuous segments (D segments), whereas those without such improvement were assigned as continuous segments (C segments). Clinical and radiological parameters were compared, and multivariate logistic regression analysis was performed to identify factors associated with SA correction >10° after MIS-OLIF.

Results: Of 211 segments included, 38 segments (18.0%) were classified as D segments. Compared with C segments, D segments demonstrated a significantly smaller preoperative SA (mean±standard deviation [SD], -1.1°±6.7° vs. 6.6°±6.3°; $p<0.001$), larger change of SA (mean±SD, 13.5°±3.4° vs. 3.1°±3.9°; $p<0.001$), and a higher rate of presence of facet effusion (76.3% vs. 48.6%, $p=0.002$). Logistic regression revealed preoperative SA (odds ratio [OR], 0.733; 95% confidence interval [CI], 0.639–0.840; $p<0.001$) and facet effusion (OR, 14.054; 95% CI, 1.758–112.377; $p=0.027$) as significant predictors for >10° SA correction after MIS-OLIF.

Conclusions: Preoperative kyphotic SA and facet effusion can predict SA correction >10° following MIS-OLIF. For patients with lordotic SA and no preoperative facet effusion, supplemental procedures, such as anterior column release or posterior osteotomy, should be prepared for additional lumbar lordosis correction required for remnant global sagittal imbalance after MIS-OLIF.

E055

A rare and less-reported complication of Keloid formation after anterior cervical decompression and fusion

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Background: A keloid is a benign fibroproliferative tissue growth that exceeds the initial wound margin in individuals with genetic susceptibility without spontaneous regression and usually develops after tissue trauma. Keloids often cause cosmetic and functional problems that may lead to the patient feeling embarrassed and having decreased self-esteem. Most importantly, keloids in joints can cause joint contractures, thus limiting joint movement. Problems that arise due to keloids can interfere with a person's quality of life.

Case Report: A case of a 43-year-old male who presented with a keloid following anterior cervical decompression and fusion is presented to highlight a rare and less-reported complication of keloid formation after anterior cervical decompression and fusion.

Discussion: Clinically, keloids present as slow-growing, benign, dense, raised fibrous tissue that extends beyond the original wound or inflammatory response margin. A PubMed search using "keloid" and "anterior cervical decompression and fusion" as two keywords revealed no results. As a result, the following factors were discussed: definition, incidence, etiology and risk factors, differential diagnosis, prevention/prophylaxis, and treatment strategies of keloid secondary to surgery.

Conclusions: Orthopedic surgery inevitably causes tissue trauma that will lead to the formation of keloids in a few patients, which can cause cosmetic and functional problems, thus interfering with a person's quality of life. Various prophylaxis modalities can be used to prevent the formation of a keloid. Furthermore, should a keloid form, there are various treatment modalities such as intralesional triamcinolone acetonide injection, 5-fluorouracil, laser, radiotherapy, cryotherapy, and surgical scar revision.

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E061

Comparative analysis endoscopic L5–S1 foraminotomy versus biportal endoscopic L5–S1 fusion

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Background: For patients with foraminal stenosis at the L5–S1 level, there are two surgical options: simple L5–S1 foraminotomy and L5–S1 fusion. With advancements in endoscopic surgery, L5–S1 foraminotomy 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.
Methods: Patients with L5–S1 foraminal stenosis were divided into two groups: one group underwent L5–S1 foraminotomy 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 Visual Analog Scale (VAS) Back, VAS Leg, Oswestry Disability Index (ODI), and McNab criteria before and after surgery, and post-surgical complications were recorded. VAS back, VAS leg, and ODI scores were compared using a student T-test. McNab criteria were compared with the Mann-Whitney *U* statistical test.
Results: Foraminotomy group: 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. McNab criteria showed excellent results in two cases, good in seven, fair in five, and poor in five. Fusion group: 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. McNab criteria showed excellent results in nine cases, good in six, fair in two, and poor in one. The most common complication in the foraminotomy group was symptom recurrence, while the fusion group experienced complications related to multi-segmental fusion, including junctional problems.
Conclusions: The clinical improvement in the foraminotomy group was inferior to that in the fusion group.

E065

Cervical spine injury; is late surgery always a failure?

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Study Design: A prospective analysis comparing the neurological outcomes of surgery performed for cervical spinal cord injuries at later versus earlier time points.
Purpose: The study aimed to determine whether early surgery (within 7 days of spinal cord injury) improved neurological and functional outcomes in patients with traumatic cervical spinal cord injuries (C3–T1, American Spinal Injury Association grades A–D) compared to patients undergoing surgery later (more than 7 days after spinal cord injury).
Background: The optimal timing for surgical decompression and stabilization of cervical spinal cord injuries remains a topic of debate. While numerous retrospective studies have been conducted, no prospective studies have compared the neurological outcomes of early versus late surgical intervention for cervical spinal cord injuries.
Methods: Individuals meeting the inclusion criteria were randomized to receive surgical treatment either early (within 7 days of spinal cord injury) or late (after 7 days of spinal cord injury). Neurological and functional outcomes were documented from acute hospital admission to the most recent follow-up.
Results: Comparison of the two groups revealed no significant differences in the duration of acute postoperative critical care unit stay, length of inpatient rehabilitation, or improvement in motor score or American Spinal Injury

Association grade between the early (mean, 5.6 days) and late (mean, 21.8 days) surgical groups.
Conclusions: The study findings indicate that there is no apparent neurological advantage to performing cervical spinal cord decompression within 7 days of injury (mean, 5.6 days) compared to waiting beyond 7 days (mean, 21.8 days).

E072

Tuberculosis infection of spine: current surgical treatment situation in Yala Regional Hospital, a rural area of Southern Thailand

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Background: Tuberculosis infection is endemic in Southeast Asia, and Thailand is among the 30 countries listed with a high tuberculosis burden, with an incidence of 155 per 100,000 population. Spinal tuberculosis poses a significant threat, potentially leading to disability if left untreated. Despite advancements worldwide, the issue of spinal tuberculosis persists, particularly in rural areas, where it often goes unnoticed.
Methods: Data were collected from patients diagnosed with spinal tuberculosis at Yala Regional Hospital in southern Thailand from 2017 to 2020. The study focused on the incidence, clinical features, diagnostic procedures, imaging studies, treatments, and outcome of patients after treatment. Analysis was conducted using Microsoft Excel (Office 365).
Results: Over the period from 2017 to 2020, there were 2,940 tuberculosis-infected patients, among whom 52 had spinal lesions. Twenty patients underwent surgeries, including decompressions and instrumentations. Seventy-five percent of surgical cases presented with lower back pain, with 11 patients experiencing symptoms for over a year. Ninety-five percent of patients tested negative for sputum acid-fast bacilli (AFB) without evidence of pulmonary infection. Fifty percent had thoracic lesions, and 25% had lumbar lesions. The disease involved 2 to 10 levels of the spine, with 50% of patients exhibiting significant kyphosis. Sixty percent had cord compressions, and all patients had either paraspinal or psoas abscesses. Motor improvements were observed in 72.7% of patients compared to preoperative status. Only 20% had positive AFB in pus, and less than half had polymerase chain reaction (PCR) or tuberculosis culture results. All patients exhibited necrotizing granulomatous patterns on histological study. There were no recurrent diseases post-treatment; however, kyphotic deformity improved in 30% of patients and worsened in 25%. Permanent neurodeficit and kyphosis were observed in 55% and 30% of patients, respectively, while pain and compression were completely resolved.
Discussion: The incidence of spinal tuberculosis remains high, with many patients presenting with advanced disease due to its indolent course. Mild symptoms and lack of awareness contribute to delayed treatment-seeking behavior. Most spine lesions were isolated from the lungs, with extensive abscesses often extending to adjacent organs. Challenges in treatment include limited investigation tools, requiring lengthy processing times, and the impact of poverty and limited surgical expertise in rural areas. Despite these challenges, treatment outcomes were generally favorable, allowing patients to return to daily activities and work.
Conclusions: Spinal tuberculosis in Southeast Asia requires increased attention, as it can lead to devastating deficits if untreated. Given the favorable response to treatment, more focus should be placed on addressing endemic situations, and support should be provided to young surgeons practicing in rural areas.

E073

Feasibility of endoscopic lumbar discectomy in a remote government hospital in Thailand: a cost-utility analysis

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Background: Treatments for lumbar discectomy have evolved over time. Recently, endoscopy has played an important role. However, a major obstacle to endoscopy in rural areas is the cost of surgery, particularly

for endoscopes and disposable equipment. We assessed the cost-effectiveness of endoscopic lumbar discectomy compared to the traditional open microdiscectomy technique in a government hospital in a developing country.

Methods: This study focused on 50 patients who underwent endoscopic lumbar discectomy between April 2019 and March 2020 at Yala Regional Hospital and were reviewed by our team. The duration of hospital stays, operative time, follow-up, and clinical outcomes at 1, 3, and 6 months postoperatively were observed and compared with 30 patients who underwent microscopic lumbar discectomy. Hospital expenses were calculated and compared using *t*-tests.

Results: The average length of stay for endoscopic discectomy was 4.00 days, while for microscopic discectomy, it was 9.77 days. The pain score was 8.82 for endoscopic surgery and 9.1 for microscopic surgery. The operative price for endoscopic discectomy was US $144.69 higher than that for open lumbar discectomy due to the cost of disposable equipment. However, each patient in the microdiscectomy group had a longer hospital stay and required more perioperative care, which reduced the difference in total hospital expenses (US $1,420.612 vs. US $1,399.16).

Conclusions: Full endoscopic lumbar discectomy is an effective procedure that is beneficial for patients. The total hospital costs are not significantly different between the two procedures. To ensure that more patients receive this benefit and to develop surgical competency in government hospitals, the surgical reimbursement fee for endoscopic discectomy should be more affordable than that for conventional discectomy.

E077

A neglected conundrum: outcomes of posterior spinal instrumented fusion for neuromuscular scoliosis secondary to spinal muscular atrophy

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Background: Scoliosis is one of the most significant problems faced by patients with spinal muscular atrophy (SMA), especially non-walkers. We conducted a prospective study on the outcomes of spinal fusion using an all-pedicle-screw segmental instrumentation construct for neuromuscular scoliosis secondary to SMA.

Methods: Twelve patients with a confirmed genetic diagnosis of SMA were included in the study from 2020 to 2023. All children were non-walkers, with 10 having SMA type 2 and two having SMA type 3. The inclusion criteria for surgery were sitting imbalance secondary to progressive deformity in children above 10 years of age. All patients underwent posterior spinal fusion using segmental pedicle screw instrumentation. Extension to the ilium using S2 alar-iliac screws was indicated for children with pelvic obliquity. Postoperative outcomes assessed included improvement in sitting balance, pulmonary function, complications, and revised Scoliosis Research Society-22 (SRS-22r) scores.

Results: Seven females and five males were included. The mean age at surgery was 12.5 years (range, 10–32 years). The mean preoperative Cobb angle was 86° (range, 65°–110°), which was corrected to 29° post-surgery (66% correction). Two children were advised to undergo preoperative halo gravity traction for 1 month since their curves were rigid and above 100°. The mean duration of surgery was 320 minutes (range, 240–388 minutes). Intraoperative cell saver salvage was used in six cases to reduce the transfusion requirement. All children had better sitting balance and were satisfied with the outcomes of surgery. Three children underwent contracture release of the lower extremities concurrently or at a later date. No implant failures or revision surgeries were noted at a mean follow-up of 2 years. There was one mortality, a 12-year-old boy who died 6 months post-surgery secondary to pneumonia and acute respiratory distress syndrome. SRS-22r scores improved significantly with the surgery, though they were significantly lower compared to comparable data on idiopathic scoliosis.

Conclusions: We recommend posterior spinal fusion using segmental pedicle screw instrumentation for neuromuscular scoliosis secondary to SMA after 10 years of age to improve sitting balance and pulmonary function.

E082

Scoliosis correction by double incision traditional growing rod application: still an effective treatment in developing countries?

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Background: Adolescent idiopathic scoliosis (AIS) is the most common type of scoliosis. This disorder appears in early puberty, affects 1%–4% of adolescents, and disproportionately affects females. Unlike other forms of scoliosis, the etiology of AIS is still debatable. In terms of the management of AIS, the use of magnetic growing rods shows benefits of low infection risk and does not require subsequent operative procedures. However, due to the high cost, this technique has not been widely adopted in developing countries. In developing countries, traditional dual growing rod procedures are still preferred due to cost efficiency while maintaining a low risk of infection without compromising the outcome of treatment. In this paper, we present a case of AIS treated using traditional growing rods with a double incision approach.

Methods: An 11-year-old female patient presented with asymmetrical back pain that had been present for 2 years prior to hospital admission. Initial spinal X-ray examination showed a degree of scoliosis of 50°. Prior to hospitalization, the patient came to the outpatient clinic for routine follow-up examinations, which revealed a remarkable increase in the degree of scoliosis to 82°. Clinical examinations showed the patient had asymmetrical shoulder height, ribs, scapula, waist, and hips. From the Adam's forward bending test, a right rib hump was observed. No neurologic or motor deficit was observed. Fluoroscopic examinations prior to hospitalization showed the apex of the main thoracolumbar curve at the T9 level, with the upper end at T5 and the lower end at L1. The main thoracic curve was 82.1°, with a proximal thoracic curve of 38°. The lumbar coronal angle was 39°, the thoracic sagittal profile was 27°, and the lumbar lordotic angle was 38°. From the spinopelvic parameters, the sacral slope was 30°, pelvic tilt was 11°, pelvic incidence was 41°, and sagittal vertical axis was negative. The final diagnosis after evaluations was juvenile idiopathic scoliosis, Lenke 1BN, Risser 0, and Sanders 4.

Results: The operation was carried out with two midline incisions, one at the level of the proximal and one at the level of the distal foundations, which were preoperatively prepared based on the type and placement of the curve. Through C-arm fluoroscopic guidance, pedicle screws were instrumented as proximal and distal anchors with a total of five pedicle screws on each anchor. After shaping the rods for sagittal alignment, they were implanted subcutaneously and linked with tandem connections at the thoracolumbar junction, with no cross-connectors employed. Follow-up was done 6 months post-operation. Results observed were a decrease in the main thoracic angle from 82.1° to 33.0°. The lumbar coronal angle also decreased from 39° to 8°. No surgical complications were observed.

Conclusions: Developing countries may still favor the traditional growing rod method due to lower costs at the time of implantation. Surgical intervention indicated in patients with a shorter expected growth period (above 15 years of age) will greatly benefit in terms of cost by the traditional growing rod procedure. In our presented case, spinal curve correction was achieved with no complications of failure or infection.

E084

The role of computed tomography Hounsfield units as a predictive factor for progression of osteoporotic thoracolumbar fracture and its implication for surgical treatment

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Background: Osteoporotic vertebral fractures (OVFs) in the thoracolumbar junction are related to low-energy trauma and low bone mineral density (BMD). Computed tomography (CT) Hounsfield units (HU), a measure of radiodensity, have been implicated in the assessment

of bone quality, showing significant correlations with dual-energy X-ray absorptiometry scores. Few studies have assessed the relationship between CT HU and the progression of thoracolumbar OVFs. Thus, the purpose of this study was to determine the relationship between CT HU and conservative management failure in acute OVFs in the thoracolumbar junction.

Methods: A total of 256 patients diagnosed with thoracolumbar OVFs at a single institution were retrospectively analyzed. Among them, 36 patients (group I) who underwent surgical treatment after conservative treatment failure and 40 patients (group II) who successfully underwent conservative treatment were included. Demographic data, radiographic data including sagittal spinopelvic parameters, paraspinal muscle degeneration, and CT HU around the fracture site were analyzed. The relative difference of HU (ΔrHU) was defined as the difference between the HU of the fracture site and the average HU value in the vertebral body above and below the fracture site.

Results: Patients in group I underwent surgical treatment due to fracture progression approximately 8 weeks after injury. There were no significant differences between the two groups in demographic data, including BMD, and paraspinal muscle degeneration around the fracture site. In terms of radiologic parameters, follow-up height loss (group I: 60.09%, group II: 35.74%) and local kyphotic angle (group I: 26.34°, group II: 18.27°) were significantly higher in group I. Logistic regression analysis showed that ΔrHU (odds ratio, 1.08; 95% confidence interval, 1.01–1.17; $p<0.05$) was a significant risk factor for fracture progression requiring surgical treatment. Receiver operating characteristic curve analysis indicated that the cut-off value of ΔrHU requiring surgical treatment was 100 ($p=0.021$).

Conclusions: As a predictor of the progression of thoracolumbar OVFs, CT HU is useful. In particular, ΔrHU is a risk factor for worsening thoracolumbar OVFs, and surgical treatment may be necessary when the value exceeds 100.

E085

Decision of pedicle subtraction osteotomy vertebra in surgical correction for ankylosing spondylitis with thoracolumbar kyphosis

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Background: Pedicle subtraction osteotomy (PSO) can effectively correct thoracolumbar kyphosis in ankylosing spondylitis (AS) patients, but the optimal location for the procedure remains controversial. This study aims to provide a method for determining the apical vertebra as the site for PSO in corrective surgery for AS with thoracolumbar kyphosis.

Methods: A total of 235 AS patients with thoracolumbar kyphosis who underwent PSO from May 2009 to August 2021 were retrospectively enrolled in this study. Using our proposed method, the Kim's Apex (KA) vertebra, defined as the farthest vertebra from a line drawn from the center of the T10 vertebral body to the midpoint of the S1 upper endplate, 229 patients with apices at T12, L1, or L2 were finally analyzed (excluding L3; six patients). We divided all patients into two groups: group A (n=144) underwent PSO at the KA vertebra, while group B (n=85) underwent PSO at a different level. Demographic and radiologic data, including sagittal spinopelvic parameters of the entire spine, were collected. An additional analysis was performed on patients with the same KA vertebra.

Results: The distribution of patients based on KA were T12 (28 [12.2%]), L1 (119 [51.9%]), and L2 (82 [35.9%]). The correction of sagittal vertical axis (SVA, 101.0±48.5 mm vs. 82.0±53.8 mm; $p=0.010$), global kyphosis (GK, 31.6°±10.0° vs. 26.4°±10.5°; $p=0.005$), and thoracolumbar kyphosis (TLK, 29.4°±10.2° vs. 24.2±12.9°; $p=0.012$) in group A was significantly greater than in group B. There was no difference in the correction of thoracic kyphosis (TK), lumbar lordosis (LL), and pelvic incidence (PI) between the two groups. Further analysis showed that group A had greater correction in TK (26.2°±13.7° vs. 4.5°±20.1°, $p=0.013$) for patients with T12 as the KA, greater improvements in SVA (101.5°±44.2° vs. 73.4°±48.7°, $p=0.020$), GK (30.6°±11.0° vs. 26.0°±10.4°,

p=0.046), and TLK (32.6°±7.8° vs. 26.7°±9.9°, p=0.012) for those with L1 as the KA, and significant correction in TLK (30.0°±6.3° vs. 4.3°±19.5°, p=0.008) for patients with L2 as the KA, compared to group B.

Conclusions: PSO at the apical vertebra provides a greater degree of correction of sagittal imbalance. Our proposed method, using the KA, is easily reproducible for determining the apex level in AS patients with thoracolumbar kyphosis.

E086

Reconstruction surgery for iatrogenic flatback (≤3 level fusion): indications for pedicle subtraction osteotomy

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Background: Studies have shown that osteotomy can serve as a surgical method to correct fixed sagittal imbalance resulting from long-level fusion. Additionally, the sagittal imbalance caused by degenerative changes can be harmoniously aligned through an anterior-posterior combined approach. Nevertheless, there is no consensus on the treatment of patients with flatback syndrome due to a previous short-level fusion. This study aims to evaluate the effectiveness of the combined posterior anterior-posterior approach (P-AP) and when pedicle subtraction osteotomy (PSO) is performed in patients with flatback syndrome after a previous short-level (≤3 levels) fusion.

Methods: From 2011 to 2022, 30 patients with iatrogenic flatback syndrome due to previous short-level fusion who underwent long-level revision surgery at a single institution were finally enrolled. We divided the patients into two groups. Group A (n=20) underwent a P-AP approach, while group B (n=10) underwent a P-AP approach with additional PSO. Group A was subdivided into two groups: excessive-group (n=7) are those with excessive distraction of the anterior disc space, and adequate-group (n=13) are those with adequate anterior disc space. Radiological spinopelvic parameters were measured and compared between the two groups. Complications were recorded. Patient-reported outcomes were measured with Visual Analog Scale (VAS) and Oswestry Disability Index (ODI).

Results: Group A had a lesser number of previous fusion levels than group B (1.1±0.2 vs. 2.2±0.8, p<0.001). In group B, the PSO levels were located at L3 (4 [40%]), L4 (4 [40%]), and L5 (2 [20%]). Both groups achieved significant sagittal balance correction. Group B had a more severe preoperative C7 sagittal vertical axis (C7–SVA, 219.8±76.4 mm vs. 293.8±90.3 mm; p=0.026); however, the correction of C7–SVA (-157.9±84.9 mm vs. -263.0±79.9 mm, p=0.003) was greater than in group A. Postoperatively, seven patients (35%) in group A had excessive distraction of the anterior intervertebral disc space, and none in group B. The segmental angulation in extension and dynamic segment angle (DA) were significantly smaller in the excessive-group compared to the adequate-group (0.4°±5.6° vs. -8.3°±5.1°, p=0.003; 2.8°±1.1° vs. 9.1°±3.4°, p<0.001, respectively). The optimal cutoff values of preoperative radiographic parameters for selecting PSO were: C7–SVA >242.8 mm and DA <4.28°. Both groups showed significant improvement in VAS and ODI postoperatively (p<0.05).

Conclusions: The P-AP approach and P-AP approach with PSO can provide satisfactory outcomes. The addition of PSO may be appropriate for patients if the preoperative C7–SVA is greater than 242.8 mm, or DA is less than 4.28°.

E087

Comparative analysis of sagittal alignment following short-level lumbar interbody fusion in degenerative lumbar spondylolisthesis: a comparison between posterior and lateral approaches

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Background: Short-level lumbar interbody fusion surgery is commonly performed for degenerative lumbar

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spondylolisthesis, but its effects on global sagittal alignment are not well established. Moreover, no studies have compared the impact of lateral (LLIF) and posterior lumbar interbody fusion (PLIF) on global sagittal alignment in patients with sagittal imbalance. This study aimed to compare the impact of LLIF and PLIF on sagittal alignment following short-level lumbar interbody fusion in patients with degenerative lumbar spondylolisthesis.

Methods: Radiographic data from patients who underwent lumbar interbody fusion (≤2 levels) using PLIF or LLIF for degenerative lumbar spondylolisthesis were analyzed. Radiographic parameters, including disc height (DH), neuroforaminal height, segmental lordotic angle (SLA), lumbar lordosis (LL), pelvic incidence (PI), sacral slope (SS), pelvic tilt (PT), C7 sagittal vertical axis (SVA), thoracic kyphosis (TK), thoracolumbar kyphosis, and T1 pelvic angle, were evaluated preoperatively and 2 years postoperatively. Patients with sagittal imbalance were defined as having preoperative PT >20° or PI–LL >11° or SVA >50 mm.

Results: A total of 87 patients underwent LLIF, and 114 patients underwent PLIF. Patients' demographics and preoperative radiographic parameters, except for operation time, did not differ significantly between the PLIF and LLIF groups. The LLIF group showed significantly greater improvements in DH (4.4±2.7 mm vs. 1.5±2.2 mm, $p<0.001$), SLA (8.1°±6.9° vs. 4.6°±7.3°, $p<0.001$), LL (8.2°±7.4° vs. 4.1°±8.2°, $p=0.004$), and PI–LL (-7.1°±6.8° vs. -3.8°±9.2°, $p=0.03$) compared to the PLIF group. Significant differences in DH, SLA, LL, PI–LL, and TK were observed when only patients with sagittal imbalance were included in each group. Preoperative PT >20° was associated with a significantly greater reduction in PI–LL (−2.35° vs. 1.51°, $p=0.005$) and an increase in SS (1.26° vs. −1.56°, $p=0.04$) compared to patients with preoperative PT <20°.

Conclusions: LLIF was found to have a more favorable impact on both local and global sagittal alignment than PLIF following short-level interbody fusion in patients with degenerative lumbar spondylolisthesis. LLIF is highly recommended for patients with degenerative spondylolisthesis with sagittal imbalance, even for short-level cases.

E088

The corrective criteria to avoid adjacent segment degeneration following surgical correction for lumbar spondylolisthesis

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Background: Previous studies have reported factors associated with adjacent segment degeneration (ASD) following posterior lumbar interbody fusion (PLIF). However, there have been few studies about the effect of surgical correction on the development of ASD after PLIF for degenerative lumbar spondylolisthesis (DLS). The purpose of this study is to determine the correction criteria to prevent adjacent segment ASD following surgical treatment for degenerative spondylolisthesis (DS).

Methods: This study included consecutive 633 patients who underwent PLIF for L4–L5 DS between 2011 and 2017 in a single institution with a minimum of 5-year follow-up. Patients with adult spinal deformity defined as sagittal imbalance (C7 sagittal vertical axis >+ 5 cm) or coronal imbalance or with conditions known to be risk factors for ASD in previous studies, such as preexisting spinal stenosis at the cranial adjacent segment, were excluded. We used the following three radiologic parameters to present correction criteria: sagittal translation (ST), sagittal rotation (SR), and disc height (DH). Demographic data and radiologic data including sagittal spinopelvic parameters on the whole spine of patients were collected and analyzed to identify the risk factors for ASD. Like a previous study of Moreau and his colleagues, ASD was defined by the presence of one or more of the following three radiographic criteria in the level immediately above the fusion, comparing immediate postoperative and 3-year follow-up radiographs: onset of ≥10° segmental kyphosis, and/or ≥50% loss of disc height, and/or ≥3 mm anteroposterior translation. Logistic regression analysis was used to identify the risk factors for ASD. The receiver operating characteristic curves were plotted to evaluate the cut-off value for changes of SR and restoration of DH.

Results: A total of 117 patients (37 were male and 80 were female) met the inclusion criteria. ASD developed in 19 patients (16%). The non-ASD group showed a

lower probability of partial ST than the ASD group (8/98: 8.1% vs. 5/19: 26.3%; p=0.021). The non-ASD group also showed significantly greater changes in SR (7.55° vs. 4.92°, p<0.001) and DH (4.91 mm vs. 3.54 mm, p=0.034) compared to the ASD group at immediate postoperative. On logistic regression analysis for potential risk factors of ASD, change of SR (p<0.001) and restoration of DH (p=0.041) were associated with postoperative development of ASD. The cut-off value was 5.01° (p=0.012) and 4.08 mm (p=0.034) in changes of SR and restoration of DH, respectively.

Conclusions: We suggest the three corrective criteria should be satisfied to prevent ASD following surgical correction for DS: complete ST, a change in SR of more than 5.01°, and restoration in DH of more than 4.08 mm.

E089

Anterior to psoas lateral lumbar interbody fusion versus minimally invasive surgery-transforaminal lumbar interbody fusion: a retrospective comparative study of clinical and radiologic outcomes

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Background: Lumbar back pain affects 70%–85% of individuals during their lifetime. Low back pain (LBP) may be accompanied by radicular symptoms due to central or foraminal stenosis. The prevalence of back pain increases with age, and lifetime recurrence is as high as 85%, with chronic LBP being the most common cause of disability in patients between 45 and 65 years of age. Multiple factors may be relevant for the onset of LBP, including degenerative disc disease, facet arthropathy, disc herniation, spondylolysis, and spondylolisthesis. Anterior to psoas (ATP) and minimally invasive surgery-transforaminal lumbar interbody fusion (MIS TLIF) have become well-established surgical techniques and are extensively used worldwide with satisfactory outcomes, but their relative efficacy has yet to be determined locally.

Methods: From January 1, 2022 to September 30, 2023, 26 patients were included, with 18 in the ATP LLIF group and eight in the MIS TLIF group. A total of 31 levels were studied, 22 under the ATP LLIF group and nine in the MIS TLIF group. To analyze the data between the preoperative and postoperative outcomes and measurements, the researcher used the paired sample t-test and Wilcoxon signed t-test. Comparing the final outcomes between the ATP LLIF group and MIS TLIF group, the study utilized the independent sample t-test and the Mann-Whitney U test. The results were tabulated and graphed based on age, sex, body mass index (BMI), preoperative and postoperative Oswestry Disability Index (ODI), Visual Analog Scale (VAS) for back and leg pain, intervertebral height, neuroforaminal height, and lumbar lordosis using MS Excel.

Results: There was no significant difference in age (p=0.053), sex (p=0.099), BMI (p=0.959), and number of levels operated (p=0.628) between the two groups. The ATP LLIF group showed a significant difference between the preoperative and postoperative ODI, VAS (back), VAS (leg), intervertebral height, and neuroforaminal height (p<0.001 for all, respectively). However, there was no significant difference between the preoperative and postoperative lumbar lordosis (p=0.050). In the MIS TLIF group, the study also showed a significant difference in the preoperative and postoperative ODI, VAS (back), VAS (leg), intervertebral height, and neuroforaminal height (p<0.013, p<0.018, p<0.011, p<0.00, and p<0.00, respectively). There was also no significant difference in the preoperative and postoperative lumbar lordosis (p=0.327). When comparing the ATP LLIF to the MIS TLIF group, no significant differences were found in the ODI, VAS back, and lumbar lordosis between the two groups at preoperative and 1 month postoperative (p=0.802, p=0.368, and p=0.222). However, the ATP LLIF group showed significant better VAS leg improvement (p<0.003), intervertebral height (p<0.037), and neuroforaminal height (right and left) (p<0.00, p<0.001) restoration.

Conclusions: Compared with MIS TLIF, ATP LLIF showed a significantly greater change in VAS leg score, restoration of intervertebral and neuroforaminal height, with no significant difference in terms of ODI, VAS back score, and lumbar lordosis.

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E094

Narrative review of minimally invasive spinal decompression surgery

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Background: Spinal decompression surgery appears to be beneficial for lumbar spinal stenosis (LSS) patients who have progressive neural dysfunction and severe chronic pain. In recent decades, minimally invasive spinal surgeries (MISS) utilizing posterior decompression techniques that preserve the midline have been introduced. Endoscopic spinal surgery (ESS) arose as a means of reducing the surgical footprint and has been achieving results that demonstrate comparable efficacy to conventional laminectomies. However, there is a lack of scientific evidence to support the various midline-retaining techniques that have been introduced, nor to identify their potential benefits and drawbacks. The provision of evidence-based guidelines for clinical practice is desperately needed. Thus, the medical community would benefit from this thorough, in-depth review article on various MISS techniques.
Methods: According to the PRISMA (Preferred Reporting Items for Systematic Review and Meta-analyses), a systematic literature search was conducted to identify publications from inception to January 2024 on PubMed and the Cochrane academic search engine using the MeSH (Medical Subject Headings) terms "minimally invasive spine surgery" AND "spinal decompression" AND "endoscopy" OR "endoscopic" OR "endoscopic spine surgery." Inclusion criteria were original clinical human studies, English language, and subjects who underwent MISS for spinal decompression with reported treatment outcomes. The Methodological Quality of Systematic Reviews was used to guide this systematic review. Main outcome measurements were the size of incisions, blood loss, the amount of time to return to normal activities, and visualization. Articles selected were reviewed independently by three authors.
Results: A total of 28 studies met the inclusion criteria. Open and MISS techniques were described, with a greater emphasis on ESS. MISS and ESS techniques reduce tissue dissection, operation times, peri- and postoperative complications, blood loss, length of hospital stay, and incision size, making spine surgeons and patients more receptive to them. Compared to traditional open procedures, MISS also enables patients to resume daily activities sooner, reduces healthcare costs, and improves postoperative outcomes.
Conclusions: Patients with LSS may benefit from endoscopic decompression. With less surgical footprint and fewer complications than open surgery, MISS and ESS have proven to produce comparable results. Appropriate patient selection is crucial for achieving the best possible results in robotic and MISS. Artificial intelligence and machine learning will be used in the near future to assist spine surgeons in better preoperative planning, surgical execution, and patient selection, leading to better postoperative outcomes and patient satisfaction.

E095

Robot-assisted minimally invasive transforaminal interbody fusion: a complete workflow pilot feasibility study

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Background: Robotic-assisted spinal surgery has reportedly improved the accuracy of instrumentation with smaller incisions, improving surgical outcomes, and reducing hospital stays. However, robot-assisted spine surgery has thus far been confined to the placement of pedicle screw instrumentation only. This pilot study aims to explore the feasibility of utilizing the Mazor X Stealth Edition (Medtronic Sofamor Danek USA), robotic-arm platform in the minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) procedure inclusive of interbody cage placement, in our institution.
Methods: Single-center, single-surgeon prospectively collected case series of 30 patients who underwent robot-assisted MIS-TLIF (RA-TLIF) with the Mazor X Stealth system, focusing on patient demographics (age, gender, body mass index, Charlson comorbidity index), and postoperative outcomes.
Results: Of the 30 RA-TLIF cases planned, two cases

were abandoned due to software start-up issues, and one was excluded due to multiple concurrent injuries. One patient underwent revision surgery for a posterior-migrated interbody cage. No loosening of posterior instrumentation was seen in all cases at the 6-month follow-up.

Conclusions: Our single-institution pilot study on the Mazor X Stealth RA-TLIF has shown high pedicle screw insertion accuracy and relatively low complication rates, comparable to that of conventional MIS O-arm navigation systems. However, the discerning surgeon should be on the lookout for potential system-related pitfalls, as well as understand the limitations for robotic interbody cage placement. Further studies will also be required on patient outcomes and cost-effectiveness before consideration for wide-scale implementation.

E096

Intrathecal nusinersen injection for spinal muscular atrophy post-spinal deformity correction surgery: a technical note

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Background: Spinal muscular atrophy (SMA) is a rare genetic disorder resulting in progressive muscular weakness and scoliosis, which is most common in type 2 and type 3 SMA children. The majority of them would need spinal fusion surgery at some point in time to maintain sitting balance. Many medications have been approved for the treatment of SMA, and intrathecal Nusinersen injection via lumbar puncture is advised for children above 2 years of age. We present a technical note on the feasibility of an image-guided tranforaminal approach to access the intrathecal space to administer injections in patients who have undergone spinal deformity correction surgery.

Methods: We report on an 18-year-old girl who was diagnosed with SMA type 3 at the age of 2 years and underwent spinal fusion surgery at 16 years of age with posterior instrumented deformity correction from D2 to the pelvis, owing to progressive scoliosis with pelvic obliquity and significant sitting imbalance. A postoperative image showing spinal fusion is shown below. She was selected for intrathecal Nusinersen administration, and the first four loading doses were given at 2-week intervals as per protocol, with further two maintenance doses given every 4 months thereafter. Due to the difficulty owing to the extensive metal implantation and fusion in the interlaminar space in such cases, it was preferred to use an image-guided novel technique to access the transforaminal route and administer the drug intrathecally.

Results: Computed tomography (CT)-guided transforaminal technique was successfully used in all six sittings (four loading doses and two maintenance doses) in this girl with no associated complications of the procedure to administer Nusinersen injection. Having completed 9 months since the first loading dose, she has noticed better breathing function and subjective improvement in the power of upper limbs since the administration of the 3rd dose. No other specific techniques described in the literature like L3 laminectomy or shorter fusions are necessary during scoliosis surgery in these children if we use this technique.

Conclusions: Severe neuromuscular scoliosis and previous spinal fusion surgery for scoliosis make it difficult to access the intrathecal space by usual methods. Intrathecal Nusinersen injections administered by a CT image-guided transforaminal route for children with SMA who are operated earlier for scoliosis is a feasible and successful technique. This report is unique and describes a therapeutic challenge and is of high clinical significance considering many children would be able to access this therapy in the coming future.

E105

Sagittal parameter does it influence surgical decision making in low grade spondylolisthesis

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Background: The well-established surgery of lumbar and lumbosacral spinal fusion is utilized to treat degenerative spondylolisthesis. However, it is unknown how the clinical result would be affected by the shrinkage of the afflicted section and the improvement of the radiological sagittal parameters. The goal of the research is to

examine the relationship between the clinical result following lumbar spinal fusion in patients with low-grade degenerative spondylolisthesis and the radiological sagittal parameters.

Methods: Patients with low-grade degenerative spondylolisthesis of a single lumbar segment have been included in a monocentric prospective clinical trial. Depending on the pathophysiology of the treated segment, lumbar spinal fusion was performed on each patient. One and 2 years after surgery, patients attended clinical and radiological follow-up appointments. The Oswestry Disability Index (ODI) and the Visual Analog Scale (VAS) were used to evaluate the clinical outcome. Assessments were made of lumbar lordosis, sagittal rotation, anterior displacement, and sagittal spinopelvic radiological characteristics of the afflicted segment. Analysis was done on the relationship between the sagittal radiological characteristics and the clinical result.

Results: The study comprised 82 patients, 45 of whom were female and 37 of whom were male, with an average age of 58.6 years. Every patient completed their follow-up exams. There was a noticeable improvement in the ODI and VAS scores across all follow-up tests. Records were kept for pelvic incidence (PI), sacral slope, pelvic tilt, and PI–lumbar lordosis mismatch. Following surgery, a noteworthy decrease in anterior displacement was observed and documented during the follow-up.

Conclusions: Clinical outcomes and preoperative and postoperative sagittal parameters were shown to be strongly correlated.

E107

Single posterior dynamic approach for surgical correction of adolescent idiopathic scoliosis

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Background: Scoliosis surgery is a complex and highly specialized procedure aimed at correcting abnormal curvature of the spine. This condition, known as scoliosis, can range from mild to severe and can significantly impact a person's quality of life. The purpose of this abstract is to provide a concise overview of scoliosis surgery, including its indications, surgical techniques, potential risks and complications, and postoperative care.

Methods: From February 2009 to November 2023, 181 cases underwent surgery. Of these, 108 were female and 73 were male, with ages ranging from 14 to 38 years. The pedicle serves as a power nucleus of the vertebra and offers a secure grip of all three columns. Pedicle screw instrumentation ensures rigid fixation with improved three-dimensional correction. Accurate placement of screws is important to reduce possible irreversible complications. All cases were corrected by transpedicular screws and rods, and one case was stabilized by sub-laminar wiring. One hundred seventy-two cases were managed by only a posterior approach, while nine cases required both anterior releases, costoplasty, and posterior stabilization as well. Fusion was performed in selected segments. The total follow-up time was about 10 years (range, 6 months to 7 years). All patients were assessed for deformity correction, cosmesis, and functional outcome. The use of Neuromonitor is an excellent and effective method for the prevention of postoperative neuro deficits.

Results: Forty percent of patients had an average coronal plane Cobb's angle measuring about 70° preoperatively and 17.12° immediately postoperatively. Two percent of patients developed neurodeficit, with three regaining completely but another regaining her neurological deficit very slowly. There were malpositions of screws in 13%, painful prominence of screws in 10%, and superficial infection in 4%. Eighty percent of patients improved cosmetically.

Conclusions: Scoliosis surgery is a valuable treatment option for individuals with significant spinal curvature. While it carries certain risks, advancements in surgical techniques and postoperative care have improved patient outcomes and overall success rates.

E108

Spinal epidermoid tumors: a case report and description of endoscopic-assisted intra-dural resection technique

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Background: Spinal epidermoid tumors are rare intra-

dural spinal tumors, comprising less than 1% of tumors involving the spine. These tumors are either congenital or acquired and arise from pathological displacement of epidermal cells into the spinal canal. Histologically, they consist of stratified squamous epithelium supported by an outer layer of collagenous tissue. The mainstay of treatment is gross total surgical resection, typically resulting in good outcomes. We report a case of a lumbosacral epidermoid tumor that was surgically resected via an endoscopic-assisted approach.

Purpose: To describe a spinal epidermoid tumor in the lumbosacral region and the technique of surgical resection via a traditional posterior lumbar laminectomy with an intra-dural endoscopic-assisted approach.

Case Report: We report a case of a 45-year-old woman who presented to our clinic with longstanding bilateral lower limb weakness (Medical Research Council [MRC] scale 3/5 for proximal lower limbs and 1/5 for distal lower limbs), with reduced sensation to light touch from L2 to S1 dermatomes. Magnetic resonance imaging of the spine revealed an intra-dural tumor spanning the L1 to L5 levels, extending into the sacral canal of S1 to S2 (Conus at L2 level and appearing contiguous with the intra-dural mass lesion). The initial radiological impression was a myxopapillary ependymoma due to its morphological and signal enhancement characteristics.

Results: The patient underwent elective L1–L5 laminectomies and intra-dural endoscopic-assisted resection of the lesion to allow for maximal safe resection within the area of the laminectomies and to avoid the need for extension down to S2. Intraoperatively, the intra-dural tumor appeared to be a mixture of soft yellowish lesions with flakes. A thin tumor capsule was adhered to numerous motor and sensory nerve roots, while the proximal portion of the tumor was intra-medullary at the level of the conus. Hence, the tumor mass was maximally safely resected, with portions of the tumor capsule and the intramedullary portion of the tumor left untouched. The patient had an uneventful recovery and was discharged home well. At the 6-month postoperative review, her lower limb sensation and proximal power (now at MRC scale 5/5) had improved. Final histology revealed an epidermoid cyst.

Conclusions: Traditional posterior laminectomy with an intra-dural endoscopic-assisted approach for the resection of spinal epidermoid tumors is a novel and safe technique. Maximal safe resection of the tumor was achieved, with an associated improvement in the patient's neurological condition.

E111

Incidental intraoperative finding of lumbar spinal gout in an asymptomatic patient: what do we do? a case report

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Background: Spinal gout is largely under-diagnosed due to the wide range of symptoms it may mimic. Limitations in its diagnostic methodology can result in unexpected intraoperative findings of spinal tophi, further complicating management. We present a case of asymptomatic spinal gout where deposits of spinal tophaceous gout were found intraoperatively. The aim of this case report is to highlight the diagnostic difficulties and establish a surgical strategy for such incidental findings.

Case Report: A 59-year-old woman with underlying diabetes mellitus, hypertension, and dyslipidemia presented with long-standing positional axial lower back pain, associated with worsening right-sided radiculopathy pain over the L5 distribution for 3 months. She had no risk factors for gouty arthritis. General assessment did not reveal any signs suggestive of polyarthritis. Despite an unremarkable neurological assessment, significant back pain at the level of L4/L5 was elicited. The straight leg raise test was positive on the right side. A plain lumbosacral radiograph revealed degenerative changes with L4/L5 spondylolisthesis and dynamic instability. Magnetic resonance imaging (MRI) of the lumbosacral region indicated degenerative changes of L4/L5, evidenced by a dehydrated disc and facet hypertrophy causing severe central stenosis and significant right foraminal narrowing. Thus, a diagnosis of L4/L5 radiculopathy secondary to lumbar degenerative disc disease with spondylolisthesis was established. As subsequent follow-ups showed worsening back pain and radiculopathy and failure of conservative treatment, a posterior lumbar interbody fusion at L4/L5 and instrumentation from L4 to S1 was planned. However, intraoperative findings revealed an abundance of tophi originating from the bilateral facet, invaginating both bony and soft tissue components. Due to the extensive pathology, debulking of the tophi material together with a facetectomy was performed. Additional posterolateral fusion was also done to ensure successful fusion.

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Histopathology findings confirmed the diagnosis. Her symptoms improved postoperatively, and she was started on allopurinol therapy.
Discussion: Despite being aware of the salient presentation of spinal gout, including axial back pain and radiculopathy as seen in this patient, the lack of history of multiple joint pain, and a family history of gout clouded the initial diagnosis. Additionally, her inflammatory markers and uric acid levels were normal, which was contrary to other reported cases. MRI findings showing a mixture of isointense and hyperintense signals on T2-weighted imaging in the affected areas may be mistaken for spondylosis due to a lack of clinical suspicion. Intraoperative considerations include ensuring adequate decompression, temporary stabilization, and preventing recurrence by eliminating the nidus for deposition. Addressing the intervertebral disc is logical since the postulated pathogenesis of gout originates from the facet joint. Interbody fusion should be considered in patients with symptoms of instability. Retrospectively, in similar cases, removal of the facet joint along with posterolateral fusion might reduce the risk of recurrence. However, long-term studies regarding this intervention are needed to validate this finding.
Conclusions: Despite the challenges in preoperative diagnosis, the intraoperative identification of spinal gout is classical. The approach to an incidental finding of a gouty spine should focus on decompression of the spine, interbody fusion, and posterolateral fusion with facetectomy of the affected joint, and medication to prevent recurrence of tophi.

E112

Fixation of thoracolumbar fracture in patients above 80 years old: a single institution experience

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Background: The average life expectancy has increased globally since 1960 as the quality of healthcare continues to improve. However, there is a paucity of data regarding surgical fixation of thoracolumbar spine fractures in the super elderly. The aim of this study is to determine whether there is a higher rate of complications in the super elderly compared to those below the age of 80 years.
Methods: We performed a single-center retrospective study of patients who underwent surgical fixation of thoracolumbar spine fractures from 2020 to 2023 at Changi General Hospital. Patients were dichotomized into those who were 80 years old and above (super elderly) and those below the age of 80 years (normal). Variables included sex, age, Charlson comorbidity index, presence of osteoporosis, length of hospital stay, surgical and general anesthesia complications, 6- and 12-month implant status, and mortality. The incidence of revision surgery, rate of implant loosening, and mortality between the two groups were analyzed.
Results: A total of 37 patients who were 80 years and above and 71 patients who were below 80 years old were reviewed. There was no significant difference between the two groups regarding the need for revision surgery (p=0.230). All patients who required implant revision had osteoporosis. There was no difference in the rate of implant loosening at 12 months' follow-up (p=0.236) or all-cause mortality (p=0.734) between both groups.
Conclusions: There is no significant difference between the two groups in terms of implant complications, revision surgery required, or all-cause mortality. Hence, surgical fixation of thoracolumbar spine fractures in patients above 80 years old should be considered despite their advanced age.

E114

Do all spinal injuries need decompression?

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Background: The purpose of this study is to investigate the clinical outcome of posterior stabilization without decompression for thoracolumbar burst fractures.
Methods: Forty-eight consecutive cases of thoracolum-

bar fractures involving T11–L2 stabilized by a pedicle screw system were reviewed. Neither reduction of the height of the fractured body nor any decompression procedure was performed during surgery. Forty patients had incomplete paraplegia; eight patients had complete paraplegia. Neurological recovery and remodeling of the spinal canal were evaluated. Neurological status was assessed at the time of injury, just before and after surgery, and at the final follow-up. The degree of spinal canal compromise was assessed using axial computed tomography scan images. The duration of follow-up averaged 12 weeks. No significant correlation was observed between the degree of canal compromise and the severity of the neurological deficit.

Results: Canal compromise had decreased significantly 3–4 weeks after injury. Twenty-five patients regained neurological function at the final follow-up. The mean preoperative kyphotic deformity was 22.75°±4.690°, which improved to 10.53°±3.11° at the final follow-up. The Oswestry Disability Index improved from a preoperative score of 67.20 to a final score of 25.08. At the final follow-up, all patients with incomplete paraplegia had improved by at least one modified Frankel grade.

Conclusions: This study suggests that the effect of decompressing thoracolumbar fractures with neurological deficits remains unclear and questions the need to operate simply to remove retropulsed bone fragments. Posterior stabilization without decompression should constitute appropriate surgical treatment for these fractures.

E117

New classification and surgical outcomes of far advanced degenerative sagittal imbalance of the lumbar spine

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Background: Far advanced degenerative sagittal imbalance (DSI) remains poorly characterized. There is a paucity of information on the preoperative extremely sagittal imbalance and its surgical outcomes. This study aimed to investigate the characteristics of far advanced DSI and surgical outcomes after long fusion for correction of this deformity.

Methods: A total of 64 consecutive patients with severe DSI underwent surgical correction and were enrolled in the study. All patients were divided into two groups according to the apex of the kyphosis: thoracolumbar (TL) group and lower lumbar (LL) group. The standard spinopelvic sagittal parameters were compared between the two groups pre- and postoperatively. The correlations between each of the parameters were analyzed. Paraspinal back muscle degeneration through fatty infiltration was measured using magnetic resonance imaging. The incidence and survival analysis of postoperative mechanical complications (MCs) in each group were compared. Radiographic data and postoperative MCs were statistically analyzed using independent t-tests and chi-square tests.

Results: Among the 64 patients, 24 patients (37.5%) were in the TL group and 40 patients (62.5%) were in the LL group. There were no significant differences in spinopelvic parameters except for thoracolumbar kyphosis between the two groups. LL was the most important factor in determining sagittal contour in the LL group, whereas PI was relatively important in the TL group. In the comparison between the groups, paraspinal back muscle degeneration was more severe in the region where the apex is located ($p<0.05$). The overall incidence of postoperative MCs was higher in patients of the LL group, although it was not statistically significant.

Conclusions: This study demonstrated two different degenerative sagittal alignments with different compensatory mechanisms in patients with severe DSI with >250 mm of the C7 sagittal vertical axis. Both groups showed different paravertebral back muscle degeneration and different mechanical failures, including rod fracture. It suggests that the determination of the proximal fusion levels for DSI could be important to mitigate mechanical complications.

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E118

Does arthrodesis ending at l5 lead to sagittal decompensation after long-segmented fusions for degenerative adult spinal deformity? which matters more: state of disc degeneration of L5–S1 versus global spinopelvic alignment?

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Background: Postoperative sagittal decompensation (PSD) can be multifactorial; however, the use of distal fusion levels to mitigate PSD is still debated. This study aimed to determine the risk factors for PSD and compare the relevance between the preoperative status of disc degeneration at L5–S1 and correction of spinopelvic alignment after a long-segmented fusion ending at L5 for adult spinal deformity.
Methods: We retrospectively reviewed the data of 47 patients who underwent 5-level or more thoracolumbar fusion terminating at L5. Preoperative disc degeneration status was evaluated using the modified Weiner and Pfirmann grades. Spinopelvic parameters were measured. The incidence and risk factors of each junctional failure (JF) were analyzed using the log-rank test and Cox proportional hazard model.
Results: Twenty-eight patients (59.6%) developed JFs. Proximal JFs (PJFs) developed in 16 patients (34.0%), distal JFs (DJFs) in 10 (21.3%), and both in 2 (4.3%). The Weiner grade differed between the groups (p=0.024). At postoperative 2 years, PJFs and DJFs occurred in 34.0% and 19.1% of the patients, respectively. Two global parameters, the sagittal vertical axis and T1 pelvic angle (T1PA), differed between the normal and PJFs groups and between the normal and DJFs groups. Factors related to PJFs were sex (hazard ratio [HR], 0.045; 95% confidence interval [CI], 0.002–0.915; p=0.044), preoperative thoracolumbar kyphosis (TLK) (HR, 1.164; 95% CI, 1.058–1.280; p=0.002), preoperative T1PA (HR, 1.269; 95% CI, 1.030–1.565; p=0.025), and postoperative pelvic incidence–lumbar lordosis (PI–LL) (HR, 0.877; 95% CI, 0.777–0.989; p=0.033). Factors related to DJFs were postoperative proximal junctional angle (PJA) (HR, 0.899; 95% CI, 0.822–0.983; p=0.019) and postoperative LL (HR, 0.920; 95% CI, 0.863–0.981; p=0.011). Nine patients underwent reoperation for JFs, accounting for 19.1% of all patients.
Conclusions: The risk factors for PJFs were higher preoperative TLK, higher preoperative T1PA, and lower postoperative PI–LL. Lower postoperative PJA and LL were risk factors for DJF. The cumulative incidence of reoperation for JFs was 19.1%. This study suggests that the importance of correcting spinopelvic alignment might be greater than the preoperative degree of disc degeneration at L5–S1.

E124

Is Skeletal Oncology Research Group algorithm superior in predicting survival in metastatic spine disease?

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Background: Despite the availability of several survival scoring systems for surgical decision-making, their reliability and validity are still unclear. It is essential to determine the accuracy, and therefore, in this study, we compared the Skeletal Oncology Research Group (SORG) algorithm in predicting survival in metastatic spine disease versus the currently used revised Tokuhashi and Tomita scoring systems.
Methods: We retrospectively recruited a cohort of patients with metastatic spine disease who underwent surgery at a single center, operated by a single team between August 2020 to December 2022. The optimal area under the receiver operating characteristic curve (AUC) was calculated to evaluate the accuracy of the three scoring systems at 3, 6, and 12 months, respectively.
Results: A total of 54 patients (35 males and 19 females) were included. The analysis of our cohort showed that the SORG algorithm was superior in predicting survival compared to the revised Tokuhashi and Tomita scoring systems. The SORG algorithm had an AUC of 0.86 at 90 days and 0.84 at 1 year. The revised Tokuhashi and Tomita scores had an AUC of 0.64, 0.70, and 0.59 and 0.62 at 3 months and 1 year, respectively.
Conclusions: The predictive ability of the SORG algo-

rithm was superior to the currently used preoperative survival estimation scores for spinal metastatic disease.

E131

Expansion duraplasty for spinal cord injury decompression: a systematic review and meta-analysis study

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Background: Spinal cord injury (SCI) is a life-changing disability that affects individuals and healthcare systems worldwide. It presents formidable challenges, necessitating timely and adequate decompression for enhanced neurological recovery, with expansion duraplasty (ED) gaining attention as a surgical approach. This study's main objective is to provide an overview of the existing evidence regarding the effectiveness of ED for SCI decompression.
Methods: This study was a meta-analysis and systematic review conducted using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) Guidelines. Patient demographics, intraspinal pressure, neurologic outcome, and sequelae were examined. The analysis includes peer-reviewed English-language studies of SCI patients who underwent ED. Improvement, stability, and problems are included in prospective and retrospective research designs, removing insufficient data and non-primary articles. This study searched Medline (supplied by PubMed) without date constraints and analyzed studies using the Newcastle-Ottawa Scale for observational studies. The data were presented in summary tables and forest plots with diagnostic test Q-statistics and I^2 for heterogeneity.
Results: Ten out of 14 studies met the criteria, and four were eligible for meta-analysis. These studies examined 35 SCI patients who underwent ED. Control and duraplasty groups were compared. Studies reporting experimental outcomes without comparing to control used proportional meta-analysis. The study found; The study by Zhu et al. (2019) found the shortest operation duration for ED (effect size, 87.33; 95% confidence interval [CI], 110.626 to 199.374). The studies by Zhu et al. (2019) and Phang et al. (2015) generated an effect size of 15.3 and 1.42 for duraplasty and control groups, respectively, with both indicating big differences in the intraspinal pressure values. The overall effect size across all the studies was 11.19, Q=0.140, I^2=0%, and p>0.05 in favor of ED having smaller intraspinal pressure values versus control. Zhu et al. (2019) and Aarabi et al. (2022) found the most improved cases, with odds ratios (OR) 2.72 (95% CI, 1.13 to 6.57; Q=0.22, p=0.03) and 2.72 (95% CI, 1.00 to 7.39; Q=0.22, p=0.05), respectively. Telemacque et al. (2018) found a larger impact size for stable cases.
Conclusions: In conclusion, laminectomy alone is insufficient since the dura is inelastic, restricting cerebrospinal fluid (CSF) and blood flow to the injured area. The result of this meta-analysis showed the efficacy of ED in managing SCI. The data demonstrated a significant decrease in intraspinal pressure values favoring ED. Most studies reported an improvement in the American Spinal Cord Injury Association (ASIA) scores. However, few patients did not show improvement. Several variables, such as the initial magnetic resonance imaging characteristics, the level of injury, and the initial ASIA grade, could account for the lack of improvement in the neurologic outcome. Postoperative monitoring is essential because of possible complications like CSF leaks, which can be treated with appropriate measures.

E134

Carbon fiber rods in the treatment of cervical spine tumors: a case series and description of a novel surgical technique

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Background: Carbon fiber rods are not used in cervical spinal tumor surgery due to the absence of suitable rod calibers for cervical instrumentation. We propose a technique that allows the use of carbon fiber rods in cervical spinal tumor surgery.
Methods: This is a retrospective case series of patients who underwent cervical spinal tumor surgery between November 2020 and September 2022. A customized titanium connector was used to allow the connection of a carbon rod to the cervical/occipital instrumentation.

Clinical, perioperative, postoperative, and radiological data were collected.
Results: There were 11 patients, eight males and three females, with a mean age of 59.4 years (range, 21–80 years). Five patients had primary spinal tumors and six had spinal metastases. In two out of 11 cases, *en-bloc* resection was performed, in four out of 11 cases intralesional debulking, and in five out of 11 cases separation surgery. The mean length of the construct was 9 levels (range, 7–13 levels), and the mean number of un-instrumented levels was 4 levels (range, 2–6 levels). Nine out of 11 patients did not require anterior reconstruction. Three patients underwent postoperative radiotherapy alone, one received preoperative radiotherapy, one received pre- and postoperative radiotherapy, and one patient underwent postoperative hadron therapy. At the 1-year follow-up, there was no evidence of loss of spinal alignment, implant pullout, or breakage for all patients.
Conclusions: In view of the decreased need for anterior reconstruction secondary to improved mechanical stability and ease of radiological surveillance and radiotherapy, we believe that our technique is a valid method to utilize the biomechanical advantages of carbon rods. Further prospective studies are needed.

E135

Anterior spinal reconstruction with structural femoral allograft post-en-bloc spinal tumor resection in the thoracolumbar spine

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Background: Structural femoral allografts may be an effective and less costly alternative to synthetic implants. We wish to report the outcomes of using femoral allograft to reconstruct the spinal column post spinal tumor resection. We also wish to report our technique of stabilizing the allograft by preinserting a pedicle screw connected to the posterior construct.
Methods: This is a retrospective review of patients who underwent *en-bloc* vertebrectomy for primary spinal tumors 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 and 2022. Primary outcomes were fusion and time to fusion, local recurrence and duration of local recurrence-free survival, and death and duration of survival.
Results: Fourteen patients were treated, with a mean age of 36 years (range, 11–63 years). Nine out of 14 patients had primary tumors of the spine, and five out of 14 had solitary spinal metastases. The median follow-up was 66 months (range, 12–324 months). An all-posterior approach was utilized for 13 out of 14 patients, with only one requiring an anterior approach. The mean time to fusion was 11 months (range, 6–14 months). There were two cases of local recurrence. The mean local recurrence-free survival was 106 months (range, 12–324 months). The mean survival in the primary tumor group was 160 months (range, 12–324 months) and 47 months (range, 24–84 months) in the spinal metastases group.
Conclusions: Structural femoral allografts are a biomechanically suitable alternative for spinal reconstruction post-vertebrectomy and are ideal for postoperative surveillance and radiotherapy. Our technique of posterior stabilization of the allograft ensures mechanical stability and removes the need for an anterior approach and stabilization.

E136

Is intraoperative cell salvage and autogenic transfusion a risk factor for postoperative metastases in spinal chordoma surgery?

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Background: There remains controversy regarding the use of intraoperative cell salvage–leukocyte depletion filter (IOCS-LDF) in sarcoma surgery due to concern about the dissemination of chordoma cells potentially leading to distant metastases. This study aimed to assess if IOCS-LDF leads to an increased risk of distant metastases in spinal chordoma surgery.
Methods: This is a retrospective review of surgically treated spinal chordoma patients treated between 2012 and 2021. Follow-up was until the time of death with a

minimum of 1-year follow-up. Data on demographics, histology, tumor location, history of previous local or systemic treatment, presence of local recurrence, and metastases were collected. Patient outcomes included local recurrence, recurrence-free survival in years, metastases, metastases-free survival in years, and overall survival.

Results: A total of 31 patients were identified, of which one patient was excluded due to intraoperative mortality. Twenty patients (66.7%) had chordomas of the mobile spine, while 10 (33.3%) were of the sacrum. Seventeen out of 30 (56.7%) patients had Enneking appropriate resections, and 13 out of 30 (43.3%) had Enneking inappropriate (EI) resections. The overall local recurrence rate was seven out of 30 (23.3%), and the metastases rate was six out of 30 (20.0%). Five out of six patients with metastases were EI patients, of whom four out of five (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 with 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]).

Conclusions: This has led to a change in practice in our center. IOCS-LDF is no longer used for non-virgin procedures; in virgin cases, it is stopped prior to any manipulation of the tumor where there may be the potential for capsular breach. We advocate further study into the use of IOC-LDF in spinal sarcoma surgery.

E137

The Oxford Spinal Sarcoma Service: excellent oncological outcomes with a centralized multidisciplinary approach to primary spinal tumor care

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Background: The Oxford Spinal Sarcoma Service is one of four designated primary spinal tumor referral centers in the United Kingdom, serving over 10 million residents. We aim to report the outcomes of this centralized approach.

Methods: A retrospective review was conducted of surgically treated primary spinal tumor patients between 2008 and 2022. Patients were divided into Enneking appropriate (EA) and Enneking inappropriate (EI) groups. Outcomes studied included local recurrence and overall survival.

Results: A total of 119 patients were included, of whom 75 (63.0%) were male. The mean age at the time of surgery was 46 years (range, 8–86 years). Eighty-six out of 119 cases (72.3%) involved the mobile spine, and 33 out of 119 (27.7%) involved the sacrum. Ninety-six out of 119 patients (80.7%) were virgin cases, and EA margins were achieved in 81 out of 119 patients (68.1%). Among the 38 (31.9%) EI patients, 23 out of 38 (60.5%) were non-virgin cases, precluding EA resection. EA margins were achieved 81 out of 90 (90.0%) of the time when EA resection was attempted. In EA patients with mobile spine tumors, the local recurrence rate was one out of 51 (2.0%), compared to five out of 28 (17.9%) in EA patients with sacral tumors, seven out of 35 (20%) in EI patients with mobile spine tumors, and four out of five (80%) in EI patients with sacral tumors. The mean local recurrence-free survival was 5.2 years (range, 1–13.5 years), and the local recurrence rate was 14.3%. The mortality rate was 21.0%, with a mean survival of 5.63 years (range, 1–13.5 years) post-surgery. On multivariate analysis, EI (p=0.019) and postoperative systemic treatment (p=0.004) were significant risk factors for local recurrence, while the presence of metastases (p=0.012) and preoperative systemic therapy (p=0.025) were significant risk factors for mortality.

Conclusions: Centralization of primary spinal tumor care has resulted in excellent oncological outcomes comparable to most large spinal tumor centers. In primary tumors of the mobile spine where EA margins were achieved, our local recurrence rate (2.0%) is one of the lowest reported in the literature.

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E142

Assessment of curve flexibility in idiopathic scoliosis patients with severe scoliosis (major cobb angle ≥90°): a comparison between the supine traction radiograph versus the physician supervised supine side bending radiographs

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Background: Flexibility assessment is important in adolescent idiopathic scoliosis (AIS) patients undergoing surgery with curves greater than 90°. ST radiographs are reported to be superior for severe AIS curves (>65°), whereas supine side-bending (SB) radiographs remain the gold standard for assessing curve flexibility in non-severe curves. The physician-supervised supine side bending (PSSB) is a modification of the conventional SB radiographs whereby maximal passive bending is supervised by the attending physician. The comparison between PSSB and ST radiographs in severe scoliosis has not been investigated. Therefore, the objective of this study is to compare ST and PSSB radiographs in the assessment of the major main thoracic (MT) and thoracolumbar/lumbar (TL/L) severe scoliosis with a Cobb angle ≥90°.

Methods: In this retrospective study, 72 severe idiopathic scoliosis (Cobb angle ≥90°) patients who underwent surgery between 2015 and 2023 were recruited. The major curves were stratified into MT and TL/L curves. The main radiological outcomes were flexibility rate, correction rate, and the flexibility correction index (SBCI/TCI).

Results: Fifty-eight patients had major MT curves with a mean preoperative Cobb angle of 107.3°±16.6° and a mean postoperative Cobb angle of 51.2°±15.5°. Eighteen patients had TL/L major curves with a mean preoperative Cobb angle of 99.7°±8.3° and a mean postoperative Cobb angle of 45.2°±12.8°. The correction rate for MT and TL/L curves was 52.7%±11.1% and 55.0%±11.0%, respectively. There was no significant difference for MT curves when comparing the SBCI (1.7±0.5) and TCI (1.7±0.9). However, for TL/L curves, the comparison between SBCI (1.2±0.2) and TCI (1.4±0.3) demonstrated a significant difference. The SBCI for TL/L curves was closer to 1, indicating that the Cobb angle on PSSB radiographs for TL/L curves could more accurately predict the postoperative Cobb angle.

Conclusions: PSSB and ST radiographs were comparable as methods for assessing curve flexibility in severe AIS patients with major MT curves. The PSSB had a better prediction for the postoperative correction of TL/L major curves.

E148

Anxiety and depression, quality of life, and coping strategies among adolescent idiopathic scoliosis patients on bracing

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Background: There is conflicting evidence as to whether psychological tendencies such as anxiety and depression are higher and whether the quality of life (QOL) is lower among adolescent idiopathic scoliosis (AIS) patients on brace treatment. We hypothesized that AIS patients on brace treatment would have a higher risk of psychological tendencies such as anxiety and depression, lower QOL, and different coping strategies compared to their non-brace counterparts.

Methods: This was a cross-sectional, questionnaire-based study. Fifty AIS patients treated with braces and fifty AIS patients under observation were recruited. Data were collected from a self-report questionnaire derived from the Hospital Anxiety and Depression Scale, revised Scoliosis Research Society-22r (SRS-22r), Spinal Appearance Questionnaire (SAQ), and Brief Coping Orientation to Problems Experienced Questionnaire.

Results: The mean age for the brace and non-brace groups was 13.6±1.6 years and 15.1±2.3 years, respectively (p<0.001). The mean Cobb angle at the time of

the interview for the brace and non-brace groups was 29.4°±9.4° and 27.3°±11.8°, respectively (p=0.313). The prevalence of anxiety disorder in the brace and non-brace groups was 38% and 22%, respectively (p=0.126). The prevalence of depression in the brace and non-brace groups was 12% and 16%, respectively (p=0.774). Respondents in the non-brace group fared better in terms of function (p=0.028) and self-image (p=0.002) in SRS-22r scores. The assessment of patients' perception of their current body shape (p=0.258) and their expectations (p=0.164) using the SAQ questionnaire were insignificant. Patients in the brace group practiced denial (p=0.001) and venting (p=0.003) as their coping mechanisms throughout their brace treatment.

Conclusions: AIS patients on brace treatment were not more likely to have anxiety and depression; however, their QOL was lower compared to non-brace patients. Denial and venting were the most common coping strategies during brace treatment.

E153

How useful is WhatsApp in the perioperative management of adolescent idiopathic scoliosis patients

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Background: Telemedicine tools have been reported to be useful in various medical specialties. WhatsApp has also been used for some specialties, but its use for scoliosis patients has not been well-described. This retrospective study reports the use of WhatsApp in the perioperative management of adolescent idiopathic scoliosis (AIS) patients.

Methods: The chat history between consultant spine surgeons, patients, and patients' parents in respective WhatsApp groups was reviewed. All surgically treated AIS patients for whom a WhatsApp group was created in 2019 were included. We defined correspondence as the initiation of a conversation until the end of the discussion on the same topic. The frequency of correspondences in preoperative utilization, intraoperative utilization, and postoperative utilization was reported.

Results: We reviewed 168 WhatsApp groups, with 84.4% (n=142) female patients and a mean age of 16.2±5.4 years. More than half (54.2%, n=91) of the patients lived ≥50 km away, and 16 (9.5%) were from overseas. We reviewed a total of 3,586 correspondences, of which the majority (94.6%, n=3,394) were relevant to patient care. Total preoperative utilization of WhatsApp was 1,811 (53.4%). Logistic issues and insurance reimbursement predominated the correspondence (17.9%, n=606 and 13.1%, n=446, respectively). Nearly all (99.3%, n=133) of the patients had intraoperative utilization. Almost half (42.7%, n=1,449) of the relevant WhatsApp utilization occurred postoperatively, with 16.2% involving clarification on postoperative care and 1.9% involving the detection of potential postoperative complications. The peak usage was between 1,100–1,359 hours (25.5%, n=916).

Conclusions: This study demonstrated the utilization of WhatsApp in AIS perioperative care, with the highest frequency in preoperative utilization. WhatsApp was helpful for spine surgeons to manage AIS patients perioperatively and to detect potential complications remotely.

E154

A dedicated spine deformity team improve operating theatre efficiency and perioperative outcomes in adolescent idiopathic scoliosis surgery

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Background: The concept of dedicated team surgery has been introduced to offer standardized high-level care and improve cost-effectiveness in recent years. At our center, a dedicated spine deformity team was employed to perform posterior spinal fusion (PSF) surgeries in adolescent idiopathic scoliosis (AIS) patients, with the aim of improving surgical outcomes. This study exam-

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ines the operating theatre (OT) efficiency and perioperative outcomes of PSF in AIS patients conducted by a dedicated spine deformity team.

Methods: We retrospectively reviewed 91 AIS patients. The dedicated team consisted of two consultant spine surgeons utilizing a dual surgeon strategy, a consultant anesthetist, three scrub nurses, two anesthesia nurses, and three radiographers. Total surgery time was defined as the time between the skin incision and the completion of wound closure. Total OT time was defined as the time between patient entry into the OT and exit from the OT.

Results: Fifteen patients were male and seventy-six were female. The mean age of the patients was 16.0±4.3 years. The mean number of fusion levels was 10.4±2.1, with a screw density of 1.2±0.1. The mean Cobb angle was corrected from 63.8°±17.2° to 24.0°±10.9°, with a mean correction rate of 62.9%±10.5%. The mean surgery time was 105.0±24.0 minutes, while the mean OT time was 148.7±29.5 minutes. The mean intraoperative blood loss was 679.4±359.7 mL, and the mean length of hospital stay was 3.8±0.7 days. One patient (1.1%) had an allogeneic blood transfusion, and one patient (1.1%) had a minor perioperative complication of superficial surgical site infection.

Conclusions: A dedicated spine deformity team can improve the efficiency of PSF surgeries among AIS patients, resulting in acceptable scoliosis correction with a short surgery and OT time, and good perioperative outcomes.

E155

Activities of daily living during the first 4 weeks following posterior spinal fusion in idiopathic scoliosis patients

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Background: Previous studies have examined how long it takes for idiopathic scoliosis (IS) patients to resume school, physical activities, and sports after posterior spinal fusion (PSF) surgeries. However, no previous studies in the English literature have explored how soon these patients can perform activities of daily living (ADL) at a closer interval (i.e., daily) within the first few weeks post-surgery. This is a critical period when patients may face severe pain, discomfort, and anxiety while doing ADL, and may need guidance and support from their surgeons. The objective of this study is to investigate the sequential recovery pattern for ADL in the first four weeks following PSF in IS patients.

Methods: Forty-three IS patients who underwent PSF in a single tertiary center were included. Their recovery milestones in the first four weeks postoperatively were retrospectively collected from a prospectively recorded database. The activities of daily living were divided into feeding, transferring/mobility, personal care/hygiene, and leisure/functional activities domains. The time to achieve independence in activities in each domain was documented.

Results: In the feeding domain, the mean time to independence was postoperative day 2 (POD2) (drinking from a cup/bottle at postoperative 64 hours (PO64H); having meals on POD3). In the transferring and mobility domain, the mean time to independence was POD9 (sitting to standing position on POD3; sitting >30 minutes on POD4; sleeping to sitting position on POD6; traveling in a car >1 hour on POD6; standing and walking >30 minutes on POD11; walking upstairs and downstairs on POD12; getting in and out of a car on POD12; and standing and walking >1 hour on POD15). In the personal care and hygiene domain, the mean time to independence was POD9 (passing urine on POD5; passing motion on POD7; grooming on POD8; shoe wear on POD10; dressing up on POD12; and showering on POD14). In the leisure and functional activities domain, the mean time for using a phone was PO38H; watching TV on POD3; writing or typing on a computer for >30 minutes on POD14; doing house chores on POD14; going out for shopping/meals/outings on POD16; and lifting a backpack/handbag/shoulder bag <3 kg on POD18.

Conclusions: Following PSF, IS patients achieved ADL recovery milestones earliest in the feeding domain, followed by transferring and mobility, personal hygiene, grooming, and lastly leisure and functional activities.

E159

Computed tomography based study on adolescent idiopathic scoliosis patients with major lumbar curves: distribution and variation of dysplastic and fully corticalized pedicles

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Background: Patients with adolescent idiopathic scoliosis (AIS) may have a higher prevalence of abnormal or dysplastic pedicles. The study aims to determine the prevalence of dysplastic and fully corticalized pedicles in adolescent idiopathic scoliosis patients with major lumbar curves.
Methods: All scoliotic patients with major (curve with the largest Cobb angle) thoracolumbar and lumbar curves who had computed tomography scans before corrective spine surgery from 2015 to 2020 were retrospectively included in this study. The exclusion criteria were: (1) non-idiopathic scoliosis, (2) thoracic major curves, (3) patients with previous spinal surgery or trauma, and (4) reverse curves (left-sided thoracic curves). Pedicles were classified as type A: cancellous channel of >4 mm; type B: cancellous channel of 2 to 4 mm; type C: cancellous channel of <2 mm or corticalized pedicle of >4 mm; and type D: corticalized pedicle of ≤4 mm. Types B, C, and D were considered dysplastic pedicles, and types C and D were considered narrow-dysplastic pedicles.
Results: A total of 1,972 pedicles from 58 patients were obtained and measured. We found that left-sided T5–T9 had the highest prevalence of fully corticalized pedicles (10.3%–24.1%), followed by right-sided T3–T5 (8.6%–19.0%). The prevalence of narrow dysplastic pedicles was highest at left T5–T9 (50.0%–75.9%) and right T3–T5 (58.6%–69.0%). The smallest pedicle widths were found at right T4 and T5 (2.6±1.0 mm, 2.9±0.9 mm) and left T6–T8 (2.9±1.0 mm, 2.8±1.4 mm, 2.8±1.0 mm). These regions generally represent the concave side of the main thoracic and proximal thoracic curves. There was a transition from larger pedicle width (5.8–6.9 mm) and fewer narrow-dysplastic pedicles (1.7%–5.2%) at T11 and T12 pedicles to smaller pedicle width (4.1–4.9 mm) and more narrow-dysplastic pedicles (15.5%–34.5%) at L1 and L2 pedicles on both sides of the vertebra.
Conclusions: The concave pedicles of the main thoracic and proximal thoracic curves had smaller width and more dysplastic pedicles. There was a transition from larger pedicle width and fewer dysplastic pedicles to smaller pedicle width and more dysplastic pedicles at the thoracolumbar junction.

E161

Does preoperative clinical shoulder balance parameters correlate with preoperative radiological shoulder balance parameters among Lenke type 1 and 2 adolescent idiopathic scoliosis patients?

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Background: Both clinical and radiological parameters assess shoulder balance in adolescent idiopathic scoliosis (AIS) patients. However, few studies have correlated them for medial and lateral shoulder balance.
Methods: Fifty Lenke type 1 and 2 AIS patients were recruited. Clinical shoulder parameters included were inner/outer shoulder height (SHi/SHo), natural log of the ratio of left to right trapezial area (Ln[L/R trapezial area]), shoulder area index 1 (SAI 1), SAI 2, shoulder angle, front/back axilla angle, trapezial angle, front/back trapezium angle ratio, neck base angle, and clinical clavicle angle. Radiological shoulder parameters were T1 tilt, first rib angle (FRA), cervical axis (CA), clavicle angle (Cla-A), coracoid height difference (CHD), clavicle-rib intersection distance (CRID), and radiographic shoulder height (RSH). Correlation analysis was conducted to evaluate the correlation between these parameters.
Results: Most patients had Lenke type 1 curves (66.0%). There were strong correlations ($r \geq 0.6$) between T1 tilt, FRA, and CA, and likewise between Cla-A, CHD,

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CRID, and RSH (r>0.9). In general, T1 tilt, FRA, and CA demonstrated strong correlations with trapezial angle, Ln[L/R trapezial area], SHi, and SAI 1. Trapezial angle and neck base angle had very strong correlations (r≥0.8) with T1 tilt and FRA. Meanwhile, Cla-A, CHD, CRID, and RSH exhibited strong correlations with shoulder angle, whereas Cla-A and RSH had strong correlations with back trapezium angle ratio. SAI 2 and neck base angle had strong correlations with almost all radiological parameters.
Conclusions: T1 tilt, FRA, and CA were indicative of medial shoulder balance (MSB) whereas Cla-A, CHD, CRID, and RSH were indicative of lateral shoulder balance (LSB). Clinical and radiological shoulder parameters correlated strongly for both MSB and LSB.

E162

Can supine computed tomography scan be used to assess curve flexibility and structurality in patients with adolescent idiopathic scoliosis?

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Background: Previous studies have reported a good flexibility correlation between side-bending radiographs and supine radiographs. One previous study documented a correlation between push-prone radiographs and supine computed tomography (CT) scans. However, none compared curve flexibility between supine side-bending radiographs and supine CT scans.
Methods: Adolescent idiopathic scoliosis (AIS) patients who had anteroposterior standing radiographs, side-bending radiographs, and supine CT scans were recruited. Data collected/calculated were demographic data, Cobb angles, and flexibility rates.
Results: A total of 262 patients with a mean age of 16.3±4.6 years were included. There were 40 (15.3%) male patients and 222 (84.7%) female patients. There was a significant (p<0.05) correlation (r=0.726 to 0.959) for proximal thoracic, main thoracic, and lumbar curves between supine CT scans and side-bending radiographs. The flexibility rates of supine CT scans were between 0.2 to 0.5 times that of side-bending radiographs. Estimating structurality on supine CT scans was only possible for proximal thoracic and main thoracic curves with possible errors between 3.3% to 36.1%. It was not possible to estimate the structurality of the thoracolumbar/lumbar curves using supine CT scans.
Conclusions: When available, supine CT scans can be used to estimate the flexibility of the scoliotic curve without the need for additional radiographs. Supine CT scans can also estimate the structurality of the minor curves, but it is not recommended to use them to determine the curve types prior to corrective surgery.

E164

The lumbosacral canal morphometry in the adult Malaysian population

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Background: The different morphometries of the lumbosacral canal may influence the safety of pedicle screw insertion. Trefoil-shaped canals may have a higher risk of medial breach by pedicle screws. The prevalence of trefoil-shaped canals in the lower lumbosacral region has been reported to be up to 28%.
Methods: This was a retrospective study on normal lumbosacral spine of patients aged 18–80 years old who had lumbosacral computed tomography scans performed from 2015 to 2019. The exclusion criteria were patients who had spinal deformities (scoliosis, kyphosis, or spondylolisthesis) or pathologies (congenital vertebrae abnormalities, fractures, tumor, or metastasis) of the lumbosacral canal which could prevent accurate anatomical analyses. The lumbosacral canal was classified into oval/round, triangle and trefoil shapes based on the following parameters: (1) transverse distance, (2) midsagittal distance, and (3) presence of a protuberance (when the perpendicular distance from a line drawn connecting the most concave part of the inner lamina to the most lateral part of the canal to the apex of protuberance is more than 1 mm).
Results: A total of 648 vertebral canals from 108 patients were obtained and measured. The prevalence

of trefoil-shaped canals was 11.7%. The prevalence of trefoil canals by the vertebral level at L3 was 2.8%, L4 was 14.8%, L5 was 36.1%, and S1 was 16.7%. L5 vertebra had the highest prevalence of trefoil canals followed by S1 and L4. There were no trefoil canals at L1 and L2 vertebrae. The prevalence of triangular-shaped canals was 35.6%. Triangular canals were found from L3–S1 with the highest prevalence at S1 vertebra (83.3%). There were no triangular canals at L1 and L2. Oval/round shape canals were found at L1 to L4 vertebrae with a total prevalence of 52.6%. L1 and L2 vertebral canals were all oval/round shaped (100%). There were no oval/round canals at L5 and S1.

Conclusions: Trefoil-shaped canals can be found from L3 to S1 vertebrae with the highest prevalence at L5. Triangular-shaped canals can be found from L3 to S1 with the highest prevalence at S1. Oval/round shaped canals can be found from L1 to L4 vertebrae. All L1 and L2 vertebral canals were oval/round.

E170

Surgical treatment outcomes of anterior-only correction and reconstruction for severe cervical kyphotic deformity with neurofibromatosis-1: a retrospective study with a 5-year follow-up

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Background: The aim of our study is to evaluate the safety and effectiveness of anterior decompression and spinal reconstruction for the treatment of cervical kyphosis in patients with neurofibromatosis type I (NF-1).

Methods: Twelve patients with NF-1-associated cervical kyphotic deformity were retrospectively reviewed between January 2010 and April 2020. All patients underwent anterior-only (AO) correction and reconstruction. X-rays were followed up in all these patients to assess pre- and postoperative local kyphosis angle (LKA), global kyphosis angle (GKA), sagittal vertical axis (SVA), and T1 slope. Visual Analog Scale score, Japanese Orthopaedic Association (JOA) score, and Neck Disability Index (NDI) score were used to evaluate the improvement of the clinical symptoms.

Results: The LKA and GKA decreased from the preoperative average of 64.42 (range, 38 to 86) and 35.50 (range, 10 to 81) to an average of 16.83 (range, -2 to 46) and 4.25 (range, -22 to 39) postoperatively, respectively. The average correction rates of the LKA and GKA were 76.11% and 111.97%, respectively. All patients had achieved satisfactory relief of neurological symptoms. JOA scores improved from 10.42 (range, 8 to 16) preoperatively to 15.25 (range, 11 to 18) at final follow-up. NDI scores decreased from an average of 23.25 (range, 16 to 34) preoperatively to an average of 7.08 (range, 3 to 15) at the final follow-up.

Conclusions: AO correction and reconstruction are safe and effective methods for correcting cervical kyphosis in NF-1 patients. In fixed cervical kyphosis cases, preoperative skull traction should also be considered.

E175

Long-term outcome of isobar TTL system for the treatment of lumbar degenerative disc diseases

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Background: The Isobar TTL dynamic fixation system has demonstrated favorable outcomes in the short-term treatment of lumbar degenerative disc diseases (LDDs). However, there is a paucity of extensive research on the long-term effects of this system on LDDs. This study aimed to evaluate the long-term clinical and radiological outcomes of patients with LDDs who underwent treatment utilizing the Isobar TTL dynamic fixation system.

Methods: The study analyzed the outcomes of 40 patients with LDDs who underwent posterior lumbar decompression and received single-segment Isobar TTL dynamic internal fixation at our hospital between June 2010 and December 2016. The evaluation of clinical therapeutic effect involved assessing postoperative pain levels using the Visual Analog Scale and Oswestry Disability Index, both before surgery, 3 months after, and at the final follow-up. To determine the preservation of functional motion in dynamically stable segments, we measured the range of motion (ROM) and disc height of stabilized and adjacent segments preoperatively and during the final follow-up. Additionally, we investigated the occurrence of adjacent segment degeneration (ASD).

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Results: Forty patients were evaluated, with an average age of 44.65 years and an average follow-up period of 79.37 months. Fourteen patients belonged to the spondylolisthesis group, while the remaining 26 were categorized under the stenosis or herniated disc group. The preoperative ROM of the stabilized segment exhibited a significant reduction from 8.15°±2.77° to 5.00°±1.82° at the final follow-up (p<0.001). In contrast, there was a slight elevation in the ROM of the adjacent segment during the final follow-up, increasing from 7.68°±2.25° before surgery to 9.36°±1.98° (p<0.001). The intervertebral space height (IH) in the stabilized segment exhibited a significant increase from 10.56±1.99 mm before surgery to 11.39±1.90 mm at the 1-week postoperative follow-up (p<0.001). Conversely, there was a notable decrease in the IH of the adjacent segment from 11.09±1.82 mm preoperatively to 10.86±1.79 mm at the 1-week follow-up after surgery (p<0.001). The incidence of ASD was 15% (6/40) after an average follow-up period of 79.37 months, with a rate of 15.38% (4/26) in the stenosis or herniated disc group and 14.29% (2/14) in the spondylolisthesis group; however, no statistically significant difference was observed in the occurrence of ASD among these groups (p>0.05).
Conclusions: The Isobar TTL dynamic fixation system is an effective treatment for LDDs, improving pain relief, quality of life, and maintaining stabilized segmental motion. It has demonstrated excellent long-term clinical and radiographic results.

E180

Survey on the necessity of intraoperative neurophysiological monitoring for spinal cord surgeries in Asian countries

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Background: Intraoperative neurophysiological monitoring (IONM) is a critical technology employed by spine and spinal cord surgeons to ensure the safety of surgical procedures. Despite its importance, there has been a lack of reports detailing the current state of IONM utilization in Asian countries. Thus, this study aimed to investigate the awareness of the necessity for spinal cord monitoring among surgeons involved in various surgeries. This study had two main objectives: (1) to assess the necessity of IONM for different types of spine and spinal cord surgeries in Asian countries, and (2) to explore the required modalities for each specific surgical type.
Methods: A web-based survey was conducted using Google Forms from October 1 to November 30, 2023. The questionnaire was distributed to all 626 members of the Asia Pacific Spine Society via email. The survey focused on determining the necessity for spinal cord monitoring and the required modalities for representative spinal cord surgeries, including correction surgery for adult spinal deformity (ASD) and scoliosis, decompression and fusion surgery for ossification of the posterior longitudinal ligament, and resection surgery for spinal cord tumors.
Results: The response rate was 30.8%, with 193 members providing feedback. Out of the 193 respondents,

8.3% (16 surgeons) reported not using IONM at all. The highest awareness of the need for IONM was observed in procedures related to correction surgery for scoliosis (idiopathic, congenital, or neuromuscular in pediatric cases) (98.8%), followed by correction surgery for kyphosis (cervical, thoracic, thoracolumbar) (95.7%), and corrective surgery for ASD (92.4%). Conversely, 72.3% of respondents considered IONM unnecessary for decompression surgery for lumbar spinal stenosis. Transcranial motor-evoked potential was the most common modality for all surgeries, followed by somatosensory evoked potential and spontaneous electromyogram. The perceived need for multimodality monitoring was widespread, with surgeries such as intramedullary spinal cord tumor (IMSCT) surgery (91.4%) and resection surgery for extramedullary spinal cord tumor (91.3%) being prominent.

Conclusions: This web-based survey aimed to assess the current status of IONM use in Asia. In a Japan-specific survey, IONM was deemed necessary in 100% of IMSCT cases. However, our study highlights the perceived importance of IONM in correction surgery, suggesting variations in the types of cases handled by spinal surgeons across different countries. Moreover, there was a relatively high perceived need for multimodality IONM.

E188

Iliopsoas compartment syndrome: a rare complication after vertebroplasty: a case report

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Background: Iliopsoas compartment syndrome following vertebroplasty has not been described in the literature so far and, hence, can pose diagnostic and treatment challenges. This case report aims to describe, for the first time, the management of iliopsoas compartment syndrome after vertebroplasty utilizing a combination of retroperitoneal and posterior approaches.

Case Report: A 63-year-old male had undergone percutaneous vertebroplasty for an L2 osteoporotic fracture. He experienced progressively worsening pain radiating along the left groin and anterior aspect of the thigh. Repeat radiological investigations showed spindle-shaped extravasated cement in the left psoas muscle, with surrounding edema and swelling. With progressively increasing pain and these radiological features, the diagnosis of iliopsoas compartment syndrome due to cement leakage was made. Subsequently, through the retroperitoneal approach, cement removal, anterior reconstruction with autografts, and a mesh cage were performed. Intraoperatively, we noted grossly necrosed and unhealthy psoas muscle, which was thoroughly debrided. Then, posterior instrumentation was done at the same stage. At the 2-year follow-up, the patient had made a complete recovery and returned to his daily activities.

Conclusions: The authors conclude that progressively worsening pain after vertebral cement augmentation procedures should raise suspicion among treating surgeons regarding extraosseous cement leaks causing muscle injury, and prompt surgical intervention is necessary for a better outcome.

E189

Is deformity correction essential in a "sick" spinal cord?: a case series

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Background: The incidence of preoperative neurological deficits in pediatric patients with complex deformities ranges from 15% to 23%. Furthermore, the likelihood of postoperative neurological deficits can be considerably increased, up to 83.3%, in the presence of preoperative neurological deficits. Here, we describe four consecutive cases of pediatric spinal deformity with a "sick" cord, all of which have been managed with decompressive surgeries and stabilization without any attempts to correct the deformity. All the patients have recovered well neurologically, without any progression of deformity.

Methods: The authors obtained all the patients' informed written consent. All four cases had myelopathy signs clinically with a progressive worsening neurological deficit. The pathology in all cases was located in the thoracic region. Of the four cases, two were due to post-tubercular deformity and two to congenital deformity. All patients had a significant neurological deficit (Nurick grade 4 or 5) preoperatively. The treatment

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strategy in all cases was circumferential decompression of the spinal cord with posterior pedicle screw instrumentation, without any attempt at correction of deformity.
Results: All patients had significant neurological recovery (Nurick grade 0 to 2) and showed no worsening of deformity at their latest follow-up, up to 5 years. All patients had good improvement in all domains of the revised Scoliosis Research Society-22 questionnaire. The patients and their families were counseled about the need for deformity correction surgery at their follow-up, but all decided against it.
Conclusions: It is challenging for spine surgeons to manage complex spinal abnormalities in pediatric patients with "sick" spinal cords. Even minimal manipulation of the cord during surgery might result in severe long-term morbidity for the patient. The primary objective in managing such patients should be aimed at neurological recovery rather than deformity correction: "First do no harm," and if necessary, the deformity can be corrected at a later stage under neuromonitoring.

E190

Post-tubercular lumbosacral kyphotic deformity in a 11-year-old girl corrected with L4, L5 posterior vertebral column resection: a case report

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Background: A unique feature of pediatric tuberculosis is that, contrary to observations in adults where deformity becomes static after healing, in children, the deformity continues to grow even after a complete cure of the disease. It is commonly believed that lumbar or lumbosacral kyphotic deformities are less likely to progress than thoracic or thoracolumbar lesions. We present a case of an 11-year-old girl with a post-tubercular lumbosacral kyphotic deformity with intact neurology and an L5 vertebral body almost completely destroyed, where posterior vertebral column resection (VCR) was performed with an optimum result.
Case Report: Intraoperative blood loss was 1,100 mL, and surgery time was 370 minutes. There were no major intraoperative complications. The drain was removed on the third postoperative day, and the child was mobilized. As the child was made to stand upright, there was almost instantaneous correction of thoracic lordosis and cervical kyphosis in postoperative standing whole spine X-rays. At her 3-year follow-up, her Oswestry Disability Index and Scoliosis Research Society scores had markedly improved compared to preoperative scores, and her standing radiograph maintained good overall sagittal and coronal alignments.
Conclusions: Post-tubercular kyphotic deformities can cause secondary changes in other regions, such as the loss of thoracic kyphosis and cervical lordosis. Therefore, such deformities should be addressed at an early age to prevent structural changes in compensatory curves. Periapical VCR can effectively correct such deformities in young children.

E191

Spontaneous spinal epidural hematoma: time is running out!

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Background: Spontaneous spinal epidural hematoma (SSEH) is the rarest cause of spinal cord compression, leading to paraparesis or quadriparesis. They account for less than 1% (0.1 patients per 100,000 per year) of all spinal canal space-occupying lesions, resulting in a paucity of literature regarding the diagnosis, management, and prognosis of SSEH. Here, we report three cases of SSEH, all of which had a neurological deficit on presentation and were surgically managed with decompressive laminectomy and evacuation of the hematoma.
Case Report: Of the three patients, one had a history of coronary artery disease and was on anticoagulants. In the remaining two patients, no cause could be identified. The location of the hematoma was in the thoracic region in two patients and the cervical region in one. Hematomas were located dorsal to the cord in two patients and ventral in one. Two cases presented within 30 hours of the onset of symptoms with adolescent idiopathic scoliosis (AIS) A and AIS B neurology. Both showed a complete recovery during their latest follow-up. However, one case presented after 2 days with AIS B neurology and showed no improvement postoperatively.
Conclusions: SSEH is a very rare pathology causing

spinal canal compression and neurological deficits. The myriad of symptoms and the need for magnetic resonance imaging for diagnosis have made this entity difficult to diagnose clinically. Unlike other spinal pathologies where the severity of the preoperative neurological deficit is the best predictor of prognosis, in SSEH, time is the best predictor of prognosis. Our series highlights the fact that, irrespective of the severity of the preoperative neurological deficit, timely diagnosis and early, adequate decompression surgery are essential for complete neurological recovery.

E192

Long-term effect on pain and functional outcome of selective nerve root block in patients with lumbar stenosis

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Background: Low back pain may be due to several pathologic causes, most commonly involving degenerative changes and disc herniation. It is prevalent in individuals aged 40 to 69 years and is a leading cause of decreased workforce productivity and prolonged physical disability. Recalcitrant low back pain with radiculopathy, despite maximization of conservative measures, is an indication for stepping up to non-surgical procedures such as selective nerve root block (SNRB). Classically, this method provides pain relief and subsequent functional improvement for approximately three months post-procedure. This study aims to determine whether the method provides symptomatic relief and functional improvement for long-term periods.
Methods: Thirty-three individuals were included in the study, with documentation of post-procedure pain (via the Numeric Pain Rating Scale) and functional outcome (using the Oswestry Disability Index) at 1 week, 3 weeks, 3 months, 6 months, and 12 months.
Results: Despite two patients eventually needing repeat SNRB and one requiring surgery, most patients reported improvement in both outcome measures. Using the chi-square goodness of fit analysis, no significant difference was noted across the different follow-up periods.
Conclusions: With correct patient selection, SNRB is an effective means of addressing low back and radicular pain, with effects lasting up to a year after the procedure. This provides a means of enhanced workplace productivity for afflicted individuals and may delay the need for surgery, which requires significant perioperative planning.

E199

Convolutional neural network-based X-ray diagnosis of lumbar disc herniation: preliminary study

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Background: Intervertebral disc herniation is a condition that causes radiating pain due to biochemical and morphological changes in intervertebral tissue caused by aging or acute external pressure. This tissue protrudes into the spinal cavity and compresses the dura mater or nerve root. Magnetic resonance imaging (MRI), along with symptom confirmation, is required to diagnose intervertebral disc herniation. While MRI is effective for diagnosing this condition, it is expensive and time-consuming, necessitating alternative methods for pre-diagnosis. The purpose of this study is to devise a convolutional neural network (CNN)-based method to diagnose lumbar disc herniation using lumbar spine (L-Spine) lateral radiographic imaging.
Methods: Radiographic images were collected from 200 patients who underwent X-ray and MRI tests for back pain and were referred to MRI readings for the lumbar disc herniation site. Each image was annotated to label the vertebral and disc spaces on L-Spine lateral X-rays. The labeled image set was used to train, validate, and test with region-based CNN techniques in an 8:1:1 ratio. We analyzed the reliability of the test results compared to the MRI readings.
Results: Close to 99% of L-Spine lateral radiographic images had successfully detected vertebral and disc spaces. The intra-rater reliability was 0.65 between the predicted lumbar disc herniation site and the MRI readings.
Conclusions: Our findings show a moderate level of reliability. The limitations of our study suggest the need for further research, such as increasing the dataset size

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and modifying precise algorithms. However, if it becomes possible to quickly diagnose lumbar disc herniation in radiographic images before MRI examination and increase the diagnostic accuracy for lumbar herniations that do not clearly show imaging symptoms, effective diagnosis and treatment will be possible.

E203

Whole spinal alignment in asymptomatic older women with low bone mass: a focus on global tilt angle

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Background: Alignment of the spine is known to affect the overall musculoskeletal health of people, especially the elderly. Analysis of whole spine sagittal alignment in aged females should also consider their bone and muscle health conditions, coronal malalignment, and regional alignment parameters. This study aimed to investigate the sagittal alignment characteristics in asymptomatic older women with low bone mass, with a focus on the incidence of coronal malalignment and its association with various spinal parameters, including global tilt (GT).

Methods: A total of 165 older women with a mean age of 68.91±7.25 years and a body mass index of 24.26±3.66 kg/m^2 were recruited from a single medical center. The spinal parameters were assessed using full-length standing anteroposterior and lateral radiographs. Multivariate linear regression analyses were conducted to identify factors associated with GT, and the results were used to develop a predictive model for GT.

Results: Multivariate regression analyses revealed significant associations between larger GT angles and factors such as coronal malalignment, C7 slope, and pelvic incidence, with an adjusted R^2 of 0.809. A predictive model for GT was successfully developed as: GT=−4.60+4.12×(coronal malalignment or not)+0.23×C7 slope−0.41×upper lumbar lordosis−0.54×lower lumbar lordosis+0.78×pelvic incidence.

Conclusions: We found a notable prevalence of coronal malalignment among asymptomatic older women with low bone mass and established its significant associations with key spinal parameters, particularly GT. The predictive model for GT may offer clinical value in tailoring patient-specific treatment planning.

E205

A new arena in quantifying functional deficits with the severity of spinal cord compression in degenerative cervical myelopathy

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Background: Degenerative cervical myelopathy (DCM) is the most prevalent degenerative spinal disease in individuals aged 50 years and above. Currently, the diagnosis and treatment of DCM rely on magnetic resonance imaging (MRI) and the modified Japanese Orthopaedics Association Scoring System for Cervical Myelopathy (mJOA). MRI confirms the extent of cord compression, while mJOA evaluates functional deficits subjectively. Objective Physical Performance Tests (PPT) are rarely used for diagnosis or clinical monitoring, likely due to the lack of evidence regarding their validity with cord compression. Previous studies have used subjective scoring systems such as mJOA, Neck Disability Index (NDI), or Myelopathy Disability Index (MDI) as gold standards for validity testing. However, the relationship between PPT and cord compression remains unclear. Therefore, this study aims to compare the validity of PPT with commonly used subjective outcome measures in assessing the severity of cord compression in DCM.

Methods: The study included participants aged 50 or above who have been diagnosed with DCM. The severity of cord compression was determined by measuring the cross-sectional area (CSA) at the most stenotic level on magnetic resonance imaging. Physical performance was assessed using a comprehensive PPT protocol, including the 10-second Grip-and-Release Test (GR), Nine-Hole-Peg Test (9HPT), 10-second Step Test (SST), Foot-Tapping Test (FTT), and the 30-meter Walking Test (30MWT). Subjective outcome measures in this study included the 36-item Short Form Health

Survey Physical Composite Summary (PCS), EuroQol 5-dimensional-5 levels (EQ-5D-5L), mJOA, and NDI. Pearson's correlation analysis was used to evaluate the validity of PPT and all subjective outcomes with CSA. The diagnostic accuracy of each test was determined using receiver operating characteristic (ROC) analysis, considering the areas under the ROC curve (AUC), sensitivity, and specificity.

Results: The study included 451 subjects with DCM (224 male, 227 female) with a mean age of 63.6±10.8 years and a mean BMI of 25.15±4.33 kg/m$^{2.}$ The mean CSA was 46.2±21.1 mm^2, and the mean scores for mJOA, NDI, EQ-5D-5L, and PCS were 12.9±2.7, 24.87±18.42, 0.668±0.288, and 34.57±11.12, respectively. The mean scores for GR, FTT, and SST were 21±7, 27±8, and 16±6, respectively, while the mean time-scores for 9HPT and 30MWT were 29.5±11.9 seconds and 27.9±11.7 seconds, respectively. In Pearson's correlation analysis, PPT showed a strong correlation with CSA, with correlation coefficients (r) ranging from 0.707 to 0.805 (p<0.001). However, the association between subjective outcomes and CSA was weak (r=0.410–0.491, p<0.001). The AUC of PPT (0.867–0.946) was significantly higher than that of subjective scoring (0.710–0.769), and the diagnostic accuracy of PPT and subjective outcomes ranged from 80.44% to 88.80% and 57.54% to 73.59%, respectively.

Conclusions: This study is the first to demonstrate the validity of PPT with the severity of cord compression in DCM. The findings support the fact that PPT may be a more valid and objective tool for assessing DCM compared to the current subjective gold standards.

E206

Cast Test: surgical outcome prediction of thoraco-lumbar spine correction surgery for sagittal vertical axis (+) type dropped head syndrome: a report of initial five cases

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Background: Dropped head syndrome (DHS) is defined as a syndrome characterized by a passively correctable chin-on-chest deformity caused by significant weakness of the neck extensor muscle power. Regardless of the underlying causes, a classification based on spinal sagittal alignment has been proposed by Miyamoto and colleagues. According to their report, DHS can be classified by the value of the 7th cervical vertebra sagittal vertical axis (SVA) into SVA (-) and SVA (+) types. SVA (-) type DHS shows apparent cervical spine kyphosis and compensatory lumbar hyperlordosis and/or thoracic hypokyphosis. SVA (+) type DHS is primarily caused by kyphotic deformity in the thoracolumbar spine leading to an increase in T1 slope. A large T1 slope requires compensatory increase in cervical hyperlordosis to maintain forward gaze. If decompensation of cervical spine hyperlordosis occurs, it easily results in head drop. As for surgical strategy, there is ongoing debate regarding surgical options for SVA (+) type DHS.

Methods: Five consecutive patients who received thoracolumbar spine kyphosis correction for SVA (+) type DHS in our institute from 2019 to 2023 were included in this small case series (initial report of case series) study. Application of a body cast prone position on a Risser table. Immediate reduction of dropped head symptoms was considered as positive cast tests.

Results: In all five cases, a significant improvement in dropped head symptoms was observed immediately after applying the body cast. In all five cases, a significant improvement in dropped head symptoms was observed after surgery.

Conclusions: The Cast Test might be useful for surgical decision-making and patient explanation in cases of SVA (+) type DHS.

E207

New technologies for the prevention and control of scoliosis using traditional Chinese and Western medicine

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Background: The incidence of scoliosis in children and adolescents in China is high, with the number of patients exceeding 5 million and 300,000 new cases every year. Adolescent idiopathic scoliosis (AIS) has a hidden onset and lacks effective prevention and treatment

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methods. It has problems such as late clinical diagnosis, a high incidence of severe scoliosis, and difficulty in diagnosis and treatment, which places a heavy burden on society and families. There is an urgent need to establish a new prevention and control technology system that integrates prevention, diagnosis, and treatment. The complex pathogenesis of AIS is a "stuck" problem that affects its "early diagnosis and early treatment." In-depth study of risk factors for disease occurrence and progression, giving full play to the unique advantages of traditional Chinese medicine in disease prevention and treatment, and innovating new technology systems integrating traditional Chinese and Western medicine are the keys to achieving early diagnosis and accurate treatment. This project aims to achieve key technological breakthroughs and innovations in disease early warning, intelligent prediction, precise diagnosis and treatment, and equipment research and development.

Methods: By exploring the theory of traditional Chinese medicine for AIS, this study aims to carry out prospective, multi-center clinical controlled studies with no fewer than 6,000 people, verify and form new technologies and programs that combine Chinese and Western medicine, and establish a new system for AIS diagnosis and treatment. By using artificial intelligence technology to combine traditional Chinese medicine characteristics and clinical signs, bioinformatics, imaging, electrophysiology, and other multi-source clinical data, this study aims to establish a low-cost, high-efficiency, and high-accuracy early warning screening system and intelligent risk prediction model suitable for large-scale promotion based on the ResNet residual network. On the basis of action and myoelectric combined technology, this study aims to develop a wearable home scene intelligent rehabilitation monitoring system to achieve remote, real-time, dynamic monitoring, and evaluation.

Results: A multi-center clinical database was established, and an early warning screening system and an intelligent prediction model were constructed, with an accuracy rate of 90%; a new technology system integrating traditional Chinese and Western medicine for AIS prevention and stratified treatment was formed; a home rehabilitation monitoring and evaluation system was developed, with the effective rate reaching 90%, and the operation rate dropped by 87%.

Conclusions: Integrated traditional Chinese and Western medicine technology has significant advantages in the new technology with full-cycle prevention and control of AIS early warning, progression prediction, precise diagnosis and treatment, and intelligent monitoring, achieving the goals of "early prevention, early diagnosis, and early treatment." It gives full play to the advantages of traditional Chinese and Western medicine to improve treatment effects and forms a "Chinese plan" led by traditional Chinese medicine.

E209

Postoperative surgical site infection after spine surgery with *Achromobacter xylosoxidans*: a case series

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Background: The Gram-negative organism, *Achromobacter xylosoxidans*, is an aerobic, motile, oxidase-positive, non-fermenting bacteria found widely in hot and humid environments, primarily affecting immunocompromised patients. *Achromobacter* infections in the spine are relatively rare. To the best of our knowledge, this is the first-ever series of postoperative surgical site infections with *A. xylosoxidans.*

Methods: We conducted a retrospective analysis of all cases of *A. xylosoxidans* surgical site infections that occurred at our institution during the severe acute respiratory syndrome coronavirus 2 pandemic. Detailed data were retrieved from 16 patients. *A. xylosoxidans* was considered the causative agent if all of the following conditions were met: the patient showed signs of infection at the surgical site; the surgical site sample for culture and Gram staining was properly collected; microscopic examination of Gram-stained smear revealed the presence of Gram-negative bacilli (*A. xylosoxidans*) associated with an inflammatory response at the surgical site; and the organism was the only or predominant bacterium isolated in culture.

Results: The mean age of patients was 49.3 years (range, 21–73 years). Thirteen cases (81.2%) had degenerative etiology, two cases (12.5%) had traumatic etiology, and one case (6.2%) had inflammatory etiology. The mean time period during which the infection developed after surgery was 12 days (range, 4–28 days). Five out of 16 cases (31.25%) had deep surgical site infection, and all required surgical debridement. Of the 11 patients (68.7%) who had superficial surgical site infections, 10 recovered with culture-specific intravenous antibiotics alone, except one who required debridement due to a non-response to antibiotic therapy. Carbapenems

(imipenem or meropenem) were the most prescribed drugs, followed by piperacillin-tazobactam and minocycline. A combination of two drugs was used in two cases. One patient died due to sepsis, and the remaining patients recovered. None of the patients required implant removal during their follow-up period.
Conclusions: Contrary to previous reports, in our series, most of the patients were immunocompetent, and we also had a low mortality rate (6.25%). More stringent infection prevention and control measures and vigilant monitoring of operative cases were implemented, because of which the surgical site infections caused by *A. xylosoxidans* ceased to occur.

E210

Sagittal parameter: does it influence my practice in low grade spondylolisthesis?

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Background: Sagittal balance is a valuable tool for enhancing the functional outcomes of spine surgeries for spondylolisthesis. This study aims to assess functional outcomes when sagittal balance is incorporated into preoperative planning for surgeries targeting low-grade spondylolisthesis.
Methods: Thirty patients diagnosed with low-grade spondylolisthesis underwent surgery at a tertiary medical center following failed medical treatment. Preoperatively, sagittal balance parameters, including sagittal vertical axis (SVA), spinopelvic angles, lumbar lordosis, pelvic tilt, sacral slope, and pelvic incidence, were measured and correlated with functional outcomes using the Oswestry Disability Index (ODI) and Visual Analog Scale over a 1-year postoperative follow-up period starting from June 2017. Preoperative parameter correction was estimated manually and using the Surgimap application, then applied intraoperatively.
Results: All patients underwent posterior instrumentation and fusion with transforaminal lumbar interbody fusion cages. The mean lumbar lordosis and spinopelvic angles increased significantly. Pelvic tilt decreased insignificantly, while pelvic incidence remained unchanged, consistent with its constant nature. Sacral slope increased insignificantly. Results indicated that 27 patients experienced a statistically significant improvement in their ODI (>20%) at the last visit. Three patients exhibited poor clinical outcomes with an ODI score showing <20% improvement. It was observed that the pathology level was at L4–L5, SVA was positive and worsened postoperatively, accompanied by decreased lumbar lordosis. Changes in ODI demonstrated statistically significant improvement when considering sagittal parameters preoperatively, during surgery, and for reoperations.
Conclusions: Considering sagittal balance parameters in the surgical management of low-grade spondylolisthesis cases can enhance their functional outcomes.

E212

Efficacy, safety, and reliability of single posterior approach for unstable thoracolumbar burst fracture treated with anterior reconstruction and posterior instrumentation

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Background: Management of unstable thoracolumbar burst fractures is still a controversial issue. Fracture morphology, neurological status, and surgeon preference play major roles in deciding the appropriate approach. Though combined anterior and posterior instrumentation provides the most stable repair, optimizing neural decompression and stable internal fixation using a single approach over the least number of spinal segments is the goal. Moreover, the use of both approaches on a trauma patient may increase morbidity. Anterior reconstruction of the spine through only one approach can provide an effective outcome. The purpose of this study is to evaluate the neurological, functional, and radiological outcomes of anterior reconstruction of the spine by a single posterior approach in cases of unstable thoracolumbar burst fractures.
Methods: Eighteen patients with acute unstable thoracolumbar burst fractures (T11 to L4) with neurological deficit from July 2012 to June 2022, in the age group of 16–60 years, with McCormack's score 6 or more and thoracolumbar injury severity score (TLISS) 5 or more were included. Neurological status, Visual Analog

Scale, angle of kyphotic deformity, McCormack's score, and TLISS score were evaluated.
Results: The mean duration of surgery was 255 minutes. The mean blood loss was 440 mL. The mean improvement of the American Spinal Cord Injury Association scale was 1.67 in a patient with incomplete spinal injury, whereas patients with complete spinal injury remained the same at the last follow-up. The mean preoperative kyphotic angle improved from 25° to 5° postoperatively. The Visual Analog Scale score improved from 6.1 to 1.7.
Conclusions: A single posterior approach is a safe, cost-effective, and reliable surgical approach for the reconstruction of all the columns of the spine. It reduces operative time, blood loss, and the morbidity associated with a combined approach, with a good outcome.

E214

Efficacy, safety, and reliability of the single anterior approach for sub-axial cervical spine dislocation

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Background: Although ongoing controversy surrounds the best treatment option for cervical spine dislocation (CSD), anterior cervical surgery with direct decompression is becoming widely accepted. However, managing all cases of sub-axial CSD entirely with a single anterior approach is rarely seen in the published literature.
Methods: The study comprised patients with sub-axial CSD who underwent surgical stabilization utilizing a single anterior approach. Most cases of CSD were reduced, and anterior cervical discectomy and fusion were performed. Anterior cervical corpectomy and fusion were performed in cases of unreduced dislocations. The patients' neurological condition, radiological findings, and functional outcomes were assessed. Statistical analysis was conducted using IBM SPSS ver. 25.0 (IBM Corp., Armonk, NY, USA).
Results: The total number of operated cases was 64, with an average follow-up of 42 months. 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, with only 7.8% of patients requiring 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 showed neurological improvement (87.63%). The mean Neck Disability Index (NDI) was 11.14±11.43, and the preoperative mean Visual Analog Scale score finally improved to 2.05±0.98 (p<0.05). Fusion was achieved in all cases. The most common complication was transient dysphagia (23.4%). No patient developed or aggravated a neurological impairment after surgery. Implant failure was not observed at the final follow-up, except for two cases where screws were partially pulled out.
Conclusions: Based on the results of this study, a single anterior approach is a safe and effective procedure for the treatment of sub-axial CSD, with favorable radiological, neurological, and functional outcomes.

E215

Acute traumatic sub-axial central cord syndrome: can delaying surgery causes disaster?

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Background: Traumatic central cord syndrome (TCCS) is an incomplete spinal cord injury defined by greater weakness in the upper extremities compared to the lower extremities, variable sensory loss, and bladder, bowel, and sexual dysfunction. The optimal timing of surgery for TCCS remains controversial. The purpose of this study was to evaluate whether the timing of surgery for TCCS predicts neurological outcomes, length of stay, and complications.
Methods: Forty-two patients with TCCS without fracture or dislocation were identified and divided into two groups: the early surgery group and the delayed surgery group. Clinical outcomes, including the American Spinal Cord Injury Association Motor Score (AMS) and Japanese Orthopaedic Association (JOA) score upon admission and follow-up, change in AMS, and JOA recovery rate were analyzed. Logistic regression analysis was performed to show the correlation between the timing of surgery and clinical outcomes.
Results: All patients received a minimum of 1-year follow-up and showed significant neurological recovery at the final follow-up. No statistical differences in final

AMS and JOA scores were observed between the two groups. There is insufficient evidence that the lengths of hospital or intensive care unit stay differ between patients who undergo early versus delayed surgery. Furthermore, there is insufficient evidence that the timing between injury and surgery predicts mortality rates or serious or minor adverse events.
Conclusions: Surgery for TCCS performed 24 hours after injury appears safe and effective. Although there is insufficient evidence to provide a clear recommendation for early surgery (within 24 hours), it is preferable to operate during the first hospital admission and within 2 weeks after injury.

E216

Reliability and validity of the Bengali version of the revised Scoliosis Research Society-22 questionnaire for idiopathic scoliosis in Bangladeshi population

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Background: The revised Scoliosis Research Society-22 (SRS-22r) questionnaire is a well-accepted instrument used to measure health-related quality of life in patients with idiopathic scoliosis. No validated tool exists in Bangladesh for idiopathic scoliosis, and the use of the SRS-22r in non-English language countries requires its transcultural adaptation. The objective of this cross-sectional and observational study was to culturally adapt the translated Bengali version of the SRS-22r questionnaire and to determine its reliability using statistical tests for internal consistency and test-retest reliability.
Methods: The transcultural adaptation process was carried out according to the recommendations of the American Academy of Orthopedic Surgeons. The prefinal version was administered to 68 patients with idiopathic scoliosis. The mean age of the participants was 15.42 years, and the mean curve magnitude was 57.4°. A subgroup of 56 volunteers completed the questionnaire a second time 1 week later to determine the scale's reproducibility. Internal consistency was determined using Cronbach's α coefficient, and the test-retest reliability was determined using the intraclass correlation coefficient (ICC).
Results: No floor effects were observed using the Bengali version of the SRS-22r. Ceiling effects were observed in the "pain" and "satisfaction" with "management" domains. The internal consistency values were very good for three domains and good for two domains. The ICC values were excellent for all domains.
Conclusions: Based on the results proving its reliability and validity, the adapted Bengali version of SRS-22r can be effectively used in Bengali-speaking Bangladeshi adolescent idiopathic scoliosis patients.

E217

Advancing scoliosis surgery in resource-constrained environments: a long road ahead

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Background: Scoliosis, a prevalent spinal deformity, spans various age groups and demands clinical attention. While commonly observed in teenagers, it also affects extreme age groups and adults. Timely surgical intervention yields favorable functional and radiological outcomes, emphasizing the importance of correction and cosmesis. This study aims to assess the radiological and functional outcomes of scoliosis surgery utilizing pedicle screws, rods, and spinal osteotomies through a posterior-only approach.
Methods: A prospective case series comprising 28 scoliosis patients treated between July 2018 and June 2022 at the National Institute of Traumatology and Orthopedic Rehabilitation and a private hospital. Preoperative assessments included investigations and clinical evaluations. Patients and attendants received comprehensive explanations about the procedure, associated risks, and benefits. Radiological outcomes were measured using pre- and postoperative Cobb angle assessments, determining the percentage correction. The lower instrumented vertebra served as the neutral vertebra (when indicated), with its level recorded. Functional outcomes were evaluated using the revised Scoliosis Research Society-22 (SRS-22r) patient questionnaire.
Results: Among the 28 patients, 19 were male and nine were female, with an average age of 17.7 years. The mean preoperative Cobb angle was 79°, reducing to

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20° postoperatively, signifying a 78% correction. The average follow-up duration was 2.6 years. One major complication involved postoperative neurological deterioration, while two minor complications were related to wound infection. SRS scores indicated favorable outcomes: pain (4.3), self-image (4.1), functional status (4.2), mental status (3.6), and satisfaction (4.5). No significant correlation was found between scoliosis correction percentage and functional outcome. Patients with higher preoperative Cobb angles tended to experience improved functional and mental statuses postoperatively. No association was observed between the lower instrumented vertebra and functional outcomes.

Conclusions: Posterior instrumentation combined with spinal osteotomies emerges as a reliable, safe, and effective technique for scoliosis treatment when surgery is warranted. Successful outcomes hinge on thorough preoperative assessment planning and adequate training in spinal deformity correction.

E221

Assessment of medial and lateral shoulder imbalance in scoliosis using radiographic and clinical parameters

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Background: Shoulder-level asymmetry not only influences the patient's appearance but also affects the truncal shift and has a bearing on functional outcomes too. While there is a uniform consensus about the paramount importance of shoulder balance in scoliosis patients, what constitutes shoulder symmetry is still debatable. The objective of the study is to evaluate radiographic and clinical parameters for both the medial and lateral components of shoulder balance.

Methods: A prospective database of scoliosis was reviewed. Patient demographics and radiological parameters, including radiographic shoulder height, clavicle angle, T1-tilt, first-rib angle, coracoid height difference, and clavicle rib intersection distance, were recorded. Clinical parameters such as shoulder angle, axillary angle, neck trapezius angle, lateral and medial shoulder height, axillary height, and neck height were also recorded by two independent observers. The revised Scoliosis Research Society-22 score was used for patient-reported outcome measure.

Results: Fifty-seven patients (adolescent idiopathic scoliosis [AIS], 31; early-onset scoliosis [EOS], 26) were recruited. Intraobserver and interobserver reliability were excellent for both radiographic and clinical parameters. Most of the radiological parameters had poor to moderate correlation with clinical parameters, except radiological shoulder height with lateral shoulder height (r=0.63, p<0.05) and first rib angle with medial shoulder height (r=0.65, p<0.05) showing strong correlations. On comparing EOS and AIS patients for radiographic and clinical parameter correlation, no significant difference was found between the two groups. The first rib angle, neck trapezial angle, and neck height were significantly higher in the medial shoulder imbalance group, while the coracoid angle, radiological shoulder height, coracoid height difference, and shoulder angle were significantly higher in the lateral shoulder imbalance group.

Conclusions: The results indicated that radiographic parameters could only partially reflect the clinical appearance of shoulders. In surgical planning for deformity correction, both medial and lateral components of shoulder balance should be taken into consideration for both radiological and clinical parameters.

E231

When should one not use minimally invasive surgery for metastatic spine tumor surgery?

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Background: Metastatic spine tumor surgery (MSTS) is a crucial treatment modality for metastatic spinal disease (MSD). Open spine surgery (OSS) was previously considered the gold standard of treatment until the early 2010s. However, recent advancements in MSTS have introduced minimally invasive spinal surgery (MISS) techniques for MSD treatment. The clear benefits of MISS have led to a paradigm shift towards its adoption as the current gold standard, along with early adjuvant

radiation therapy for MSD patients. Despite the improvements in surgical techniques and the growing literature supporting MISS for MSD, there are situations where MISS may not be desirable or suitable. However, there is a lack of literature describing the considerations for not using MISS in today's clinical context. This review aims to address this gap by highlighting situations where OSS should be approached with caution and identifying scenarios where MISS is preferable, drawing from available literature and personal experiences.

Methods: This narrative review utilized PubMed, Medical Literature Analysis and Retrieval System Online (Medline), The Cochrane Library, and Scopus databases up to August 31, 2023. Studies discussing the type of surgery in MSTS were included, while those lacking descriptions of the surgical procedure were excluded. Personal experiences from senior authors supplemented the discussion on situations unsuitable for MISS.

Results: A total of 52 studies were included, discussing various advantages and appropriate situations for MISS in today's clinical context. However, unique circumstances exist where MISS may be less suitable. These considerations are crucial for MSTS surgeons, with OSS being a viable option when MISS is less feasible. Considerations include tumor characteristics (e.g., hypersclerotic or hypervascular), planned extent of surgery, previous operations at the surgical level, tumor location, patient profile, and miscellaneous factors such as equipment availability.

Conclusions: MISS may be less feasible in patients with pediatric profiles, short stature, or previous surgery at the surgical level. Tumors located in the occipitocervical and cervicothoracic regions also present challenges for MISS due to access and imaging difficulties. Additionally, MISS for hypersclerotic and hypervascular tumors may pose challenges in cannulation and bleeding control, making OSS more suitable in such cases. Surgeon experience should guide decision-making regarding the appropriateness of MISS. This review highlights circumstances where MISS may be less applicable despite its advantages, emphasizing the need for individualized MSTS approaches based on patient characteristics and surgeon experience. OSS remains a valuable approach in MSTS and should be considered based on the clinical situation.

E236

Expandable cages for transforaminal lumbar interbody fusion: 2-year radiological outcomes of lumbar lordosis, vertebral foramen height, and disc height

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Background: Expandable interbody cages are being increasingly used as they expand inside the disc space and increase the surface area for fusion using a minimally invasive corridor. The need for distraction and compression is also less as we can achieve good intervertebral height without compromising the vertebral end plate integrity. There are very few studies observing the radiological parameters after using Expandable interbody cages—particularly in minimally invasive spine surgery (MISS) transforaminal lumbar interbody fusion (TLIF). This is designed to study radiographic outcomes—lumbar lordosis (LL), vertebral foramen height (VFH), anterior disc height (ADH), posterior disc height (PDH), and Oswestry Disability Index (ODI) scores after performing TLIF in single and double level cases of lumbar canal stenosis and intervertebral disc prolapse.

Methods: A prospective interventional study performed from 2020 March to 2022 March includes 30 patients of mean age 55 years and with a minimum 1-year follow-up. Patients with up to two levels of lumbar canal stenosis or intervertebral disc prolapse with a minimum 1-year follow-up are included. Exclusion criteria comprised infectious pathologies and patients lost to follow-up. All procedures were performed by a single surgeon at a single center using either open or MISS TLIF with expandable cages. Preoperative and 1-year postoperative computed tomography scans and ODI scores were calculated for each patient. Preoperative and 1-year postoperative LL, VFH, ADH, and PDH were calculated respectively. Clinical analysis was conducted using preoperative and postoperative ODI scores recorded in electronic health record software, with statistical analysis performed using SPSS software.

Results: The average surgical time was 128 minutes with a blood loss of 340 mL. Complications included one case of cage backout and one case of surgical site infection. Preoperative and 1-year postoperative LL av-

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eraged 38° and 40°, respectively. ADH increased from an average of 13.2 mm preoperatively to 15.4 mm postoperatively, while PDH increased from 7.3 to 9.8 mm. Average preoperative and 1-year postoperative TFH increased from 16.8 to 18.3 mm. Preoperative and postoperative ODI scores averaged 35 and 82, respectively, all showing statistical significance ($p<0.05$).

Conclusions: TLIF using expandable interbody cages is a reliable and simple technique that avoids extensive dissection of the posterior longitudinal ligament and annulus, offering the advantage of increased surface area for fusion. Extensive distraction and compression maneuvers are also unnecessary, which might otherwise increase blood loss and surgical time, particularly in MISS TLIF. With the added benefits of a statistically significant increase in PDH, ADH, TFH, and ODI scores, as well as a mild but statistically significant increase in LL, this technique appears to be a promising technical advancement in spine surgery for the future.

E240

Osteoporotic burst fractures with incomplete neurology: is indirect decompression and stabilization with index vertebra augmentation enough?

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Background: Elderly patients present with disabling pain and delayed neurological deficits when osteoporotic burst fractures are neglected. Direct decompression, spinal stabilization with anterior reconstruction in these patients not only warrants functional recovery but also prevents prolonged recumbency and further neurological deterioration. However, these extensive procedures can also increase morbidity and mortality. Recently, indirect decompression has also been a well-documented technique in these fractures. This study aimed to assess the functional outcome of indirect decompression and fixation with index vertebra augmentation in patients with osteoporotic burst fractures with incomplete neurology.

Methods: All osteoporotic burst fracture patients presenting with neurological compromise (incomplete) operated on by fixation with index vertebra augmentation without any direct decompression from 2017 to 2023 from two centers were included. Augments like cement, fenestrated screws, and bullet interbody cages were used. Preoperative function, radiology, and neurology were noted from the digital medical record and imaging database. Postoperative assessment of function (Visual Analog Scale [VAS] and Oswestry Disability Index [ODI]), improvement in neurology (FRANKEL), and radiological changes were noted at each follow-up. Complications, if any, were noted. All patients were medically managed for osteoporosis.

Results: Sixty patients were included from two centers, of which 42 were females, with a mean age of 68.67 years (range, 50 to 87 years) and an average lumbar spine T score of -3.0. Fifty-five out of the 60 patients presented with more than 1 month history of pain following the onset of neurologic symptoms. All patients had fractures at the thoracolumbar junction (T10–L2) except two who had fractures at L3 and L4. Ninety percent of the patients had more than 50% loss of vertebral height. They also presented with instability and retropulsion of fragments causing canal compromise. At presentation, 30 patients were Frankel grade D, 24 were Frankel grade C, and six were Frankel B. Twenty-four patients had short segment and 36 patients had long segment fixation. The mean time to follow-up was 13 months. With two early deaths, the patients had postoperative improvement in neurology by at least one grade; however, four patients plateaued after initial improvement. There was significant symptomatic improvement (mean VAS score reduced from 7.33 to 2.51) and improvement in functional score (mean ODI improved from 63.86 to 27.92). There were two cases of asymptomatic implant loosening at 3-year follow-up.

Conclusions: Indirect decompression and fixation with index vertebra augmentation is an effective method to treat osteoporotic burst fractures. It promises symptomatic, functional, and neurological improvement, especially in patients with more than 50% vertebral height loss.

E241

Dynamic computed tomography imaging of the cervical spine in patients with atlantoaxial instability

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Background: We proposed to evaluate more details of the facetal alignment and the implications of malalignment of facets by dynamic computed tomography (CT) imaging of the cervical spine in patients with atlantoaxial instability.
Methods: This retrospective study included 16 patients (nine males and seven females) with or without atlantoaxial instability. Radiography and CT were performed with the neck in the neutral position, flexed, and extended position. Magnetic resonance imaging was performed in the neutral position in all patients. Atlantodental interval (ADI) and dynamic changes in facet joint congruence were taken.
Results: In this study, dynamic CT was performed for 16 patients. Seven patients were diagnosed with atlantoaxial instability, eight cases were combined with Os Odontoideum, and five cases were associated with basilar invagination. Posterior instrumentation and fusion at only the C1–2 level were performed in nine patients. Whereas C1–2-level fixation and fusion using Margel's technique were performed in two patients with anomalous vertebral artery, and occipitocervical fusion combined with transoral anterior decompression was performed in five patients with basilar invagination. Another patient with a bilateral partial bony avulsion fracture of the transverse atlantal ligament, without atlantoaxial instability, received conservative treatment. All these patients showed good to excellent improvement after treatment at follow-up.
Conclusions: The alignment of the upper cervical spine may change significantly according to the neck position. Dynamic computerized tomography scans can provide useful, more detailed information for the diagnosis and management of atlantoaxial instability.

E242

Anterior cervical decompression and fusion with cervical uncinectomy for cervical radiculopathy with foraminal stenosis

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Background: This study aims to describe the technique for anterior cervical decompression and fusion (ACDF) with incomplete or complete uncinectomy for the management of cervical radiculopathy due to foraminal stenosis.
Methods: We retrospectively collected clinical and radiological data from June 2018 to June 2021. A total of 20 patients (30 segments) were included. In total, 30 disc levels were investigated. The mean follow-up duration was 6.1 months (range, 4.5–19.2 months). The Neck Disability Index (NDI) and Visual Analog Scale (VAS) scores for neck pain before surgery and at final follow-up were used to evaluate the clinical results. The occurrence of surgical complications, surgical time, and blood loss volume were also investigated.
Results: The mean VAS scores before surgery and at final follow-up were 6.6 and 1.5, respectively. The mean NDI before surgery was 0.38 and 0.08 at the final follow-up. The scores decreased significantly at the final follow-up ($p<0.01$). The mean surgical time and the mean blood loss volume were 125 minutes and 10 mL, respectively. There were significant improvements at the final follow-up. All patients were decompressed completely and had a good to excellent outcome.
Conclusions: The results in the present study were consistent with previous reports of ACDF with uncinectomy for cervical foraminotomy, especially when severe osseous foraminal stenosis accompanies other pathologies that require an anterior approach to the cervical spine. Despite completely decompressing the nerve due to bony foraminal stenosis, this technique performed well in the short-term, although longer-term follow-up is required.

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E250

Incidence of rare complications during and after lumbar spine surgery in Hong Kong

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Background: Rare complications (RC) in spine surgery are a class of serious but uncommon complications perioperatively and carry a significant risk of secondary complications, disability, and even death. However, due to their scarcity, their incidence is not well captured in the current literature. This study aims to investigate the actual incidence of RC among patients with lumbar spine surgery in two hospitals in Hong Kong preliminarily.

Methods: This was a retrospective study conducted in Queen Mary Hospital (QMH) and the Duchess of Kent Children's Hospital (DKCH) in Hong Kong. Patients aged 18 years and older who underwent surgeries involving the lumbar spine were collected from the content management system. The data collection period was from January 2022 to December 2023 in QMH and January 2022 to December 2022 in DKCH. RC in lumbar spine surgery is identified based on fourteen criteria.

Results: A total of 198 patients (83 males and 115 females) who underwent lumbar spine procedures were included. The mean age of this population was 60.8±17.9 years. Sixteen cases were diagnosed as RC, with a total incidence rate of 8.08%, including four postoperative symptomatic epidural hematomas or cauda equina syndrome requiring reoperation, one perioperative death, six misplaced pedicle screws requiring reoperation within 30 days, three implant fractures/failures, one re-herniation, and one iatrogenic pars fracture after lumbar decompression without fusion. There was no significant difference between RC and non-RC groups in terms of age (57.94±16.55 years vs. 61.09±17.97 years, p=0.501) and gender (χ^2=1.3604, p=0.244). In the univariable logistic models, two risk factors were identified in the preoperative diagnosis with positive adjusted odds ratios (OR): scoliosis (OR, 3.154; 95% CI, 1.064–9.042) and other diseases (including tumor, spine fracture, and epidural infection; OR, 0.091; 95% CI, 0.005–0.463; p=0.022). Notably, the procedure approach cohort did not show statistically significant differences in the development of any RC, except for transforaminal lumbar interbody fusion (TLIF) (OR, 6.225; 95% CI, 1.911–19.164; p=0.002).

Conclusions: Given that RC of lumbar spine surgery have not been systematically reported in the literature, our study makes the first contribution based on this important area. The overall incidence rate of RC for all procedure approaches was found to be 8.08%. Risk factors associated with RC include scoliosis, non-deformed preoperative diagnosis, and TLIF in vertebrae. Further research with a larger sample size is needed to obtain more reliable data on the incidence of RC during and after lumbar surgery, which can contribute to improving clinical management in such cases.

E251

Full endoscopic laminectomy: a more minimally invasive and muscle preserving treatment for cervical spondylotic myelopathy: a case series

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Background: Cervical extensor muscles are essential in maintaining cervical lordosis and preventing neck pain after laminoplasty. Various surgical techniques were developed to protect the functional musculature. We have described a posterior cervical muscle-preserving approach and decompression method under full endoscopy. We have also described the operation details and clinical outcomes of selected patients who underwent this technique.

Methods: The endoscopic and decompression approaches were performed on 20 patients with central cervical stenosis. Our procedure includes exposure of the interspinous space, modified to Shiraishi's technique.

Results: There were no complications; no patient required conversion to open laminoplasty. The mean operating time per level was 63 minutes, blood loss was minimal, and the length of hospital stay was just 4 days. The modified Japanese Orthopedic Association scores at 3 months postoperative were significantly different from preoperative scores. The postoperative Neck Visual Analog Scale score was 0.9. There was no significant difference in pre- and postoperative cervical lordosis.

Conclusions: The modified Shiraishi's endoscopic approach and decompression were minimally invasive. It is safe and effective for treating central stenosis caused by cervical spondylotic myelopathy in selected patients.

E253

5-year radiological outcomes between decompression alone and decompression with an interlaminar device for lumbar spinal stenosis

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Background: Spinopelvic parameters are known to be predictors of good clinical outcomes. There is limited literature regarding radiological outcomes in the use of interlaminar devices (ILD) compared to decompression alone for symptomatic lumbar spinal stenosis (LSS). This study aims to assess and compare 5-year radiological outcomes following uninstrumented spinal decompression and decompression with ILD.

Methods: We conducted a retrospective review of prospectively collected data of 94 patients who underwent spinal decompression with or without ILD insertion between 2007–2015. Patients with symptomatic LSS who met the study criteria were offered spinal decompression with or without ILD insertion. Those patients who accepted ILD insertion were placed in the D+ILD group (n=39); while those opting for decompression alone were placed in the DA group (n=55). Radiological indices were assessed preoperatively, immediately postoperatively, and at 2 years and 5 years postoperatively using standardized, erect anteroposterior and lateral lumbosacral radiographs. To promote standardization, pictorial charts demonstrating the standing posture and reinforced through standardized verbal instructions were given by the radiographer. Radiological indices were categorized into three groups. First, sagittal balance was accounted for using standard measurements—pelvic incidence (PI), pelvic tilt (PT), and sacral slope (SS). Second, lumbar lordosis (LL) was measured by overall lordosis (from lumbar one to sacral one) and sagittal angle (at the index segment). Third, intervertebral height was measured through anterior disc height, posterior disc height, and foraminal height.

Results: There was a total of 94 patients, with 55 in the DA group and 39 in the D+ILD group. In both the DA and D+ILD groups, there was no significant change postoperatively in the sagittal balance parameters—mean PI, PT, SS, and PI–LL during the 5-year follow-up. Comparing between the groups, there was no significant difference in sagittal balance parameters. Comparing DA versus D+ILD, there was no significant difference in overall lordosis, but the D+ILD group had a significant reduction in sagittal angle (at the index level) of 2.3° compared to the DA group (p=0.01). In the control group, there was no significant difference in the anterior disc, posterior disc, and foraminal height postoperatively. In the D+ILD group, there was a significant mean increase of 1.3 mm in anterior disc height, 1.8 mm in posterior disc height, and 4.7 mm in foraminal height compared to the control group. In both the DA and D+ILD groups, there was significant improvement postoperatively in all clinical outcomes, namely, 36-item Short Form Health Survey (SF-36) physical component summary (PCS), mental component summary (MCS), and Visual Analog Scale (VAS). Comparing the groups, there was significant improvement in the D+ILD group in SF-36 MCS (p=0.01) but no difference in SF-36 PCS or VAS. Reoperation rates were equivalent.

Conclusions: Our study found that in the management of lumbar stenosis, the use of an interlaminar device compared to decompression alone had significant improvement in anterior disc, posterior disc, and foraminal height with expected focal kyphosis at the level of intervention without change in sagittal balance at the 5-year timepoint. The interlaminar group had, in addition, significant improvement in SF-36 MCS scores. The rest of the radiological parameters were comparable.

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E254

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

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Background: A 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 computed tomography (CT) scans are performed routinely in cancer patients, and high-grade MESCC is often underdiagnosed 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 the potential reduction in diagnostic delays.

Methods: This is a retrospective review of 140 patients who underwent surgical decompression and stabilization for MESCC between January 2015 to January 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 magnetic resonance imaging (MRI) was reviewed by a consultant musculoskeletal radiologist (J.H.) and consultant spinal surgeon (J.T.) and classified into cases with and without high-grade MESCC. A previously validated DLM was then used to classify these scans. Their findings were then compared to the original radiologist reports. Inter-rater agreement was assessed. A potential decrease in diagnostic delay was calculated in days from screening CT to the first MRI scan diagnosing high-grade MESCC.

Results: Preoperative CT scans were available for 95 out of 140 patients (67.8%). High-grade MESCC was identified in 84/95 (88.4%) of the preoperative CT scans by two authors (J.H. and J.T.). High-grade MESCC was reported in only 32/95 (33.7%) of preoperative scans by the original radiologist. There was almost perfect agreement between J.H. vs. J.T. (kappa, 0.947; 95% confidence interval [CI], 0.893–1.000; $p<0.001$), J.H. vs. DLM (kappa, 0.891; 95% CI, 0.816–0.967; $p<0.001$), and J.T. vs. DLM (kappa, 0.891; 95% CI, 0.816–0.967; $p<0.001$). There was poor interobserver agreement between the original radiologist and all other readers (kappa, between 0.021 to 0.125). There was a mean potential reduction in diagnostic delay of 19 days.

Conclusions: There was a high incidence of undiagnosed high-grade MESCC in the original radiologist 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.

E255

Predicting the radiographic correction of spondylolisthesis following oblique lateral interbody fusion

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Background: When managing lumbar spondylolisthesis with posterior fusion techniques, prone traction radiographs have been shown to be superior to flexion-extension views when correlating and predicting postoperative changes in several radiological parameters. However, advances in lateral approaches such as the oblique lateral interbody fusion (OLIF) have seen patients achieving greater restorations in lordosis, discal, and foraminal height as opposed to posterior approaches. With the uniqueness in outcomes achieved by this technique, the study aims to investigate whether prone traction radiographs maintain their utility over conventional flexion-extension views when predicting the radiological correction of spondylolisthesis treated with lateral interbody fusions.

Methods: From January 2016 to February 2023, 45 consecutive patients (62 lumbar levels) who underwent OLIF for lumbar spondylolisthesis were retrospectively

reviewed. In all patients, preoperative lateral prone traction, standing, flexion-extension radiographs were obtained, with the degree of slip, slip angle, mid-discal, and foraminal height measured in all views. Spearman's rank correlation was used to identify preoperative features that significantly correlated with immediate postoperative changes in radiological outcomes; this was followed by regression and curve estimation to assess the predictive ability of different parameters.

Results: Lumbar levels treated with OLIF saw a mean 2.4% (standard deviation [SD]=6.8%) and 0.1% (SD=0.2%) percentage increase in discal and foraminal height, respectively, as well as a 0.9% (SD=3.3%) increase in the lordotic slip angle. The degree of slip was reduced by an average of 9.6% (SD=8.4%). These postoperative changes in disc height (Spearman's rank correlation coefficient [rs]=0.706, $p<0.001$), slip angle (rs=0.702, $p<0.001$), and degree of slip (rs=0.640, $p<0.001$) significantly and best correlated with measurements obtained from prone traction radiographs. The postoperative change in foraminal height significantly correlated with preoperative prone traction films (rs=0.348, $p=0.006$), but best correlated with extension radiographs (rs=0.352, $p=0.005$). Regression analysis and scatter plots showed that postoperative corrections in disc height (Akaike information criterion corrected for small sample sizes [AICc]=19.061, $p<0.001$, $R^2=0.996$), slip angle (AICc=234.425, $p<0.001$, $R^2=0.621$), degree of slip (AICc=4.6498, $p<0.001$, $R^2=0.429$), and foraminal height (AICc=5.4908, $p=0.002$, $R^2=0.222$) were all significant and best predicted by prone traction radiographs.

Conclusions: Following the use of OLIF in lumbar spondylolisthesis, extension radiographs best correlate with the postoperative corrections in foraminal height, while prone traction radiographs best correlate with postoperative corrections in disc height, slip angle, and degree of slip. Prone traction radiographs also offer the most accurate prediction of postoperative improvements in disc height, slip angle, degree of slip, and foraminal height.

E256

NiTinol shape memory smart implants in spine surgery: a review of precise three-dimensional printing, biocompatibility, potential clinical and surgical applications

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Background: The growing prevalence of spine diseases and the subsequent increase in surgeries have prompted innovations in implants and instruments. However, the selection of the right implant is critical due to the unique mechanics of the spine. Specifically, spinal implants necessitate exceptional properties such as biocompatibility, super-elasticity, strength, and fatigue resistance, similar to the characteristics of NiTinol shape memory smart implants. Yet, the precise design of NiTinol implants for clinical practice remains challenging. Three-dimensional (3D) printing has emerged as a promising solution to customize implants according to individual medical requirements. Our objective is to assess the current status of shape memory NiTinol in clinical use within orthopedic and spinal surgery. Additionally, we aim to investigate the future potential of these materials in the clinical fields. We also aim to thoroughly explore the opportunities and challenges tied to 3D printing NiTinol "smart" components for biomedical implants, bridging various facets, including biocompatibility, clinical applications, and insights from existing literature. We aim to centralize this critical information, serving as a valuable resource for both surgeons and engineers.

Methods: The review comprehensively investigates 3D printed NiTinol implants, analyzing literature from 2000 to the present (11/2023) with search terms "NiTinol alloys for spine implants" and "3D printed NiTinol alloys for spine implants." Utilizing tools like "Origin Pro," the analysis indicates a notable surge in publications related to NiTinol implants, highlighting the growing influence of 3D printed NiTinol shape memory implants.

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Results: Significant advancements have been achieved in NiTinol biomedical implants, encompassing NiTinol staples, interbody fusion cages, rods, and expandable pedicle screws. These developments ensure both biocompatibility and safety. Notably, the use of NiTinol rods has facilitated minimally invasive techniques, allowing for compact delivery and subsequent expansion upon placement.
Discussion: This review illuminates the potential and challenges associated with utilizing 3D printing for NiTinol smart components in biomedical implants. It consolidates existing knowledge, underscoring the significance of these implants for medical practitioners and researchers. However, the need for further *in vivo* studies to assess the long-term systemic effects of these "smart" implants across diverse patient groups is emphasized. The 3D printed NiTinol "smart" biomedical implants play a crucial role in addressing gaps in various aspects of NiTinol implants, particularly in terms of biocompatibility and clinical applications.
Conclusions: The application of NiTinol implants through 3D printing demonstrates considerable promise in spinal surgery. Modified NiTinol variations, featuring diverse nickel and titanium compositions, show promising outcomes for patients. However, comprehensive *in vivo* studies encompassing diverse patient groups are essential to comprehensively understand the long-term systemic effects of these implants. Despite the advancements above, substantial research remains indispensable to precisely identify and improve implant materials in alignment with the evolving requirements of future patients requiring spinal instrumentation.

E257

Biportal endoscopic lumbar interbody fusion: techniques and outcomes

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Background: Spinal endoscopy has been extensively developed and has been used for procedures ranging from simple decompression to spinal fusion. Biportal endoscopic spine surgery (BESS) provides detailed visualization of the surgical view, as well as flexible and independent instrument handling, allowing surgeons to perform fusion. This technique is believed to be an option for reducing damage to normal structures and achieving faster recovery after surgery. However, mastering this technique requires overcoming some challenging steps. Our purpose is to provide a technical description and report the outcomes of biportal endoscopic lumbar interbody fusion.
Methods: Surgery was performed on patients with lumbar spondylosis or spondylolisthesis who met the indication. The interbody cage was inserted posterolaterally after removing the inferior articular process. Percutaneous pedicle screws were added after the insertion of the cage. The patients were then monitored from the initial procedure to 12 months following surgery. The outcome parameters that we used are the Visual Analog Scale (VAS), the Oswestry Disability Index (ODI) score, and the fusion rate using the Girasole criteria.
Results: Forty patients have successfully undergone biportal endoscopic lumbar interbody fusion. Following surgery, the VAS of radicular pain significantly decreased from the initial level, and back pain significantly reduced within weeks to 1 month. The ODI score improved within weeks to 3 months. The fusion rate at 1-year postoperative follow-up was 80%.
Conclusions: Biportal endoscopy has emerged as an option to assist minimally invasive lumbar fusion. A satisfactory result was achieved with a decrease in VAS and ODI scores during follow-up. A good understanding of anatomical configuration, detailed technique, and common pitfalls is important to perform the surgery properly. Further development might be required to achieve an even higher fusion rate.

E258

Experience using carbon fiber reinforced polyether ether ketone implants in metastatic and primary spine tumor surgery: a single center experience

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Background: Titanium is the implant material of choice used in operative fixation in both metastatic (metastatic

spine tumor surgery [MSTS]) and primary spine tumor surgery. However, these titanium implants result in artifact generation during postoperative imaging modalities such as computed tomography and magnetic resonance imaging scans, resulting in poor radiotherapy planning, suboptimal tumor surveillance, and inadequate care for the patients. Carbon fiber reinforced polyether ether ketone (CFR-PEEK) implants (e.g., Icotec) were developed for specific use in MSTS and primary spine tumor surgery. Advantages include generating less artifact in imaging, which allows for better evaluation of complications and monitoring of disease recurrence. This also results in less backscatter of radiation during radiotherapy, which improves the efficacy of treatment. This in turn does not sacrifice the biomechanical strength of the implants as it has been shown to be comparable to titanium implants. There is also the added benefit of having a modulus of elasticity closer to bone, thereby reducing the risk of implant-related problems. However, it is to be noted that using CFR-PEEK implants is technically more challenging, with greater difficulty in the insertion of the screws. This is greatly affected by the surgeon's experience with the implants, which may be limited due to the recent introduction of CFR-PEEK implants. Smaller case series have shown favorable outcomes in patients undergoing surgery with CFR-PEEK implants, with a few studies showing the potential radiotherapy benefits. In this study, we aim to review our 2-year clinical and radiological outcomes of 20 patients who underwent spine tumor surgery using Icotec.

Methods: Twenty patients were recruited from a single institution who underwent MSTS and primary spinal tumor surgery using Icotec implants from 2020 to 2024. Patient data, including demographics, operative details, clinical outcomes, and radiological data, were collected.

Results: A total of 20 patients were recruited in this study. Five (25.0%) of the patients underwent hybrid spinal fixation, while the remaining 15 (75.0%) underwent spinal fixation solely using Icotec implants. The mean age of the patients was 63.6, with males to females in a ratio of 1:1. The mean duration of survival post-spinal operation was 292 days. Eleven patients underwent postoperative radiotherapy after a mean duration of 30.7 days, with only 1 (9.1%) patient undergoing stereotactic body radiation therapy, while the other 10 patients underwent conventional radiotherapy. Two patients had postoperative complications. One patient experienced screw loosening and underwent revision surgery for the removal of implants about 6 months post-index spinal surgery. The other patient developed wound dehiscence 2 months post-index surgery and after adjuvant radiotherapy. One patient was noted to not have a spinal tumor after intraoperative histopathology reviewed benign findings of the suspected pathological fracture.

Conclusions: CFR-PEEK implants display promising outcomes in improved radiotherapy planning, better tumor surveillance, and safety. The benefits of the CFR-PEEK implants appear to outweigh the operative drawbacks, with low complication rates shown in our study.

E259

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

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Background: Delayed treatment in symptomatic metastatic epidural spinal cord compression (MESCC) is significantly associated with poorer functional outcomes. In this study, we aim to identify the patterns of treatment delay in patients and factors predictive of postoperative ambulatory function.

Methods: We conducted a retrospective review of patients with symptomatic MESCC treated surgically between January 2015 and January 2022. MESCC symptoms were categorized into those suggesting cord compression requiring immediate referral and those suggestive of spinal metastases. Multivariate analysis was performed to identify factors predictive of postoperative 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), and compared between patients.

Results: We identified 178 patients. In this cohort, 92 patients (52.0%) were able to ambulate independently, and 86 (48.3%) patients were non-independent. Among

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them, 139 patients (78.1%) had symptoms of cord compression, and 93 (52.3%) had neurological deficits on presentation. On multivariate analysis, preoperative neurological deficits (p=0.01) and symptoms of cord compression (p=0.01) were significantly associated with postoperative ambulatory function. The mean total delay was 66 days, with patient delay at 41 days, diagnostic delay at 16 days, referral delay at 3 days, and surgical delay at 6 days. In patients with neurological deficits, there was a significant decrease in all forms of treatment delay (p<0.05). There was no significant decrease in patient delay, diagnostic delay, and referral delay in patients with symptoms of cord compression.

Conclusions: Both patients and physicians understand the need for urgent surgical treatment of MESCC with neurological deficits; however, there is still a need for increased education and recognition of the symptoms of MESCC.

E262

Prone transpsoas lateral lumbar interbody fusion: segmental lordosis and patient reported outcome measures in case series comparable to current literature

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Background: Lateral lumbar interbody fusion (LLIF) is a well-published procedure initially described by Pimenta and his colleagues in 2006. It is an effective and safe technique, and the procedure can be used to treat various lumbar disorders. LLIF is a minimally invasive surgery (MIS) that reduces posterior muscle damage and relieves neurological symptoms through indirect decompression. The literature has shown that LLIF provides the opportunity to affect an inherently biomechanically stable fusion environment, with the ability to implant wider cages with greater area for bone graft. LLIF achieves excellent disc and foraminal height restoration and quick recovery due to reduced morbidity of the MIS retroperitoneal access. LLIF also promotes more significant segmental lordosis than standard posterior techniques. More recently, prone transpsoas (PTP)-LLIF has been introduced as a modification to standard LLIF. The transpsoas approach provides access to the lumbar spine with predictable anatomy and obviates the need for an access surgeon. Being prone offers a more familiar position with less time-consuming initial positioning. Additional time is saved with the ability to perform additional posterior surgical procedures without repositioning the patient intraoperatively. Simultaneous access to the lateral and posterior approaches is also easily achieved. Prone positioning has also been shown to improve lumbar lordosis. This study aims to compare the segmental lordosis of the patients in the case series post-PTP-LLIF with the data available in the current literature. Objective and quantifiable assessments are also carried out to measure the outcomes of the patients.

Methods: This is a prospective cohort study carried out in two institutions by three surgeons in Australia. The inclusion criteria are patients undergoing PTP-LLIF surgery, with lateral profile X-rays at baseline preoperatively and postoperatively. The patients received surgery from one of the three surgeons in the two institutions. The exclusion criteria were patients with low-quality X-rays that do not allow adequate measurements, patients with subsidence >25% at the follow-up and patients with non-degenerative pathologies. The prone transpsoas technique was performed according to the article by Pimenta and his colleagues in 2020. The selected patients did not receive any osteotomy or anterior longitudinal ligament release. All the patients received posterior instrumentation with pedicle screws. Pre- and postoperative sagittal alignment were measured on the lateral profile erect X-rays using commercially available software. Oswestry Disability Index (ODI), Visual Analog Scale (VAS), and EuroQol 5-dimensional-5 levels (EQ-5D-5L) index were obtained pre- and postoperatively. The segmental lordosis measurements are compared to the available data in the current literature.

Results: Thirty patients were included in the analysis. There is an improvement in the segmental lordosis after PTP-LLIF, comparable with the current literature. There is also an improvement in ODI, VAS, and EQ-5D-5L from preoperative to postoperative.

Conclusions: In this case series, PTP-LLIF provides improved segmental lordosis comparable to current literature. The results also demonstrate that the patients have improved patient reported outcome measures.

E265

Use of diffusion tensor imaging magnetic resonance imaging in evaluating lumbar spinal stenosis: a systematic review and meta-analysis

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Background: Lumbar spinal stenosis (LSS) is a common condition in the elderly, causing chronic pain and decreased quality of life. Traditional imaging techniques can fall short in understanding the microstructural changes occurring within the spinal cord and adjacent structures. Diffusion tensor imaging (DTI) is a specialized magnetic resonance imaging (MRI) technique that can provide better insights into the microstructural properties of biological tissues, particularly the nervous system. DTI can potentially revolutionize how clinicians understand and diagnose LSS.
Methods: The study used the PRISMA (Preferred Reporting Items for Systematic Review and Meta-analyses) guidelines for reporting. The lists of published articles were obtained using Medline via PubMed, Cochrane Central Register of Controlled Trials, Herding Plus, Embase, and Google Scholar from inception of the database until the first quarter of 2024. All articles included in this study are case-control or cohort studies. Quality assessment was done using the Newcastle-Ottawa Scale for observational studies. We reported the raw data and calculated relative risks (RRs) or odds ratios (OR) and their 95% confidence intervals (CIs) if not provided by the authors. The data was presented in summary tables and forest plots with diagnostic test Q-statistics and I^2 for heterogeneity. The GRADE (Grades of Recommendation, Assessment, Development, and Evaluation) approach was used to evaluate the overall quality of the evidence.
Results: The study reviewed 86 studies and shortlisted 14 eligible studies. Meta-analysis was done with only eight studies. This meta-analysis included 615 patients. DTI-derived fractional anisotropy (FA) values may differ between symptomatic and asymptomatic LSS patients, with the asymptomatic group having higher FA values, indicating superior microstructural integrity. However, FA values vary throughout research, which may be impacted by sample size, patient characteristics, and DTI acquisition procedures. More studies and meta-analyses are needed to explain these findings and determine the clinical value of DTI in assessing LSS. Out of the 258 samples from the symptomatic group and 357 samples from the asymptomatic group, the result shows that the mean difference is 0.05 (95% CI, 0.09 to 0.04) in favor of the asymptomatic patients having larger FA values compared to symptomatic patients. However, there is significant heterogeneity among the results presented by the study as evident by the significant tau-square and chi-square values (τ^2<0.01, χ^2=184.49, degrees of freedom=7, p>0.01). The I^2=96% also indicated a very high heterogeneity score further describing the significant difference in the values being presented.
Conclusions: Generally, the studies demonstrate lower average FA values in symptomatic LSS patients than in asymptomatic individuals. This suggests that DTI can detect microstructural changes in nerves compromised by spinal stenosis. There is some variation in FA values across studies. This could be due to differences in patient populations, DTI techniques, and severity of LSS. The findings highlight the potential of DTI to complement traditional MRI for diagnosing LSS. It can provide additional insights into nerve damage, potentially helping to confirm diagnosis. DTI could support MRI findings in cases of suspected LSS. FA values might correlate with the severity of nerve compression, guiding treatment choices. DTI might be used to track nerve recovery after surgical or conservative LSS treatment.

E266

Cortical bone trajectory technique minimizes surgical invasiveness in adjacent segment disease

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Background: Cortical bone trajectory (CBT) screw methodology has been used in adjacent segment disease of the lumbar spine when extension of the pre-existing instrumentation column was required. Decompression and stabilization can be done via minimal

access and did not require removal of the original instrumentation.
Methods: Fifteen patients with single-level adjacent segment disease at the cephalad end of previous instrumented lumbar fusion were studied from 2016 until 2021. They were followed up for a minimum of 24 months. Parameters studied included clinical signs of instability and radiographic imaging; radiographs and computed tomograms. Ten of these patients were elderly, and of these, seven had bone density T-scores worse than or equal to -2.5. All patients were operated upon by the same surgeon.
Results: After surgery, all patients experienced improved physical function and relieved clinical symptoms. Follow-up imaging did not reveal any implant loosening or implant failure. At the end of 24 months or more, fourteen patients displayed evidence of radiographic fusion. The sole patient who did not, remained clinically well, resuming the preoperative level of physical activity. From our small series of patients, it is proposed that (1) this technique is suitable for handling adjacent level syndromes cephalad to the original construct. A caudal lesion would experience physical stresses from a long cephalad stiff fusion moment arm. (2) Physical integrity of the cephalad two last instrumented vertebrae (LIV) must be ascertained to prevent insufficiency fracture of the corpus. It is not advisable to have multiple attempts, potentially weakening the original LIV. (3) Interbody fusion is likely required to reduce the possibility of a recurring failure/non-fusion. (4) This technique would face technical difficulty if the cephalad LIV is thoracic, with challenges increasing with ascending thoracic level. Beyond T10, its feasibility becomes very limited.
Conclusions: The CBT technique appears to be a viable option for use when faced with adjacent segment disease that requires extension of the pre-existing instrumentation. We are still in the process of curating a statistically meaningful number of cases before we can submit a stronger statement.

E270

Efficacy and safety of lumbopelvic fixation in spinal metastasis comparing S2 alar-iliac screw and conventional iliac screw

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Background: There are two screw methods used in the lumbopelvic fixation procedure—the conventional iliac (CI) screw and the S2 alar iliac (S2AI) screw. Research is limited in comparing their effectiveness for spinal metastasis patients. It is important to choose the right method based on the patient's needs and spinal condition for optimal safety and effectiveness. This study aimed to compare the effectiveness of the CI screw technique and the S2AI screw technique in spinal metastasis patients.
Methods: A retrospective chart review analyzed 38 patients with spinal metastasis from April 2014 to April 2022 who indicated lumbopelvic fixation surgery. Twenty-one patients had S2AI screws. Seventeen patients had CI screws. Various demographic and clinical data, including age, gender, body mass index, primary cancer origin, spinal region involvement, reoperation, operative time, estimated blood loss, navigator use, complications, length of stay, and survival time were collected.
Results: The S2AI group had lower estimated blood loss and shorter operative time, although the differences were not statistically significant (estimated blood loss: 1,073.53±1,122.45 mL in the CI screw group vs. 592.86 mL in the S2AI group, p=0.137; operative time: 207.06±105.69 minutes in the CI screw group vs. 181.19±47.35 minutes in the S2AI screw group). Length of stay was statistically lower in the S2AI screw group than in the CI screw group (24.35±21.59 days in the CI screw group vs. 13.38±8.35 days in the S2AI screw group). There were two cases in the CI screw group without navigation use (N=13). The cause of reoperation was a broken rod in two cases.
Conclusions: The S2AI technique did not show statistically significant differences when compared to the CI screw technique in rates of reoperation, estimated blood loss, and operative time. Interestingly, there was a statistically significant reduction in the length of hospital stay with the S2AI technique. Using navigation

during surgery has the potential to lower the need for further operations, but more data is required to make a definitive conclusion.

E271

Assessment of osteoporosis using magnetic resonance imaging: is dual-energy X-ray absorptiometry ready for retirement?

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Background: Dual-energy X-ray absorptiometry (DXA) is recommended by the World Health Organization for osteoporosis screening as a diagnostic tool with a high prevalence of false increases in the bone mineral density value, masking the real situation of cancellous bone in the spine. Our aim was to assess the value of vertebral bone quality (VBQ) scores, muscle fat index (MFI), and cross-sectional area (CSA) of the paraspinal and psoas using conventional magnetic resonance imaging (MRI) to assess the severity of osteoporosis and the risk of osteoporotic fracture.
Methods: A retrospective analysis was conducted on 157 patients who had undergone both DXA and MRI of the lumbar spine; they were divided into normal, osteopenia, and osteoporosis groups based on the DXA score. The L1–L4 vertebral body and L3 cerebrospinal fluid signal intensities in the sagittal T1-weighted lumbar MRI image were used to calculate the VBQ scores. Using axial T2-weighted images, the MFI and CSA of paraspinal and psoas muscles were calculated. MFI was calculated as the mean signal intensity of the psoas muscle divided by that of the multifidus (MF) and erector spinae (ES) at the upper endplate at L1, L2, and L3. The VBQ, MFI, and CSA were compared across the groups (normal, osteopenia, and osteoporosis) using one-way analysis of variance. Post-hoc pairwise testing was done using Bonferroni's method. The CSA of ES and MF were averaged across sides before comparing between groups. These were also compared between fracture and non-fracture groups using a two-sample t-test. The associations between the MRI scores and DXA scores were estimated by calculating Pearson's correlation coefficient and drawing scatterplots. All tests were tested for $p<0.05$ for significance. The tests were done using NCSS statistical software.
Results: Of the 157 patients, 36 had vertebral fractures. The mean age of patients was 62.4 years (range, 38–82 years), with 93.8% being female. The mean VBQ in the normal, osteopenia, and osteoporosis groups were 2.78, 3.14, and 3.7, respectively ($p=0.003$). The mean MFI was 0.559, 0.573, and 0.576 ($p=0.935$). The fracture group had a VBQ of 3.77 compared to the non-fracture group (3.09) ($p=0.005$). The CSA of the psoas muscle was significantly lower (6.412 $cm^{2)}$ in the osteoporosis group compared to the normal group (8.970 cm^2) ($p=0.002$). There was no significant difference between the CSA of paraspinal muscles (ES and MF) between the normal and osteoporosis groups.
Conclusions: It was found in our study that a higher VBQ and lower CSA of the psoas muscle are significantly associated with osteoporosis. There was no difference between MFI and CSA of paraspinal muscles between all groups. The fracture group had significantly higher VBQ than the non-fracture group.

E272

Analysis of surgical strategies for two cases of ankylosing spondylitis kyphosis complicated by anterior dural ectasia/spinal cord herniation

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Background: Ankylosing spondylitis (AS) complicated by anterior dural ectasia (ADE) or spinal cord herniation (SCH) is rare in clinical practice, with an incidence rate of approximately 0.25%. There have been no reported cases of successful correction surgery for AS kyphosis complicated by ADE/SCH. Currently, two cases have been identified in which nerve damage leading to decreased muscle strength in the lower limbs occurred during surgery. It is crucial to promptly identify such rare complications, formulate rational surgical plans, and avoid nerve damage.
Methods: Comparative analysis of the diagnosis, surgical strategy formulation, and intraoperative and postoperative findings of two AS kyphosis patients complicated by ADE/SCH in our department, combined with a review of previous cases from other hospitals, was

conducted to summarize the diagnostic and treatment essentials and surgical experience for such patients.
Results: Case 1: A 39-year-old male diagnosed with "ankylosing spondylitis kyphosis" upon admission. Preoperative sensation and muscle strength in both lower limbs were normal, and X-rays and computed tomography (CT) scans showed no abnormalities. Due to positioning limitations, magnetic resonance imaging (MRI) examination was not completed. L1 pedicle subtraction osteotomy (PSO) correction was performed, with intraoperative cerebrospinal fluid leakage at the osteotomy site and severe adhesion of the spinal cord nerves, leading to herniation. Postoperatively, there was a decrease in muscle strength in the left lower limb (grade I in the tibialis anterior muscle and grade I in the extensor hallucis longus muscle). Reviewing the patient's CT scan revealed slight osteolytic defects at the posterior margins of the T12 and L1 vertebrae. Combined with intraoperative findings, a diagnosis of "spinal cord herniation" was considered. Partial recovery of muscle strength was noted upon discharge (grade III in the tibialis anterior muscle and grade IV in the extensor hallucis longus muscle). Case 2: A 33-year-old male diagnosed with "ankylosing spondylitis kyphosis" upon admission. Preoperative sensation and muscle strength in both lower limbs were normal. CT scans showed significant osteolytic defects at the posterior margins of the L1 and L2 vertebrae, and MRI revealed cerebrospinal fluid signals within the osteolytic defects of the L1 and L2 vertebrae, with partial herniation of the spinal cord and cauda equina nerves, leading to a diagnosis of "ADE." Surgical strategy: Avoiding the segments with ADE at L1 and L2, T11 and L3 PSO correction was performed. Intraoperative nerve monitoring was normal, and postoperatively, sensation and muscle strength in both lower limbs remained the same as preoperatively, with good correction results. One-year postoperative MRI follow-up showed a reduction in ADE compared to before.
Conclusions: Patients undergoing corrective surgery for AS kyphotic deformity should be vigilant for the rare occurrence of ADE/SCH. Even with mild ADE/SCH, misdiagnosis and direct osteotomy at the affected vertebra can lead to serious nerve damage. If MRI examination is not feasible due to positioning limitations, routine careful examination of CT scans is necessary. If ADE/SCH is suspected, osteotomy should be avoided at suspicious segments. For AS patients with confirmed ADE/SCH, avoiding the affected segments and performing 1–2 osteotomies based on the severity of the kyphosis is a safe and feasible surgical strategy.

E277

Three-dimensional printing to aid dystrophic scoliosis correction in neurofibromatosis

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Background: Neurofibromatosis is associated with severe dystrophic scoliosis with short sharp curves and severe rotation of the apex vertebra. Dural ectasia causes expansive and erosive deformity resulting in vertebral scalloping and spinal canal widening. This makes pedicle screw placement, as well as performing corrective osteotomies, challenging. Three-dimensional (3D) printing has been reported to be a useful adjunct in spine surgery. We present two patients with Neurofibromatosis type 1 and dystrophic scoliosis where the use of preoperative 3D printing improved surgical planning for a safer correction of their deformities.
Results: Patient 1 was a 21-year-old male with previous spinal instrumentation at 6 years of age. Severe left lumbar kyphoscoliosis was noted, causing skin tenting. Radiographs showed a Cobb's angle of 107° from T12 to L5. He underwent L3–4 and L4–5 discectomy, removal of implants, and application of a halo. The second stage surgery involved a left anterior thoracotomy with 5th rib resection, T3 to T9 anterior releases, and discectomy with insertion of pedicle screws from T2 to T9 and sublaminar bands passed under T5. Four Smith-Petersen osteotomies were performed from T4 to T9 with vertebral column resection of L1–3. Three weeks later, the patient underwent the third and final stage surgery comprising vertebral body resection from L1 to L4, laminectomy of T12, and correction of scoliosis from T2 to the ilium with rod placement. Patient 2 was a 50-year-old female with right-sided lumbar kyphoscoliosis. Radiographs showed a Cobb's angle of 78 degrees from T12 to L3. She underwent anterior lumbar interbody fusion from L3 to S1 with interbody cages and application of a halo frame. An interval second stage posterior instrumentation and correction of scoliosis from T9 to the ilium was performed with symmetric pedicle subtraction osteotomy at L2 with multiple Smith-Petersen osteotomies from T8 to L3.
Conclusions: In these two cases, 3D printing helped us plan and select levels to instrument, avoiding thinned pedicles, yet maintaining adequate screw density. It al-

lowed us to plan osteotomy cuts at the thinnest parts of the bone, aided visual and tactile verification of bony anatomy intraoperatively, and identified landmarks to localize the entry points for releases and bone cuts.

E278

Long-term radiographic outcome of corrective fusion surgery for adolescent idiopathic scoliosis Lenke type 1–3

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Background: In this study, we investigated the long-term radiographic changes in coronal balance in patients with adolescent idiopathic scoliosis (AIS) Lenke types 1–3.
Methods: This study included 25 patients with AIS Lenke types 1–3 who underwent corrective fusion surgery (mean age, 14.9±2.7 years; 24 females; mean follow-up period, 8.0±2.0 years; type 1: 18 patients, type 2: four patients, type 3: three patients). The convex rod rotation maneuver was performed intraoperatively in all patients. Whole spine X-rays were taken preoperatively, 1 week postoperatively, 2 years postoperatively, and at the final follow-up to measure the radiographic shoulder height (RSH), C7 plumb line–central sacral vertical line (coronal vertical axis [CVA]), which are key parameters of coronal plane balance, L4 tilt, lower instrumented vertebra (LIV) tilt, and the disc wedging angle below LIV (discal disc wedging [DDW]). Postoperative shoulder imbalance (PSI) (+) was defined as RSH >10 mm, and PSI (++) as RSH >20 mm. Postoperative coronal imbalance (CIB) was defined as CVA >25 mm.
Results: (In the following order: preoperative, 1 week postoperative, 2 years postoperative, and final follow-up) The mean Cobb angle of the main thoracic curve was 52.9°, 12.5°, 17.4°, and 17.8°, and the correction rate at 1 week postoperatively was 76%. RSH was 18.2, 11.8, 9.9, and 7.9 mm, CVA was 10.3, 16.2, 7.1, and 6.6 mm, L4 tilt was 8.9°, 4.7°, 5.0°, and 4.6°, LIV tilt was 16.6°, 4.0°, 4.1°, and 3.4°, and DDW was 5.0°, 3.0°, 4.2°, and 4.4°. At the final follow-up, PSI (+) was observed in five patients (20%), PSI (++) in one patient (4%), and CIB in one patient (4%). There were two cases in which DDW worsened during follow-up and remained more than 10°. One case had worsening DDW due to the compensation of PSI, and the other due to the development of distal adding-on.
Conclusions: Shoulder balance and coronal balance were maintained or slightly improved in the long-term follow-up in the AIS Lenke types 1–3 patients. However, our investigation could suggest that PSI and distal addition-on might be related to disc degeneration below the LIV.

E279

Risk factors for adjacent segment disease after lateral lumbar interbody fusion for lumbar spinal canal stenosis with instability

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Background: Lateral lumbar intervertebral fusion (LLIF) has been shown to be more effective for indirect decompression by opening the intervertebral space with a larger intervertebral cage, while excessive lifting of the intervertebral space in posterior intervertebral fusion has been reported to be a risk factor for adjacent segment disorders (ASD). The purpose of this study was to investigate risk factors for ASD in LLIF with a focus on intervertebral lifting.
Methods: This study included 76 patients who underwent single-level LLIF and posterior percutaneous pedicle screw fusion for lumbar spinal canal stenosis with instability since July 2014 at our department and who were followed up for at least 2 years after surgery. The evaluation items included age, gender, body mass index, femoral bone density, and comorbidities as patient background, surgical technique, upper instrumented vertebra, and lower instrumented vertebra as surgery-related factors, presence of ASD at the last follow-up, cage factors (placement position from the anterior edge of the lower vertebra, anterior height, cage length), local lordotic angle of the fixed vertebra, and elevation distance between the fixed vertebral body, preoperative and 2-year postoperative sagittal and coronal parameters of each whole spine as radiographic evaluation, and Japanese Orthopaedic Association (JOA) scores at preoperative and last follow-up as clinical outcomes.

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Statistical analysis involved the use of Cox proportional hazards analysis, and ASD was defined as a decrease in intervertebral height of 3 mm or more on simple lateral X-ray images, the appearance of slippage of 3 mm or more, and a posterior opening of 5° or more on forward bending.

Results: There were 25 patients in the group with ASD and 51 patients in the group without ASD, and no significant differences in patient background factors were found between groups. The univariate analysis showed that the following factors were significant: elevation distance between the fixed vertebral body (with ASD 4.9 mm vs. without ASD 4 mm, p=0.03), placement position from the anterior edge of the lower vertebra (17.1% vs. 12.9%, p=0.03), and C7 central sacral vertical line at 2 years postoperatively (7.7 mm vs. -1.2 mm, p=0.04). When adjusted for age and gender, only elevation distance between the fixed vertebral body (hazard ratio, 1.28; p=0.01) and cage placement position (hazard ratio, 1.06; p=0.03) were significant factors. There was no significant difference in JOA score (23.1 points vs. 25.3 points, p=0.14) at the final follow-up.

Conclusions: It is important to place the cage in the appropriate position and with the appropriate height to reduce the incidence of radiographic ASD in LLIF.

E280

The incidence and risk factors of postoperative malnutrition in elderly patients underwent spinal surgery

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Background: There is a growing interest in the nutritional status of elderly patients perioperatively with the intention of reducing complications. This study aimed to examine the frequency and risk factors for nutritional decline during the perioperative period of spinal surgery in the elderly.

Methods: This was a retrospective cohort study. We targeted 600 consecutive cases over the age of 60 years who underwent spinal surgery at our hospital from January 2018 to July 2020 and had preoperative and 6th postoperative day blood evaluations. The Geriatric Nutritional Risk Index (GNRI) was calculated to assess nutritional status, with a GNRI >92 defined as normal and a GNRI <92 as malnourished. Data such as age, sex, height, weight, body mass index, preoperative comorbidities, medication of steroids or anticoagulants, surgical diagnosis (cervical, thoracic, lumbar, scoliosis, tumor/infection), surgical method (fusion or decompression), operation time, intraoperative blood loss, and hospital stay were collected from medical records. Univariate analysis and multivariate logistic regression analysis were used to examine factors related to postoperative malnutrition.

Results: Preoperative malnutrition was observed in 149 cases (24.8%), and 451 cases (average age, 73.3±6.7 years; 240 men, 211 women) had normal nutritional status before surgery. However, among these 451 cases, 99 (22%) experienced postoperative malnutrition. The group that became malnourished postoperatively had a significantly longer hospital stay compared to the group that remained nutritionally normal postoperatively (17.4 days vs. 14.2 days, p<0.001). Multivariate logistic regression analysis with the occurrence of postoperative malnutrition as the dependent variable showed that fusion surgery (adjusted odds ratio, 2.54; p<0.001) and operation time (adjusted odds ratio per hour, 1.31; p=0.020) were significant. On the other hand, no significant association was observed with gender, disease type, or amount of bleeding. Multivariate logistic regression analysis with the lengths of stays as the dependent variable showed that fusion surgery (adjusted odds ratio, 5.127; p=0.004) and postoperative GNRI (adjusted odds ratio, -0.16; p=0.028) were significant.

Conclusions: Despite being nutritionally normal before surgery, 22% of patients over 60 years old with spinal conditions developed postoperative malnutrition. Risk factors for postoperative malnutrition were fusion surgery and long duration of surgery. As postoperative malnutrition can result in longer hospital stays for these patients, it is crucial to implement measures to improve nutritional status during the perioperative period.

E281

Worse preoperative vertebral bone quality score as a risk factor for poor 5-year clinical outcomes after lumbar spine surgery

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Background: Vertebral bone quality (VBQ) score, measured using magnetic resonance imaging, has been associated with future osteoporotic fractures and postoperative complications. We aimed to evaluate the usefulness of the preoperative VBQ score for 5-year clinical outcomes following lumbar spine surgery.
Methods: We enrolled 189 patients who underwent lumbar surgery (≤3-disc levels) for lumbar spinal stenosis. Patients were divided into two groups based on the cutoff value of the VBQ score obtained from the receiver operating characteristic curve for the incidence of vertebral fractures within 5 years postoperatively. The determined cutoff value was 3.641 (area under curve, 0.726). Clinical scores preoperatively and 1, 2, and 5 years postoperatively, including the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ) and Short Form-36 (SF-36), were compared using a mixed-effects model.
Results: Comparative analysis indicated that the low back pain domains of JOABPEQ (p=0.024) and the physical component summary of the SF-36 (p=0.037) were significantly worse in the high VBQ group than in the low VBQ group through the study period. Using multiple regression analysis, a high VBQ score was significantly correlated with worse 5-year postoperative scores in the low back pain domains of JOABPEQ.
Conclusions: A worse preoperative VBQ score is a risk factor for poor 5-year clinical outcomes after lumbar spine surgery. The VBQ score is not only a valuable tool for analyzing bone mineral density but also a valuable prognostic factor for postoperative clinical outcomes.

E282

Morbidity of locomotive syndrome in patients undergoing surgical treatment in adult spinal deformity

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In Japan, the aging population is rapidly increasing, leading to a significant upsurge in patients with adult spinal deformity and a subsequent rise in cases necessitating surgical treatment. Locomotive syndrome indicates a state of care requirement or a high risk of care requirement due to musculoskeletal impairments. This study reported the incidence of preoperative locomotive syndrome and the potential for improvement postoperatively in patients undergoing surgery for adult spinal deformity.

E283

Utility and appropriateness of single position circumferential lumbar interbody fusion with using O-arm-based navigation in the novel oblique position

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Background: Single position surgery with patients in a lateral position involve inserting percutaneous pedicular screws (PPS) and lateral interbody fusion (LIF) to avoid changing position has been reported. The purpose of present study was to evaluate utility and appropriateness of single position LIF-PPS using O-arm-based navigation.
Methods: This study involved a retrospective analysis of 92 consecutive patients with lumbar spondylolisthesis who underwent LIF-PPS using O-arm-based navigation. Thirty-five subjects demonstrated surgery with repositioning, and 24 in the lateral decubitus position, and 33 in the oblique during PPS and position was changed to the lateral decubitus position using bed rotation without resetting. We compared these three groups in terms of the surgery time, blood loss and ac-

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curacy of screw placement.
Results: Operative time was significantly shorter in single position surgery both lateral and oblique position compared to dual position. Blood loss was significantly increased in lateral position compared to dual and oblique position. Screw trajectory angle in downside was significantly smaller in lateral position and accuracy of screw placement in downside was significantly lower in lateral position compared to dual and oblique position.
Conclusions: Current study demonstrated oblique position during PPS insertion might make single position surgery more useful to improve accuracy of PPS and blood loss.

E284

Postoperative shift in pain profile following fusion surgery for adult spinal deformity: a cluster analysis

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Background: Adult spinal deformity (ASD) is associated with a combination of back and leg pain of various intensities. The reaction of pain profiles to the surgical management of ASD is also diverse, which complicates the interpretation of the effectiveness of ASD surgery.
Methods: Multicenter prospective surveillance collected data for patients ≥19 years old who underwent primary thoracolumbar fusion surgery at five or more spinal levels for ASD between 2017 and 2021. Demographic data and surgical details such as the number of spinal levels involved and fixation technique were collected. Pain profile was recorded using the Numeric Rating Scale (NRS) for back pain (NRSback) and leg pain (NRSleg). Patient-reported outcome (PRO) scores (Short Form-12 physical component summary, EuroQOL 5-dimension, and Oswestry Disability Index) were also obtained. Two-step cluster analysis was performed utilizing preoperative NRSback and NRSleg. One-year postoperative outcomes and satisfaction rates were compared among clusters, and influencing factors were analyzed.
Results: Participants comprised 191 ASD patients. Mean age was 65.9 years and females comprised 81% of participants. Mean pain scores were 6.4 (standard deviation [SD]=2.9) for NRSback and 3.1 (SD=3.3) for NRSleg. Based on cluster analysis, patients were categorized into three groups: ClusterNP, mild pain only (n=55); ClusterBP, back pain only (n=68); and ClusterBLP, significant back and leg pain (n=68). ClusterBLP showed the worst pain profile, with a mean NRSback of 7.6 and a mean NRSleg of 6.9. ClusterBLP was the oldest 73.4 years (p<0.001) and underwent interbody fusion (88%, p<0.001) and sacral/pelvic fixation (69%, p=0.001) more commonly than the other groups. While NRSback, NRSleg, and PRO scores were all improved postoperatively in ClustersBP and BLP, ClusterBLP showed the lowest satisfaction rate (80% vs. 80% vs. 63%, p=0.11), which correlated with postoperative NRSback (rho=-0.357).
Conclusions: Cluster analysis of preoperative ASD patients revealed three clusters based on severity of back and leg pain. The cluster with the worst pain back and leg pain profile was associated with the most advanced disease and showed the lowest satisfaction rate, which was affected by postoperative back pain.

E285

Optimal intermittent administration interval of abaloparatide for low dose bone morphogenetic protein-induced bone formation in a rat spinal fusion model

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Both bone morphogenetic protein 2 (BMP-2) and abaloparatide are used to promote bone formation. However, there is no consensus about its optimal administration theory. We investigated the optimal administration theory for the pairing of BMP-2 and abaloparatide in rat spinal fusion model. Group I was implanted only carriers and saline. Carriers with 3 μg recombinant human BMP-2 were implanted in other groups. Aba-

loparatide injections were administered 3 times a week for group III (total amount 120 μg/kg in a week) and 6 times a week for group IV (total amount 120 μg/kg in a week) after surgery. They were euthanized at 8 weeks after the surgery, and we explanted their spines at that time. We assessed it using manual palpation tests, radiography, high-resolution micro-computed tomography (micro-CT) and by histological analysis. And we analyzed about serum bone metabolism markers. The fusion rate in groups III and IV was higher than in group I referring to the manual palpation tests. Groups III and IV also recorded greater radiographic scores than those in groups I and II. Micro-CT analysis showed that trabecular separation in groups III and IV was significantly lower than in group I. Trabecular number in group IV was significantly higher than in group I. Serum marker analysis showed that bone formation markers were higher in groups III and IV than in group I. On the other hand, bone resorption markers were lower in group IV than in group I. Histological analysis showed enhanced osteogenesis in trabecular bone in group IV. Frequent administration of abaloparatide may be suitable for thickening trabecular bone structure and enhancing osteogenesis in a rat spinal fusion model using BMP-2 at insufficient doses.

E286

Impact of diffuse idiopathic skeletal hyperostosis on surgical outcomes of posterior lumbar interbody fusion for lumbar spinal stenosis with spondylolisthesis

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Significantly improved compared with preoperative scores in both of the two groups, whereas postoperative Visual Analog Scale scores at 2-year and final follow-up were comparable between the two groups. Regarding Japanese Orthopaedic Association Back Pain Evaluation Questionnaire, the effective rate of all domains at 2-year follow-up showed no statistical differences between the two groups. Meanwhile, the effective rate in the walking ability domain at final follow-up was significantly lower in the D group than in the N group (D: 54.5%, N: 78.9%; p=0.007). The revision rate was higher in the D group, but not significant (D: 15.2%, N: 5.2%; p=0.077). The surgical outcomes of posterior lumbar interbody fusion for lumbar spinal stenosis (LSS) patients with diffuse idiopathic skeletal hyperostosis (DISH) are favorable at 2-year follow-up, although poorer than non-DISH patients at final follow-up, particularly in terms of walking ability. Long-term follow-up is crucial to evaluate the surgical outcomes of fusion surgery for LSS patients with DISH.

E287

Efficacy of airway management protocol for cervical anterior surgery, posterior occipitocervical fusion, and resection of intramedullary tumors

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Background: Surgical treatments for the cervical spine and spinal cord diseases occasionally lead to serious postoperative complications such as airway obstruction, which urgently requires effective airway management. This study evaluated the practicality and impact of our respiratory management protocol for patients who underwent surgeries such as anterior cervical approaches, posterior occipitocervical fusion, and intramedullary tumor removal.
Methods: In this single-center retrospective analysis, we reviewed 497 patients who received cervical surgeries—including anterior fusion, posterior occipitocervical fusion, combined surgeries, and intramedullary tumor removal—from January 2006 to June 2022. From September 2014, we adopted a specific postoperative airway management protocol. This protocol mandated continuous intubation for at least the first night after surgery, followed by a trial of spontaneous breathing and subsequent extubation 1 or more days later. We analyzed the outcomes by comparing the period before the protocol implementation (non-protocol group, n=234) with the period after (protocol group, n=263).
Results: There were no significant differences in demo-

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graphics, clinical profiles, or surgical details between the groups. In the non-protocol group, four patients required reintubation due to postoperative airway complications (one after anterior fusion, one after posterior occipitocervical fusion, and two after intramedullary tumor removal). Following the protocol's implementation, the rate of reintubation significantly decreased to zero (p=0.048).

Conclusions: The introduction of our airway management protocol significantly lowered the necessity for reintubation. These results highlight the critical role of postoperative respiratory care following cervical spine surgeries and the imperative for adopting effective preventative measures against complications.

E288

Postoperative course of pelvic axial rotation and its effect on shoulder balance in Lenke 1, 2 adolescent idiopathic scoliosis

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Background: In posteroanterior radiographs with adolescent idiopathic scoliosis (AIS), we often see a bilateral difference in the iliac wings. This is supposedly due to the pelvic axial rotation (PAR) associated with scoliosis. We often experience cases in which this pelvic rotation is changed by surgery and postoperative course. The pelvis is an important component of trunk and shoulder balance. The purpose of this study is to investigate the pre-postoperative PAR history and the relationship between PAR and shoulder balance in patients with Lenke 1, 2 AIS.

Methods: The study included 28 Lenke 1 and 2 AIS patients (four males and 24 females) who underwent scoliosis correction. The PAR and shoulder parameters were measured on posteroanterior radiographs at preoperative, 1 week postoperative, 3 months postoperative, and 2 years postoperative. Patients were divided into two groups according to the presence of preoperative PAR (rotation group and non-rotation group) and a comparison analysis was made on each parameter. The correlation between the measured parameters and the amount of change in each parameter was also examined.

Results: Eleven patients (39.3%) had preoperative PAR. Most pelvises were rotated to the right side. Six patients (21.4%) had a greater change in pelvic rotation from 1 week to 2 years postoperatively. The rotation did not change significantly from preoperatively to immediately postoperatively, but it rotated more during the first 3 months postoperatively. The rotation group had significantly fewer cases of shoulder imbalance at 2 years than the non-rotation group (p=0.025). The rotation group had a significantly greater change in shoulder balance in the postoperative course (p<0.05). The amount of change in pelvic rotation from 1 week to 2 years postoperatively correlated with the amount of change in shoulder balance.

Conclusions: We believe that the fixation of the spinal column by surgery creates a linkage between the changes in the shoulder and pelvis. The patient with preoperative pelvic rotation had a better ability to control the balance of the whole body at the pelvis, and the amount of shoulder balance correction in the postoperative course was considered to be greater. Patients with Lenke 1, 2 AIS may also have shoulder balance adjustment in the pelvic region postoperatively. Patients with preoperative PAR can be expected to have postoperative shoulder rebalance.

E290

Efficacy of a novel and simple test to evaluate finger dexterity in patients with cervical myelopathy: finger extension test

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Background: Patients with cervical spondylotic myelopathy (CSM) often exhibit unintentional wrist flexion to compensate for impaired finger extension. Focusing on this compensatory wrist flexion, we propose Finger Extension Test (FET) to evaluate concisely the severity of CSM.

Methods: Consecutive 49 outpatients (98 hands) with compressive spinal cord lesions confirmed on magnetic resonance imaging (MRI) were enrolled (mean age, 67 years; male 69%). (1) FET procedure: With the forearms kept vertical and supination-pronation neutral in sitting position, patients were asked to grasp and then extend fingers as quickly as possible only once. (2) When finger tips at extension was positioned palmar or dorsal to the forearm line, hands were grouped into the palmar (P) group (n=44 hands) or the dorsal (D) group (n=54 hands). The pictures of right and left hand in grasp and full extension were recorded separately from the front of the patients. The angle between the forearm axis (forearm line) and the line aligned to the dorsal surface of the hand was measured as the wrist angle. The difference between the wrist angles in grasp and extension was defined as the deviation angle. Results of the Grip and Release (GR) test and the deviation angles were compared between the two groups. The correlation between results of the GR test and the deviation angles were analyzed using Pearson's correlation coefficient. (3) Japanese Orthopaedic Association (JOA) score (17 points), JOA sub-score for finger dexterity (4 points), and the percentages of increased signal intensity (ISI) on T2 sagittal MRI were compared between patients with either hand in the P group (n=32; mean age, 66 years; male 69%) and those with both hands in the D group (n=17; mean age, 71 years; male 71%).
Results: The P group had significantly larger deviation angles of the wrist joint (40.6° vs. 27.9°, $p<0.01$) and smaller values of the GR test (19.8 vs. 22.4, $p<0.01$) than the D group. Results of the GR test was negatively correlated with the deviation angles ($r=-0.24$, $p=0.02$). JOA scores were likely to be lower (13.1 vs. 14.1, $p=0.10$), JOA sub-scores were significantly lower (3.0 vs. 3.6, $p=0.02$), and the percentage of ISI was significantly higher (63% vs. 24%, $p<0.01$) in patients with either hand in the P group than in those with both hands in the D group.
Conclusions: FET is a novel and simple test, simply judging the fingertip position in finger extension, and may represent the severity of CSM.

E291

Selective modified K-line interval on T2 sagittal magnetic resonance imaging can predict japanese orthopaedic association recovery rate and residual anterior compression of spinal cord after posterior decompression surgery in patients with cervical spondylotic myelopathy

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Background: Modified K-line interval (mK-line-INT), which is measured on C2–7 alignment on sagittal magnetic resonance imaging (MRI), reportedly predicts residual anterior compression of spinal cord (rACS) after posterior decompression in cervical spondylotic myelopathy (CSM) patients. However, the level where mK-line-INT is measured is not always included in the decompression levels or corresponds to the most stenotic level. This study aimed to propose "selective" mK-line (SmK-line) that is drawn within the selected decompression levels, and to investigate the efficacy of SmK-line interval (SmK-line-INT) to predict surgical outcomes and rACS.
Methods: SmK-line was defined as the line connecting the midpoints of the spinal cord at the rostral endplate level of the uppermost vertebra and caudal endplate level of the lowermost vertebra of the decompression levels on T2 sagittal MRI. SmK-line-INT was defined as the minimum distance between the ACS and SmK-line. (1) Consecutive 62 patients with CSM who underwent posterior decompression were enrolled. mK-line-INT, SmK-line-INT, the levels where these INTs were measured, the most stenotic level, and Japanese Orthopaedic Association (JOA) recovery rate [RR] at 1 year postoperative were recorded. Multiple regression analysis was performed to identify the parameters associated with JOA RR. Receiver operating characteristic (ROC) curve was used to determine the cut-off value of mK-line INT and SmK-line INT predicting JOA RR <40%. (2) Out of the 62 patients, 34 patients whose postop MRIs were available were reviewed to investigate whether the cut-off value of SmK-line INT

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can also predict postop rACS. rACS was defined as the effacement of the anterior cerebrospinal fluid buffer on sagittal and axial T2 MRI. The percentage of rACS was compared between patients with SmK-line-INT greater than the cut-off value (G group, n=19) and those with SmK-line-INT smaller than the cut-off value (S group, n=15). Then, preop C2–7 Cobb, local Cobb of decompressed levels, C2–7 sagittal vertical axis, and SmK-line-INT were compared between patients with rACS (rACS group, n=10) and those without rACS (No rACS group, n=24).

Results: (1) The percentage of the patients whose INTs were measured at the most stenotic level were 64.5% (mK-line-INT) and 85.5% (SmK-line-INT, p=0.006). Multiple regression analysis revealed that mK-line-INT (p=0.03), age (p=0.01), and SmK-line-INT (p=0.007) were associated with JOA RR. Area under the ROC curve and the cut-off value of these INTs to predict JOA RR <40% was 0.568 (p=0.03) and 4.7 mm (mK-line-INT) and 0.714 (p=0.01) and 3.4 mm (SmK-line-INT), respectively. (2) S group (SmK-line-INT ≤3.4 mm) had significantly higher rate of rACS than G group (SmK-line INT >3.4 mm) (9/15 [60%] vs. 1/19 [5.3%], p<0.001). The sensitivity and specificity of SmK-line-INT ≤3.4 mm to predict rACS was 90.0% and 75.0%, respectively. Preop C2–7 Cobb (p=0.005), local Cobb (p=0.008), and SmK-line-INT (p<0.001) were significantly smaller in rACS group than "no rACS" group, and the odds ratios of these variables for rACS by univariate logistic regression analysis were 1.12 (95% confidence interval [CI], 1.03–1.23; p=0.006), 1.15 (95% CI, 1.04–1.33; p=0.005), and 4.28 (95% CI, 1.75–17.69; p<0.001), respectively.

Conclusions: SmK-line-INT can illustrate spinal cord compression and, thereby, predict JOA RR more accurately than mK-line-INT. SmK-line-INT ≤3.4 mm can predict JOA RR <40% and rACS after posterior decompression.

E292

Dichotomous indicator on lateral X-ray to predict spinal cord compression in patients with cervical spondylotic myelopathy

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Background: This study aimed to investigate whether the presence or absence of the spinous process base to lateral mass distance (SLD) on lateral X-ray of the cervical spine can predict spinal cord compression in patients with cervical spondylotic myelopathy (CSM).

Methods: Consecutive 63 patients with CSM who underwent posterior decompression surgeries were reviewed. The SLD on the true lateral X-ray (presence [+] or absence [-], distance [mm]) and the Antero-posterior diameter of the spinal canal (APD) and the lateral mass-to-posterior canal distance (PCD) on axial computed tomography images at the pedicle level were measured for each vertebra from C4 through C6. (1) The correlations of SLD (mm) with APD and PCD were investigated by Pearson's correlation coefficient. (2) The percentages of the spinal cord compression at the rostrally adjacent segment of each vertebra were compared between vertebrae with SLD (+) and those with SLD (-). Spinal cord compression was defined as the effacement of the anteroposterior cerebrospinal fluid buffer on sagittal T2 magnetic resonance imaging.

Results: (1) SLD was more positively correlated with PCD (C4 [n=44], r=0.62; C5 [n=42], r=0.48; C6 [n=46], r=0.66) than APD (C4, r=0.35; C5, r=0.40; C6, r=0.32). (2) Vertebrae with SLD (-) had higher percentages of spinal cord compression than those with SLD (+) (C4, 40.6% [SLD +] vs. 100% [SLD -], p<0.01; C5, 54.6% vs. 87.5%, p=0.07; C6, 50% vs. 93.8%, p<0.01). Measurement property of SLD (-) to predict the spinal cord compression at the rostrally adjacent showed high specificity (C4, 100%; C5, 93.6%; C6, 93.3%), high positive predictive value (C4, 100%; C5, 87.5%; C6, 93.8%), low sensitivity (C4, 45.8%; C5, 28.0%; C6, 93.3%), and low negative predictive value (C4, 59.4%; C5, 45.5%; C6, 50.0%).

Conclusions: SLD reflects the shape of the posterior

dome in the spinal canal and can be assessed (+) or (-) dichotomously on the lateral X-ray. SLD of C4, C5, and C6 can predict the spinal cord compression at C3/4, C4/5, and C5/6, respectively, with high positive predictive value.

E293

Preoperative frailty is potential risk factor for postoperative kyphosis after posterior decompression of cervical spine

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Background: This study aimed to investigate whether frailty is associated with kyphotic change of the cervical spine after posterior decompression.
Methods: Fifty-six patients with CSM who underwent posterior decompression with minimum 1 year follow-up were reviewed. The 11-item modified frailty index (mFI-11) was used to assess frailty. Patients' demographics (age, sex, body mass index, frailty [mFI-11 ≥3]), number of decompressed segments, and radiological parameters (C2–7 sagittal vertical axis [SVA], C2–7 Cobb, C2–7 range of motion [ROM], C2–7 extension ROM [extension Cobb–neutral Cobb], C2–7 flexion ROM [neutral Cobb–flexion Cobb]) were recorded. Preoperative, postoperative, and Δ(postoperative–preoperative) values of each radiological parameter were measured. (1) All parameters were compared between frail (the F group, n=15) and non-frail patients (the NF group, n=41). (2) Multiple regression analysis was performed to identify the parameters associated with postoperative decrease in C2–7 Cobb.
Results: (1) Patients in the F group were significantly older than those in the NF group (75.2 vs. 63.9, p=0.01). There were no significant differences in the other demographics and the number of decompressed segments. Each ROM decreased postoperatively in both groups without significant intergroup differences. Preoperative (37.6 mm vs. 25.5 mm, p=0.01) and postoperative C2–7 SVA (43.7 mm vs. 29.1 mm, p<0.01) was significantly larger in the F group, but ΔSVA was similar (6.1 mm vs. 4.1 mm, p=0.46). Although there were no significant differences in preoperative (10.7° vs. 8.1°, p=0.47) and postoperative C2–7 Cobb (5.4° vs. 10.5°, p=0.23), C2–7 Cobb decreased in the F group but increased in the NF group postoperatively (ΔC2–7 Cobb, -5.3° vs. 2.5°; p<0.01). (2) Preoperative C2–7 extension ROM (p=0.02) and frailty (p=0.04) were associated with postoperative decrease in C2–7 Cobb.
Conclusions: Frailty can be one of the preoperative parameters to flag patients who have a risk for postoperative kyphosis of the cervical spine after posterior decompression. Pathological mechanisms of greater postoperative kyphotic change in frail patients need to be further investigated.

E294

Deviation from preoperative planning and accuracy of transpedicular screw fixation using intraoperative three-dimensional navigation for lumbar spondylolisthesis

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Background: 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 lumbar spondylolisthesis (DLS).
Methods: Patients affected by DLS who underwent posterior lumbar interbody fusion (PLIF) using intraoperative three-dimensional (3D) navigation with preoperative screw planning since April 2022 were included. Intraoperative cone-beam computed tomography (CBCT) (LoopX; Brainlab, Munich, Germany)

was performed prior to screw planning and following implantation in all cases. The deviation from planning was calculated as linear, angular, and 3D discrepancies between the planned and implanted screws. Pedicle screw accuracy and facet joint violation (FJV) were evaluated using Gertzbein-Robbins system (GRS) and Yson classification, respectively. Statistical analysis was performed using IBM SPSS ver. 26.0 (IBM Corp., Armonk, NY, USA). One-way analysis of variance test followed by Bonferroni post-hoc tests were performed to evaluate the association between GRS, screw deviation, and vertebral level. Statistical significance was set at $p<0.05$.

Results: This study involved 34 patients with a mean age of 64.3±7.5 years, for a total of 154 pedicle screws. The mean two-dimensional linear deviation of the screw tip in mediolateral (ML), craniocaudal (CC), and anteroposterior (AP) directions was 2.6±2.45 mm, 1.6±1.7 mm, and 3.07±2.9 mm, respectively. The mean 3D deviation of the screw tip was 5±3.3 mm. The mean two-dimensional linear deviation of the screw head in ML, CC, and AP directions was 1.83±1.8 mm, 1.7±1.67 mm, and 3.6±3.1 mm, respectively. The mean 3D deviation of the screw head was 4.94±3.2 mm. The mean deviation of the angular component on the axial plane was 3.4°±3.6°, while on the sagittal plane it was 3.77°±3.3°. A total of 98.04% of screws were clinically acceptable (grade A+B). Regarding FJV, 98% of the screws were evaluated as grade 0. Significant results were found between GRS and ML (p=0.005), AP (p=0.01), and 3D (p=0.003) tip deviations, and between GRS and AP and 3D deviations of the screw head (both p=0). Moreover, a significant correlation was found between GRS and vertebral level (p=0). At post-hoc test, L5 and S1 levels presented statistically higher accuracy than L4 (p=0).

Conclusions: 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.

E295

Enzymatic chemonucleolysis for lumbar disc herniation: assessment of historical and contemporary efficacy and safety: a systematic review and meta-analysis

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Background: Lumbar disc herniation (LDH) is one of the primary causes of low back pain (LBP) and is often managed surgically, with unsatisfactory outcomes in up to 15% of cases while exposing patients to not negligible risks. Enzymatic chemonucleolysis emerged as a non-surgical alternative, aiming to enzymatically degrade herniated disc material and assuage associated symptoms This systematic review and meta-analysis aims to assess the efficacy and safety of chemonucleolytic enzymes for LDH. The primary objective is to evaluate efficacy through "treatment success" (i.e., pain reduction) and severe adverse events (SAEs) rates. Additionally, differences in efficacy and safety trends among chemonucleolytic enzymes have been explored.

Methods: Following our PROSPERO registered protocol (CRD42023451546) and PRISMA (Preferred Reporting Items for Systematic Review and Meta-analyses) guidelines, a systematic search of PubMed and Web of Science databases was conducted up to July 18, 2023. Inclusion criteria involved human LDH treatment with enzymatic chemonucleolysis reagents, assessing pain alleviation, imaging changes, and reporting on SAEs, with focus on allergic reactions. Quality assessment employed the Cochrane Source of Bias tool and MINORS scheme. Meta-analysis utilized odds ratios with 95% confidence intervals.

Results: Among 62 included studies (12,368 patients),

chemonucleolysis demonstrated an 79% treatment success rate and significantly outperforming placebo controls (odds ratio [OR], 3.35; 95% confidence interval [CI], 2.41–4.65) and scoring similar to surgical interventions (OR, 0.65; 95% CI, 0.20–2.10). SAEs occurred in 1.4% of cases, with slightly higher rates in chymopapain cohorts. No significant differences in "proceeding to surgery" rates were observed between chemonucleolysis and control cohorts. Limitations include dated and heterogeneous studies, emphasizing the need for higher-quality trials.

Conclusions: Our comprehensive analysis underscores the evolving landscape of chemonucleolysis as a viable non-surgical intervention for LDH. With newer agents like condoliase exhibiting enhanced safety profiles and promising efficacy, the reevaluation of chemonucleolytic enzymes offers a valuable therapeutic avenue. Further research, particularly large randomized controlled trials, is imperative to solidify the evidence base and refine the clinical application of these enzymatic interventions, fostering their broader adoption in LDH management.

E296

Are atypical Hangman's fractures becoming typical?

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Background: A traditional Hangman's fracture (HFs) is a bilateral fracture traversing the pars interarticularis of C2, but there is wide variability in the fracture patterns that separate the anterior elements of the C2 vertebrae from the posterior elements. One type of fracture that is increasingly being observed is the atypical hangman's fracture, in which the posterior aspect of the C2 vertebral body, not the bilateral pars, is involved. While a typical hangman's fracture separates the anterior elements from the posterior elements of the C2 vertebrae and increases the available space for the spinal cord, the space remaining for the spinal cord does not increase secondary to fracture in the case of an atypical hangman's fracture, leading to a higher risk of neurologic injury. In this study, we review HFs treated at a single tertiary care university hospital, especially focusing on the fracture pattern and clinical characteristics associated with HFs.

Methods: The subjects of this study are the 35 HF cases treated at our institution between 2010 and 2021 comprised of 22 males and 13 females with an average age of 60.6 years. The etiology, fracture pattern, neurological status, and vertebral artery (VA) integrity were retrospectively examined from hospital records.

Results: The injury was caused by a traffic accident in 12 cases, a fall in 12 cases, tripping in nine cases, and struck by a falling object in two cases. There were six cases of spinal cord injury (SCI) in this series, of which two cases with polytrauma died soon after arriving at the hospital: one traffic accident case and another case in that was struck by a falling steel plate. According to the Levine and Edwards Classification, there were 23 cases with type 1, six cases with type 2, two cases with type 2a, and four cases with type 3 injuries (of which two are the cases that died). There were 13 typical HFs and 22 atypical HFs in which the posterior aspect of the C2 vertebral body and not the pars was involved in at least one side. The pattern of fracture of atypical HFs, according to the Li classification, was 10 cases of type A1, one case of type A2, seven cases of type B1, and four cases of type B2. There was no significant difference in the number of cases with SCI between the typical and atypical HF cases. Twenty-four cases had VA integrity examined either through enhanced computed tomography or MR angiography and seven cases (20%) were diagnoses with VA injury. All seven cases were closely followed without any intervention and no complications were observed. VA hypoplasia was suspected in three cases, and no VA injury was found the remaining 14 cases.

Conclusions: In our series, more atypical cases with vertebral body involvement were observed than traditional HFs, suggesting that atypical HFs may need to be renamed. Also, in contrast to the literature, atypical HFs cases were not associated with higher neurological injury. One contributing factor may be the fact that the cases in our series were comprised of more elderly cases with low energy trauma, unlike past reports where traffic accidents were the main cause of injury. The aging Japanese population is believed to play a role, and this change in the characteristics of HF pattern may be predictive of what awaits other nations as well. Fortunately, and possibly related to the prevalence of low energy trauma, VA injury did not lead to cerebrovascular complications, but the fact that 11 cases were not evaluated for VA injury is worrisome.

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Discectomy versus sequestrectomy in the treatment of lumbar disc herniation: a systematic review and meta-analysis

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Background: Lumbar disc herniation (LDH) is one of the primary causes of low back pain (LBP) and leg pain and may require surgical treatment in case of persistent pain and/or neurological disturbances. Conventional discectomy consists of the removal of the herniated fragment and additional material from the disc space, potentially accelerating degeneration and causing chronic LBP. Conversely, by resecting the herniated fragment only, sequestrectomy may improve postoperative LBP while increasing the risk of LDH recurrence. The purpose of this study was to compare the effects of discectomy vs. sequestrectomy in terms of risk of reherniation, reoperation rate, complications, pain, satisfaction, and perioperative outcomes (operative time, blood loss, length of stay [LOS]).

Methods: A systematic search of PubMed/Medline and Scopus databases was performed through December 1, 2023. Randomized and nonrandomized studies. The search was conducted according to PRISMA (Preferred Reporting Items for Systematic Review and Meta-analyses) guidelines. The RoB-2 and MINORS tools were utilized to assess the risk of bias in included studies. The quality of the evidence was evaluated according to the GRADE approach.

Results: A total of 16 articles (one randomized controlled trial with two follow-up studies, six prospective studies, and seven retrospective studies) published between 1991 and 2020 including 2,009 patients were included for analysis. No significant differences were noted between discectomy vs. sequestrectomy in terms of risk of reherniation (odds ratio [OR], 0.85; 95% confidence interval [CI], 0.57 to 1.26; p=0.42), reoperation rate (OR, 0.95; 95% CI, 0.64 to 1.40; p=0.78), and complications (OR, 1.03; 95% CI, 0.50 to 2.11). Although LBP (mean difference [MD], -0.06; 95% CI, -0.39 to 0.28; p=0.74) and leg pain intensity (MD, 0.11; 95% CI, -0.21 to 0.42; p=0.50) was similar postoperatively, significantly better outcomes were reported by patients treated with sequestrectomy at 1 year (leg pain: MD, 0.37; 95% CI, 0.19 to 0.54) and 2 years (LBP: MD, 0.19; 95% CI, 0.03 to 0.34; p=0.02; leg pain: MD, 0.20; 95% CI, 0.09 to 0.31; p=0.0005). Sequestrectomy also resulted in a higher patient satisfaction (OR, 0.60; 95% CI, 0.40 to 0.90; p=0.01) and shorter operative time (MD, 8.71; 95% CI, 1.66 to 15.75; p=0.02), while blood loss (MD, 0.18; 95% CI, -2.31 to 2.67; p=0.89) and LOS (MD, 0.02 days; 95% CI, -0.07 to 0.12; p=0.60) did not significantly differ compared to discectomy.

Conclusions: Based on the current evidence, discectomy and sequestrectomy do not significantly differ in terms of risk of reherniation, reoperation rate, and postoperative complications. Patients treated with sequestrectomy may benefit from a marginally higher pain improvement, better satisfaction outcomes, and a shorter operative time, although the clinical relevance of these differences needs to be validated in larger, prospective, randomized studies.

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Differential functional characteristics of Tie2-expressing nucleus pulposus progenitor cells in young versus old donors: implications for intervertebral disc regeneration

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Background: Intervertebral disc (IVD) degeneration and aging involve decreased nucleus pulposus (NP) cell quantity and activity. Tie2-expressing NP progenitor cells hold promise for cell therapy due to their regenerative capacity. Challenges in expanding these cells arise from age and disease, prompting studies to optimize culture methods to enhance Tie2-expressing cell retention. Recently, we identified an optimized culture condition that facilitates cell rejuvenation, leading to increased positivity of Tie2-expressing cells. This discovery prompted us to investigate whether Tie2-expressing cells derived from older tissue sources exhibit comparable functionality and regenerative potential to Tie2+ NP cells obtained from younger patients, to broaden the sources of cell materials.

Methods: Surgical tissues (approval by the institutional review board of Tokai University: 17R173) and with patient consent, were obtained. Tissues from patients under 25 years (young) and over 60 years (older) were washed, fragmented, and cultured as tissue fragments and subsequent mono-layer cultures following Sako and his colleagues. Resulting cells were used for TrypLE-detached cells were re-seeded and cultured for an additional 4 weeks to assess proliferation rates. Flow cytometry determined cell surface marker expression (Tie2, GD2, CD24), and IntraPrep examined type I and type II collagen and proteoglycan positivity. NP cells (1,000 cells/mL) were seeded in MethocultTM media for 14 days to assess colony formation rate. Finally, obtained cell products were applied in coccygeal induced disc degeneration rat models; 18G needle disc puncture at Co5/6–Co7/8. Directly after, each rat received 25 μL of saline solution (Sham), 25 μL of 1×10^5 older, and 25 μL of 1×10^5 young NP cells in one of each level. Rats were followed for 3 months, with monthly radiographic assessment followed by sacrifice for histological assessment. Histological score was performed through ORS Spine rat specific classification scheme.

Results: Tie2-positivity rates were high and comparable in cells from older (17.5%) and young (20.8%) sources. GD2-positivity was significantly higher in older NP cells. Despite similar Tie2-rates, young NP cells exhibited superior proliferative capacity, colony-forming units, and matrix production. Transplantation of both cell products enhanced disc height index outcomes, with young cells outperforming old cells. Histological assessment revealed responder and non-responder discs, emphasizing the impact of donor age on Tie2-expressing NP cells functionality.

Conclusions: The study underscores the importance of Tie2-expressing NP cells in IVD regeneration, highlighting the influence of donor age on cell functionality. Tie2 emerges as a key marker for regenerative potential, suggesting epigenetic changes in older NP progenitor cells due to age and chronic inflammation. This warrants further investigation as a potential therapeutic target.

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