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The Utility of MRI for Spinal Clearance in Blunt Trauma: A Retrospective Cohort-Study of 539 Blunt Trauma Patients in a Level-One-Trauma-Center in Singapore

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Majority of spinal injuries occur secondary to blunt trauma, these patients are assumed to have unstable spinal injury until radiological and clinical confirmation. MRIs are highly sensitive but can be logistically challenging for ICU patients and may prolong unnecessary spinal immobilization. In this study, we investigated the efficacy of MRIs in changing blunt trauma patients' management, noting clinical and CT findings indicating an MRI.

This is a retrospective study of significant blunt trauma patients who had MRIs performed between 2018 to 2023 in the National University Hospital, Singapore. Indications for spinal MRI included CT-determined spinal fractures, neurological deficits, obtunded patient, spinal tenderness and underlying ankylosing spinal conditions. Significant blunt trauma was defined according to Canadian C spine Rule criteria. Fracture morphology followed AO spine fracture classifications. Change in patient management was defined as MRI findings indicating operative management or conversion to operative management. Stable fractures were defined as AO type A0 cervical or thoracolumbar fracture, other fractures were considered potentially unstable. Univariate and Multivariate Analysis were performed. Duration of spinal nursing awaiting for MRI was recorded.

Of 539 patients, 135 (25%) female and 404 (75%) males, had MRI performed for spinal clearance. Of which, 234 (43.6%) MRIs changed patient management. On multivariate analysis, CT-determined potentially unstable fractures ($p<0.01$) and neurological deficits ($p<0.01$) were significant predictors of MRIs changing patient management. 234/419 (55.9%) of indicated MRIs led to management changes. 0/110 (0.00%) patients not meeting indications had scans without management changes. Patients with MRIs done without management changes averaged 2 (range 0-14) days undergoing spinal nursing awaiting MRI.

In blunt trauma patients without clear indications, MRIs may unnecessarily prolong spinal nursing without benefitting the patient. Further studies to clearly delineate MRI indications, additional costs and medical complications associated with un-indicated MRI scans are warranted.

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What is the Incidence of Symptomatic Thromboembolism Post-surgical Treatment of Spinal Metastases in an Asian Cohort of Patients

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Over 10% of cancer patients develop symptomatic spinal metastasis, and advances in surgical management have increased the number of patients undergoing operative treatment. The presence of cancer, spinal surgery and loss of mobility are known risk factors for thromboembolism. The risk of symptomatic thromboembolism (deep venous thrombosis/pulmonary embolism) has not been defined and hence we aim to identify the percentage of patients who develop symptomatic thromboembolism and the risk factors.

This is a retrospective cohort study of patients, between 2005 to 2024, at the National University Spine Institute Singapore. Inclusion criteria included patients surgically treated for symptomatic spinal metastases, excluding patients treated with only kyphoplasty/vertebroplasty. Patient clinical, demographic, neurological and oncological data were collected. The primary outcome measured was symptomatic thromboembolism, defined as symptomatic pulmonary embolism (PE) or symptomatic deep venous thromboembolism (DVT) diagnosed within 90 days of surgical treatment on CT-pulmonary angiogram and duplex ultrasound. No pre- or post-operative chemoprophylaxis was prescribed. Univariate and Multivariate analysis was performed.

503 patients were included of whom 20(4%) developed symptomatic thromboembolism. (16(3.2%) female and 4(0.8%) male) On univariate analysis, days of SHD/ICU stay, length of stay, female sex, presence of medical complication was associated with significantly higher rates of symptomatic thromboembolism. On multivariate analysis female sex ($p=0.013$) was significantly associated with symptomatic thromboembolism. The incidence of post-operative hematoma requiring surgical treatment was 9(1.8%). There were no deaths attributable to thromboembolism.

The incidence of symptomatic thromboembolism in patients post spinal tumor surgery was 4%, lower than 11-20% in Western populations, despite the absence of a consistent chemoprophylaxis protocol. This might be due to the perceived lower incidence of symptomatic thromboembolism in Asian patients when compared to western populations. However, this paper highlights the need to identify patients (female sex) at increased risk and provide appropriate chemoprophylaxis.

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Robotic-Assisted Versus Fluoroscopy-Guided Sacroiliac Screw Fixation: A Retrospective Comparative Study

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Introduction/Objectives Percutaneous sacroiliac (SI) screw fixation is a widely used technique for stabilizing sacral fractures but is considered technically demanding even in experienced hands. Conventional fluoroscopy-guided methods are associated with a relatively high risk of screw misplacement and considerable radiation exposure to patients and staff. Robotic-assisted navigation systems have been introduced to enhance screw accuracy and reduce radiation exposure. The aim of this study was to assess the efficiency, safety, and accuracy of sacroiliac screw fixation using a robot-assisted method compared with the conventional freehand technique.

Materials and Methods Medical records of patients treated with sacroiliac screw fixation for sacral fractures at a single Level 1 trauma center between December 2014 and August 2025 were retrospectively analyzed. Patients were divided into robotic-assisted and freehand fluoroscopy-guided groups for comparative analysis. Primary outcomes were intraoperative radiation exposure and operative time; secondary outcomes included screw position accuracy and complications. Statistical analysis was performed with significance set at $p < 0.05$.

Results/Discussion Twenty-five patients (mean age: 57.7 ± 22.4 years) were included; 15 in the robotic-assisted and 10 in the conventional fluoroscopy-guided groups. A total of 47 SI-screws were inserted: 29 in the robotic group and 18 in the conventional group. Operative times were comparable between groups (47.1 ± 16.3 min and. 45.1 ± 30.0 min, respectively; $p=0.85$). Compared to conventional fluoroscopy, robotic assistance was associated with reduced fluoroscopy time (55.1 ± 23.1 vs. 181.1 ± 104.4 s, $p=0.053$) and higher screw placement accuracy (94% vs. 62%, $p = 0.06$), although these did not reach statistical significance. No major intraoperative complications occurred.

Conclusion Robotic-assisted navigation in sacroiliac screw insertion can potentially lower radiation exposure and improve screw placement accuracy compared to conventional techniques, without prolonging surgical time. These findings support robotic guidance as a safe and potentially more precise alternative for sacral fracture fixation.

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Stable Low-Grade Degenerative Spondylolisthesis Does Not Adversely Affect ClinicalOutcome of Full-Endoscopic Decompression in Patients with Spinal Stenosis

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Objectives This Study aims to assess clinical outcomes, radiological stability of full-endoscopic ULBD and its impact on spinal stability/spondylolisthesis progression. Methods A total of 36 patients diagnosed with LSS and grade I degenerative spondylolisthesis who underwent Full-endoscopic ULBD at the MIS Center between February 2019 and December 2023 were retrospectively reviewed. All patients completed at least 12 months of follow-up. Clinical outcomes were assessed preoperatively, at 12 months, and at the final follow-up using the VAS back, VAS leg, and ODI. Radiological evaluations included CSA, LL, segmental LL, SVA, Slip%, PT.
Results All clinical outcome measures demonstrated statistically significant improvement from baseline at both 12 months and final follow-up ($p < 0.001$). Notably, the CSA significantly increased at final follow-up ($p = 0.001$). While LL and segmental LL did not exhibit statistically significant changes ($p > 0.1$), the slip% remained stable ($p = 0.724$). Additionally, PT improved significantly at the 12-month mark ($p < 0.001$), although this change was not maintained at the final follow-up. Subgroup analysis (age, BMI, slip percentage, gender, lumbar lordosis) showed no significant differences in 12-month VAS back scores, VAS leg or ODI changes across all subgroups ($p>0.05$), but LL subgroup had significant VAS back difference at the final followup($p=0.03$), marginal VAS leg trend, and no ODI difference.
Conclusion Full-endoscopic ULBD is safe and effective for LSS with stable grade I spondylolisthesis, yielding sustained pain and functional improvements without instability or slip progression; Future larger prospective studies are needed.

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Endoscope-assisted Anterior Cervical Discectomy and Fusion (ACDF) Outperforms Microscope-assisted ACDF in Improving Postoperative Swallowing Function with the Use of Zero-P Cage

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Objective This study aimed to compare the efficacy of Endoscopic-assisted Anterior Cervical Discectomy and Zero-P Fusion (ACDF) and Microscope-assisted Zero-P ACDF in treating single-segment Cervical spondylotic myelopathy and their effects on postoperative swallowing function recovery using clinical and imaging evaluations.
Methods The retrospective study included 68 patients with single-segment CSM who had surgical treatments from April 2020 to August 2023. Among these, 34 got Endoscope-assisted ACDF (EA-ACDF) with the use of Zero-P fusion cage, 34 got Microscope-assisted Anterior Cervical Discectomy and Zero-P Fusion (MA-ACDF) with the use of Zero-P fusion cage. Age, gender, BMI, surgical duration and blood loss were documented. mJOA assessed functional recovery. DSQ and EAT-10 evaluated swallowing function, and PSTSR change rate measured soft tissue structure changes before and after surgery.
Results 68 patients were equally split into EA-ACDF and MA-ACDF groups. No statistical differences were found in age, gender, BMI, surgical segment and follow-up time between them. EA-ACDF had a significantly shorter hospital stay than MA-ACDF ($P < 0.05$). Its operation time and intraoperative blood loss showed no significant differences compared with the ACDF ($P = 0.07$, 0.72). The mJOA scores of both groups improved significantly after surgery ($P < 0.05$). There were no significant differences in Nurick scores and mJOA between the two groups. The EA-ACDF's EAT-10 and DSQ was better than that of the ACDF at each post-surgery time point, yet not statistically significant. The EA-ACDF group's PSTSR was significantly better than the MA-ACDF group's from 3 days to 3 months after surgery ($P < 0.001$).
Conclusion Endoscope-assisted ACDF technique, based on the use of zero-profile fusion cage, has the same reliable clinical efficacy as Microscope-assisted ACDF, and is superior to Microscope-assisted ACDF in the early recovery of swallowing function after surgery, which can reflect the advantages of minimally invasive spinal surgery technique.

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A clinical comparison between MIS-TLIF with the Enhanced Recovery After Surgery (ERAS) protocol and UBE-TLIF

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Introduction Unilateral biportal endoscopy has become a procedure of choice for lumbar discectomies and decompressions at our center replacing the microscopic techniques. Lumbar fusion is performed either by Unilateral biportal endoscopic transforaminal lumbar interbody fusion (BE-TLIF) or Minimally invasive transforaminal lumbar interbody fusion by microscopic tubular technique (MT-TLIF). Our aim was to compare these two techniques.
Material and Methods A retrospective study involving 59 patients who underwent lumbar fusion between November 2019 and November 2021. 28 patients underwent BE-TLIF for 34 levels of fusion and 31 patients underwent MT-TLIF for 36 levels of fusion. All the patients were followed up for more than 12 months. Clinical outcome was measured by Visual Analogue Score (VAS) for back pain and leg pain, pre-operatively and at subsequent follow-up's. Functional outcome was measured by the Oswestry Disability Index (ODI) and McNab's criteria. The Bridwell grading system was used for assessing fusion on X-rays at follow-up.
Results Both the cohorts (BE-TLIF and MT-TLIF) showed significant improvement of back pain and leg pain post-operatively and all the follow-ups. There was statistically significant improvement of VAS for back pain at immediate post-operative, 6 weeks post-operative, 6 months post-operative and final follow-up in BE-TLIF group as compared to MT-TLIF. At final follow-up BE-TLIF cohort had better ODI scores ($P=0.04$). Fusion rates were better in BE-TLIF group at 6 months but eventually they were similar in both the groups at final follow-up but BE-TLIF cohort showed less subsidence than MT-TLIF group at final follow-up ($P=0.02$).
Conclusion UBE fusion offers a promising option for lumbar fusion, with fusion rates comparable to MIS-TLIF. It also provides advantages such as better clinical outcome scores, early ambulation, shorter hospital stay, less blood loss, earlier time to fusion, and lower subsidence rate. Both techniques exhibited low infection rates with no significant intergroup differences.

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Optimizing Intraoperative Imaging Coverage for Navigated Pedicle Screw Placement in Lateral Position Spine Surgery

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INTRODUCTION / OBJECTIVES Single-position lateral spine surgery is increasingly adopted to improve operative efficiency and avoid patient repositioning. Posterior pedicle screw placement in the lateral decubitus position introduces imaging challenges related to table interference, truncation and limited visualization of posterior elements. Quantitative data defining imaging requirements for reliable navigation in this setting are limited. The objectives of this study were to determine the imaging coverage required to visualize posterior lumbar anatomy in the lateral position and to compare volumetric fidelity across commonly used intraoperative imaging platforms.

MATERIALS AND METHODS A CT-compatible adult torso phantom was positioned in right lateral decubitus on a Jackson flat-top table with the posterior aspect oriented toward the table edge, simulating operative conditions for L2–S1 instrumentation. Five intraoperative imaging systems were evaluated under standardized positioning. A centered volumetric acquisition served as the reference dataset to which each lateral-position scan was rigidly aligned. Vertebral bodies were segmented using a semi-supervised deep learning workflow. Volumetric correspondence was quantified using Dice similarity coefficients, and residual geometric deviation after alignment was assessed.

RESULTS / DISCUSSIONS Large field-of-view systems demonstrated higher volumetric agreement with the reference dataset across lumbar levels, with Dice coefficients exceeding accepted thresholds for reliable three-dimensional correspondence. Smaller field-of-view platforms showed greater variability, particularly at lower lumbar levels, reflecting posterior truncation and reduced landmark availability. Residual geometric deviation after alignment was lowest among large field-of-view systems and increased in platforms with limited posterior capture. These findings indicate that incomplete volumetric acquisition, rather than image quality alone, drives reduced spatial reliability in lateral-position imaging.

CONCLUSION Intraoperative imaging systems with greater volumetric coverage provide superior spatial fidelity and reduced geometric deviation for navigated pedicle screw placement during lateral single-position spine surgery. Quantitative assessment of volumetric reliability may inform imaging platform selection and support safe adoption of lateral posterior instrumentation techniques.

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Remnant pain, Readmission, Reoperation , infection and Complication rates following uniportal endoscopic lumbal decompression in claudication neurologis in severe canal stenosis from 200 patients

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Objective Endoscopic techniques are becoming popular among spine surgeons because of their advantages. To share long-term clinical outcomes and our experience with Uniportal endoscopic spine surgery (UELD) for patient with claudication neurologis in severe canal stenosis (SCS).

Material and Methods We included all patients who underwent UELD for SCS from 2020 to 2025. Remnant pain, Readmission, Reoperation, infection rate and Complication rates were analyzed at one week, one month, three months, and one year postoperatively.

Results Two hundreds patients underwent UELD for SCS with complete data during 2020-2025. Most patients (90.54%) had neurogenic claudication for more than 1 year, mainly L4-5 (85.12%), followed by L5-S1 (14.88%). Early outcomes three months after surgery showed that most patients (88.02%) reported significant pain relief, and 70.54% reported improvement at their ODI scores with significant redcution from 38.35 to 17.32% ($p = 0.0052$). There were 15 (7.5%) patients have remnant pain means VAS back / leg > 5 following surgery within 1 month after surgery 10 patient relieve with medication and Five patients undergoing serial pain intervention. There were ten (5 %) patients who underwent reoperation to conventional surgery within 3 month due to neurological deficit, Four (2%) patients readmission within 1 month following surgery due to pain, eight (4%) patients have infection improve by medication and wound management within 1 months following surgery. We reported five (2.5%) patient have complication CSF leakage that stop with medication.

Conclusion This analysis demonstrates the safety of UELD for SCS which 88.02% improve the clinical outcome, with a low readmission, reoperation, infection and complication rate final follow-up period.

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Full Endoscopic Uniportal Foramen Magnum Decompression : Beyond Anatomical Limitation

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Background Full uniportal endoscopic spinal surgery (FUESS) was recently introduced and became prevalent fast. Foramen magnum stenosis is still challenging in endoscopic spine surgery field.

Case description Case 1 A 67-year old male with tetraparesis, motoric grade 3/5. The patient had cerebral palsy. The Magnetic Resonance Imaging showed stenosis on C1 and foramen magnum, and then underwent decompression by FUESS. The patient improved significantly after surgery.

Case 2 A 59-year old female, with chronic neck pain with tetraparesis motoric grade 4/5, on Magnetic Resonance Imaging showed stenosis on C1 and foramen magnum, then underwent decompression by FUESS. The patient improved significantly after surgery

Conclusion Surgery by FUESS could be a reasonable alternative for the treatment of foramen magnum stenosis to preserve the soft tissue and improve clinical outcome, which is the primary purpose of MISS.

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Accuracy Assessment of Planned Versus Actual Trajectories in Robotic-Assisted Spine Surgery Utilizing Perioperative O-arm CT Scans

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Objectives To find the deviations in entry point, axial angulation, and sagittal angulation between the planned trajectories vs achieved trajectories in Mazor-X robotic spine surgery.
Methods This study was conducted from December 2023 to June 2025, including 250 patients undergoing robotic-assisted pedicle screw fixation. Planned and actual screw trajectories were compared using perioperative O-Arm CT scans.
Results A total of 1170 screws were inserted (96 thoracic, 1074 lumbar). Mean entry deviation was 2.27 ± 1.5 mm, axial angular deviation 3.7° ± 3.7°, and sagittal deviation 3.4° ± 3.2°. A clinically acceptable placement rate of 99.6% was achieved, with only four breaches requiring revision. Operative time and screw insertion time decreased with experience, reflecting a short learning curve.
Conclusion Robotic guidance using the Mazor X: Stealth Edition ensures highly accurate, and safe pedicle screw placement in spine surgery.

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Navigation-guided Minimally Invasive Cervical Pedicle Screw Fixation Versus Convention Open Technique: A Comparative Analysis of Accurancy and Perioperative Outcomes

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Background Cervical pedicle screw fixation provides strong biomechanical stability but is technically demanding. Although navigation systems have improved placement accuracy, the influence of surgical approach on screw trajectory and deviation remains unclear.
Objective To compare navigation-guided minimally invasive cervical pedicle screw fixation (MICEPS) with the conventional open midline approach.
Methods We retrospectively analyzed 37 patients who underwent navigation-guided posterior cervical pedicle screw fixation between 2018 and 2023. Sixteen patients (48 screws) were treated using the conventional open approach (OPEN), and 21 patients (104 screws) using MICEPS. Both approaches used navigation systems. Operative time, intraoperative blood loss, screw insertion angle, and screw deviation graded by the Mobbs—Raley classification were evaluated.
Results Mean operative time did not differ significantly between groups. Blood loss was significantly lower in the MICEPS group (412.1 + 352.6 mL; median 380 mL, IQR 150-480) than in the OPEN group (657.5 + 638.2 mL; median 435 mL, IQR 300—678; $p < 0.05$). The mean screw insertion angle was significantly larger in the MICEPS group (30.2° + 5.3°) than in the OPEN group (22.8° + 6.0°, $p < 0.01$). Clinically significant screw deviation (Grade ≥2) occurred in 2.9% of screws in the MICEPS group compared with 12.5% in the OPEN group ($p < 0.05$).
Conclusion Navigation-guided MICEPS enables a more lateral and anatomically favorable screw trajectory, resulting in significantly lower rates of deviation and reduced intraoperative blood loss.

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Phase-Specific Learning Curve Analysis in Full-Endoscopic Interlaminar Lumbar Discectomy: A Multicenter CUSUM Study Focusing on Tacit Knowledge Acquisition.

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Introduction Full-endoscopic interlaminar lumbar discectomy (FESS-IL) offers significant minimally invasive benefits but is characterized by a steep learning curve. While existing literature often estimates proficiency based on operative time stability, these metrics frequently overlook the transition to "surgical independence." This study aimed to identify specific technical bottlenecks by decomposing the FESS-IL procedure into three phases and applying Learning Curve Cumulative Summation (LC-CUSUM) analysis, with a specific focus on the acquisition of tacit knowledge.
Methods A total of 155 consecutive FESS-IL cases performed by three surgeons (A, B, and C) under senior supervision were analyzed. The surgical process was divided into Phase 1 (Approach/Bony work), Phase 2 (Decompression/Ligamentum flavum resection), and Phase 3 (Discectomy). Success was defined as completing a phase within a predefined time threshold without physical intervention by the supervisor. Proficiency and autonomy were evaluated using LC-CUSUM tests.
Results Surgeon C, possessed prior micro-endoscopic experience and cadaveric training, achieved global proficiency at case 26. In contrast, Surgeons A and B reached proficiency in Phase 1 (cases 33 and 37) but did not achieve global proficiency within the study period. Phase 3 was identified as the universal "rate-limiting step," characterized by the highest frequency of supervisor intervention. While Phases 1 and 2 involve "explicit knowledge" (mechanical/bony tasks) that is more easily standardized, Phase 3 requires "tacit knowledge"—such as haptic feedback and depth perception under 2D visualization—which is significantly harder to master.
Conclusions The primary barrier to FESS-IL autonomy is Phase 3, involving delicate neural handling. Our findings suggest that traditional observational fellowships are insufficient for mastering the tacit skills required for surgical independence. Future training programs should prioritize pre-clinical simulations for mechanical phases while integrating video-based cognitive mentorship to bridge the gap in tacit knowledge acquisition.

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Innovate & Elevate MIS: Single-Position Prone Lateral Circumferential Fusion Eliminates Repositioning to Improve Efficiency and Resource Utilization

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Introduction/Objectives “Innovate & Elevate” in minimally invasive spine surgery (MIS) emphasizes smarter workflows that improve efficiency, safety, and value. Conventional anterior–posterior fusion (APF) often requires intraoperative repositioning between interbody fusion and posterior fixation, prolonging operative time and anesthesia exposure and adding repositioning-related risk. We compared perioperative efficiency, safety, and early radiographic outcomes between single-position prone lateral APF and conventional multiple-position APF.
Materials and Methods We retrospectively reviewed 40 patients undergoing thoracolumbar circumferential fusion (lateral/anterior-lateral interbody fusion plus posterior pedicle-screw fixation). Patients were grouped as multiple-position APF (n=20) or single-position prone lateral APF (n=20). Outcomes included operative metrics (total operative time, repositioning time, estimated blood loss [EBL], transfusion requirement), staffing needs (assistants, scrub nurses), anesthesia induction time, and early sagittal alignment (PI, LL, PI–LL mismatch, SVA) measured pre- and postoperatively.

Result/Discussion Surgical extent was comparable (disc levels 3.6±0.5 vs 3.5±0.5; decompressed levels 5.2±0.7 vs 5.1±0.7; screws 15.1±0.9 vs 14.7±1.0; all P>0.05). Single-position prone lateral APF reduced total operative time (402±40 vs 466±45 min, P=0.001) by eliminating repositioning (0 vs 62±12 min, P<0.001). EBL (760±180 vs 980±220 mL, P=0.002) and transfusion (4.4±1.3 vs 6.4±1.9 units, P<0.001) were lower. Staffing needs were reduced (assistants 3.5±0.6 vs 6.1±1.2; scrub nurses 2.6±0.5 vs 4.6±0.7; both P<0.001). Anesthesia induction time was longer (52±13 vs 43±8 min, P=0.042). Early sagittal alignment improvement was comparable across PI, LL, PI–LL mismatch, and SVA. No position-related neurologic or cardiopulmonary events occurred.
Conclusion Single-position prone lateral APF is a workflow innovation aligned with "Innovate & Elevate" MIS, improving operative efficiency and resource utilization while maintaining acceptable early safety and sagittal alignment outcomes. Prospective studies should confirm durability, fusion rates, and cost-effectiveness.

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Risk Factors for Reoperation after Minimally Invasive Tubular Transforaminal Lumbar Interbody Fusion: A Cohort Study of 756 Patients

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Introduction There is a paucity of high-volume series identifying the complication profile and risk factors for reoperation after MIS surgery. We analysed our department's experience with short-term (<30 days) and long-term (>30 days) reoperation for lumbar tubular TLIF.
Methods All procedures (2011-2024) were retrospectively reviewed. Eight neurosurgeons performed operations at our single centre. Two case-controls per complication were manually selected. Each control had undergone the same primary procedure within six months of the index case, at the same levels and by the same surgeon. Parameters assessed included age, sex, BMI, frailty, comorbidities, private/public status, workplace injury, antithrombotics, preoperative bloods, indications, prior spinal surgery, preoperative imaging findings, side of approach, operative time, use of postoperative drains/antibiotics, length of stay, time to follow-up, and clinical outcome. Variables were assessed with a series of univariate logistic regressions, using a broad statistical threshold of P<0.2 for identifying candidates as per convention. Multivariate logistic regressions were then conducted to reveal true associations.
Results From our database of 756 patients who underwent tubular TLIF, there was a 6.6% reoperation rate (n=50) at a mean follow-up of 1.5 years (SD 1.7 years). Short-term reoperation was predominantly for cage migration and had no statistical risk factors. Long-term reoperation was also mainly for cage migration and was associated with private status, workcover status, osteoporosis/osteopenia, and previous lumbar surgery. Combined timeframe reoperations were associated with workcover status, osteoporosis/osteopenia, diabetes, and previous lumbar surgery. Patients who had reoperations fared worse than their matched controls. Additionally, a worse patient outcome was associated with diabetes, frailty, and previous lumbar surgery.
Conclusion This retrospective case-control series reports our institution's complication profile and risk factors for reoperation and poor patient outcomes after tubular TLIFs. Our results suggest reoperation is associated with osteoporosis/osteopenia, diabetes, private-funding, workcover, and previous surgery.

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Risk Factors for Reoperation after Minimally Invasive Tubular Decompressions: A Cohort Study of 1233 Patients

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Introduction Minimally invasive lumbar decompression surgery, including laminectomy and foraminotomy, remains a standard option to relieve foraminal or canal stenosis whilst minimising iatrogenic tissue damage. However, a non-negligible group of patients require reoperations. Within a large cohort, this study examines rates and risk factors for reoperation, incorporating a breadth of assessed factors, short- and long-term timeframes, and patient outcomes, thereby addressing crucial gaps in the literature.
Methods We retrospectively reviewed all tubular decompressions performed by eight neurosurgeons at a single institution from 2011–2024. Reoperations were defined as subsequent surgeries at the same spinal level. Controls were matched by procedure type, timing, spinal level, and surgeon when possible. Collected data included demographics, comorbidities, frailty indices (mFI-5 and modified Charlson Comorbidity Index), healthcare coverage, and intraoperative details. Patient outcomes were assessed using a modified MacNab criteria. Univariate and multivariate statistical analyses were conducted to identify risk factors for reoperation and poor outcomes.
Results A total of 10.6% of patients required reoperation, of which 22.9% were early (<30 days) and 19.1% required a further reoperation. Predominantly, reoperations were washouts for haematoma in the short-term and redo decompressions for residual compression in the long-term. After multivariate analysis, patients were more likely to require reoperations in the short-term if they had depression/anxiety, a higher mCCI, preoperative platelet level or hypercholesterolaemia. In the long-term this was linked with being privately-funded or unilateral symptoms. Overall, worse MacNab outcomes were associated with younger age, depression/anxiety, and a higher MFI-5 comorbidity score.
Conclusions Within this large case-control series, we describe the complication profile after tubular lumbar decompression surgery. The identification of risk factors for reoperation and worse outcomes in both the short- and long-term may help guide preoperative planning and assist patient counselling.

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Evaluation of a Novel Posterolateral-Tip of Spinous Process (PL-TOSP) 25-Degree-Entry Angle Guide for Enhancing Precision and Efficiency in Transforaminal Endoscopic Spine Surgeries

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Study Design Prospective, randomized controlled trial involving 44 patients undergoing transforaminal endoscopic lumbar discectomy (TELD).
Purpose To evaluate the efficacy of a novel 25° PL–TOSP angle guide in improving the accuracy and efficiency of needle placement during TELD, and to determine its impact on radiation exposure, docking time, and clinical outcomes.
Methods Forty-four patients were randomized into two groups: one using the PL–TOSP 25° angle guide and the other using conventional free-hand needle placement. Procedures were performed under local anesthesia. Primary outcomes included docking time, fluoroscopic shots, radiation dose (Dose Area Product - DAP), and operative time. Secondary outcomes included pain (VAS), disability (ODI), and complication rates. Follow-ups were conducted at 15 days and 6 weeks postoperatively.

Results The PL–TOSP group had significantly fewer fluoroscopy shots (9.32 vs. 21.41; $p < 0.001$), lower radiation dose (DAP: 242.27 vs. 557.91; $p < 0.001$), and shorter docking time (16.36 vs. 26.32 minutes; $p < 0.001$). Total surgical time was lower in the guide group (83.45 vs. 94.59 minutes), though not statistically significant ($p = 0.113$). No complications were reported in either group. VAS and ODI scores showed similar improvements in both groups at all time points.
Conclusions The PL–TOSP angle guide improves procedural efficiency by reducing radiation exposure and docking time, without compromising safety or clinical outcomes. It standardizes needle trajectory, facilitating learning and consistency in transforaminal endoscopic spine surgery.

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Identification of Type-1B Niedre and Macnab Anomalous Nerve Root in Endoscopic Spine Surgery and Intraoperative Management with Damage Control: A Case Study

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Introduction Variations in lumbosacral nerve roots, such as low-lying nerve roots, are congenital anomalies that can complicate surgical procedures like routine discectomies. These anomalies can be easily missed on imaging leading to diagnostic challenges. We report a case of an undiagnosed low-lying L4 exiting nerve root led to iatrogenic complications during endoscopic decompression, requiring conversion to open transforaminal lumbar interbody fusion.
Case Report A 56-year-old female with rheumatoid arthritis and chronic low back pain presented with worsening bilateral lower limb radiculopathy. Imaging revealed an L4-5 disc herniation compressing the L5 nerve roots. During a right L4-5 percutaneous stenoscopic lumbar decompression (PSLD), an anomalous low-lying L4 exiting nerve was discovered, requiring additional facet joint burring, which led to a pars fracture. The procedure was converted to open surgery with contralateral decompression and transforaminal lumbar interbody fusion. Post-surgery, the patient experienced complete leg pain relief and improved mobility.
Conclusion This case emphasizes the necessity of thorough preoperative imaging and intraoperative vigilance in managing complex lumbar spine conditions. The unexpected discovery of an anomalous nerve structure warranted a conversion to open surgery, highlighting the importance of damage control to ensure patient safety. Adaptability during procedures can significantly reduce risks and improve outcomes in spine surgery.

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Can Fusion Be Avoided in Stable Grade I Degenerative Spondylolisthesis? Outcomes of Full Endoscopic Lumbar Decompression

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Background Fusion procedures such as TLIF remain the standard surgical option for symptomatic low-grade degenerative spondylolisthesis. However, fusion adds morbidity, cost, and loss of motion. With advances in endoscopic techniques, full endoscopic decompression may achieve similar outcomes in stable Grade I listhesis without the need for instrumentation.
Objective To evaluate clinical and functional outcomes of full endoscopic decompression in patients with stable Grade I spondylolisthesis and assess whether fusion can be safely avoided.
Methods A prospective study was conducted on 80 patients with symptomatic stable Grade I spondylolisthesis who underwent full endoscopic lumbar decompression between 2020–2024. Clinical outcomes were assessed using Visual Analog Scale (VAS) for back and leg pain, Oswestry Disability Index (ODI), and Macnab's criteria. **Radiological evaluation included slip progression at follow-up. Mean follow-up was 24 months.**
Results All patients demonstrated significant improvement in VAS and ODI scores at 3 months, sustained through 24 months ($p < 0.05$). According to Macnab's criteria, 85% had excellent-to-good outcomes. Slip progression was not observed in the majority (94%), and only 3 patients required secondary fusion during follow-up. No major complications were reported.
Conclusion Full endoscopic decompression provides excellent pain relief and functional recovery in patients with stable Grade I spondylolisthesis, with minimal risk of slip progression or need for secondary fusion. These findings suggest that routine TLIF may represent overtreatment in this subgroup, and motion-preserving endoscopic decompression should be considered a safe and effective alternative.

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Expanding the Horizons of Robotic Surgery: Robot-Assisted Oblique Lateral Lumbar Interbody Fusion (OLLIF) — A Case Report

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OBJECTIVE To describe the feasibility and technical application of robotic guidance in oblique lateral lumbar interbody fusion (OLLIF) for degenerative lumbar pathology.
METHODS A 42-year-old female with Grade I L4–L5 degenerative spondylolisthesis and bilateral radiculopathy underwent robotic-assisted OLLIF with percutaneous pedicle screw fixation. Intraoperative computed tomography–based table mounted robot with navigation capabilities (MazorX) was used for planning pedicle screw trajectories, tubular access, and interbody cage placement. Continuous intraoperative neuromonitoring, including motor evoked potentials, was employed throughout the procedure.
RESULTS Robotic guidance enabled accurate pedicle screw and interbody cage placement through a limited surgical corridor without facet joint violation. Postoperative imaging confirmed restoration of disc height and indirect foraminal decompression. The patient was mobilized on postoperative day one and experienced no perioperative neurological deficits or complications.
CONCLUSIONS Robotic-assisted OLLIF is a feasible and safe technique that combines the advantages of minimally invasive lateral access with enhanced surgical precision. This approach may expand the role of robotic technology in lateral lumbar fusion procedures. Further studies with larger cohorts and long-term follow-up are required to validate its clinical efficacy.

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The Effect of Exoscopic Minimally Invasive Cervical Open-door Laminoplasty on Reducing Postoperative Axial Pain and Cervical Kyphotic Deformity

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Objective Open-door cervical laminoplasty is widely used for cervical compressive myelopathy; however, postoperative axial neck pain and cervical kyphotic deformity remain major concerns due to posterior soft-tissue injury. We developed an exoscopic minimally invasive open-door laminoplasty (ExLAP) using an exoscope and mini-plates. This study aimed to compare one-year postoperative outcomes of ExLAP with those of the conventional open technique.
Materials and Methods Ninety patients who underwent open-door cervical laminoplasty were retrospectively reviewed. Forty patients were treated using ExLAP (E group), and 50 patients underwent the conventional Hirabayashi open-door technique (C group). ExLAP was performed through a small midline skin incision of approximately 35 mm using an exoscope, with complete preservation of the C2 and C7 semispinalis muscles. The conventional technique required an approximately 10-cm incision with partial or complete detachment of the C2 semispinalis muscle. Cervical lordosis was evaluated using plain radiographs preoperatively and at one year postoperatively. Postoperative axial neck pain and Japanese Orthopaedic Association (JOA) scores were also assessed.
Results Mean cervical lordosis changed from 11.6° preoperatively to 12.1° at one year in the E group and from 7.8° to 1.7° in the C group, with mean changes of 0.5° and −6.1°, respectively ($P < 0.001$). Postoperative axial neck pain was observed in 11% of patients in the E group and 66% in the C group ($P < 0.01$). Mean JOA scores improved from 10.7 to 13.4 in the E group and from 10.4 to 12.7 in the C group, with recovery rates of 45% and 37%, respectively ($P = 0.10$).
Conclusion ExLAP significantly reduces postoperative axial neck pain and better preserves cervical lordosis compared with the conventional technique. By minimizing posterior soft-tissue injury and fully preserving the C2 semispinalis muscle, ExLAP represents an effective minimally invasive alternative for cervical laminoplasty.

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Comparative Biomechanical Analysis of Fixation Strategies Following Oblique Lateral Interbody Fusion: Finite Element Study of Lateral and Posterior Constructs

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Introduction/Objective Oblique lateral interbody fusion (OLIF) offers indirect decompression and minimal muscle disruption through the retroperitoneal anteropsoas corridor. To enhance stability and prevent cage subsidence, posterior bilateral pedicle screw fixation (BPSF) remains the standard technique, though it requires repositioning and increases operative morbidity. Recently, lateral screw fixation (LSF) has been introduced as a less invasive alternative enabling single-position OLIF, but its biomechanical performance relative to BPSF remains uncertain.
Methods A validated finite element model (FEM) of the L1–S1 spine was developed using CT data from a healthy 64-year-old male. Eight OLIF models were constructed: single- and two-level fusions with four fixation strategies—cage alone, cage + unicortical LSF, cage + bicortical LSF, and cage + BPSF. A 400 N preload and 10 N·m pure moment were applied in flexion, extension, lateral bending, and axial rotation. Range of motion (ROM), interbody cage stress, and screw–bone interface stress were analyzed and compared among models.
Results BPSF achieved the greatest segmental stability (flexion: 32.45% of intact; extension: 26.52%) and lowest cage-endplate and screw stresses. Bicortical LSF reduced ROM and screw stress compared with unicortical LSF (flexion: 67.17% vs. 92.26%), but remained less stable than BPSF. Adjacent segment ROM increased most with BPSF, particularly in two-level fusion (flexion 147.3% of intact), indicating higher risk of adjacent segment degeneration.
Conclusion BPSF provides superior biomechanical stability and lowest implant stress, confirming its gold-standard status for OLIF fixation. However, bicortical LSF demonstrates meaningful biomechanical improvement over unicortical LSF and may serve as a viable, less invasive alternative in selected patients, balancing fixation strength with reduced adjacent-segment stress.

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Technical Feasibility and Early Outcomes of Minimally Invasive Transforaminal Lumbar Interbody Fusion with Large-Footprint Cage (MIS-LTLIF) via Tubular Approach: A Novel Surgical Technique

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Introduction Minimally invasive transforaminal lumbar interbody fusion (MIS TLIF) has become a widely accepted technique for the management of degenerative lumbar spine pathologies. Traditionally, standard TLIF cages have a smaller footprint, providing limited endplate. Larger footprint cages can only we inserted through anterior or lateral approach.
Objective To describe the surgical technique of MIS TLIF using a large-footprint cage (MIS LTLIF)
Methods A prospective analysis was conducted on 50 patients (65 levels) who underwent MIS-LTLIF for degenerative lumbar spine disease. After standard tubular docking over the facet joint, complete facetectomy was performed to create a wide window between the exiting and traversing nerve root. After meticulous disc space preparation, the cage was inserted and rotated in a reverse orthogonal maneuver to orient it in the horizontal position.
Results Preliminary findings demonstrate that insertion of large footprint cage is feasible via MIS TLIF approach without any complications. Our average cage size was 40 × 15 × 10 mm and the average operative time was 1 hour 55 minutes per level. VAS (back pain) improved pre-operatively from 8.00 ± 0.87 to 4.22 ± 0.97 ($p= 0.000039$) while VAS (leg pain) improved from 8.22 ± 0.83 to 1.67 ± 0.51 ($p= 0.000000017$) post-operatively. The ODI score improved from 59.78 ± 4.87 to 21.22 ± 2.68 ($p < 0.001$) indicating statistically significant improvement. Only one patient complained of post-operative unilateral radicular pain which got relieved with medication over 2 weeks.
Conclusion MIS LTLIF represents a novel, minimally invasive modification of the conventional MIS-TLIF technique that facilitates the placement of a large-footprint cage. By combining the advantages of posterior minimally invasive access with the biomechanical benefits of wider-footprint cages, this technique has the potential to bridge the gap between MIS-TLIF and anterior/lateral fusion strategies.

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Stand-Alone OLIF: A Viable Treatment Option for Adjacent Segment Disease

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Background Adjacent segment disease (ASD) remains a challenging complication following spinal fusion surgery. Stand-alone Oblique Lateral Interbody Fusion (OLIF) has emerged as a promising minimally invasive solution.
Objective To evaluate the efficacy and safety of stand-alone OLIF in treating ASD.
Methods A total of 25 consecutive patients who underwent stand-alone OLIF for the treatment of adjacent-segment disease were reviewed. Visual analog scale (VAS) of back pain and leg pain and the Oswestry Disability Index (ODI) before surgery and at last postoperative clinic visits were obtained. Clinical outcomes, radiographic parameters, and complications were assessed.
Results During the study period, 25 cases were successfully treated with stand-alone OLIF. The mean follow-up was 12.7 ± 8.3 months. The back pain VAS improved from 7.2 ± 1.4 to 2.0 ± 1.2 ($P < 0.01$), and the leg pain VAS improved from 8.0 ± 1.8 to 1.4 ± 0.9 ($P < 0.01$). ODI improved from 29.0 ± 7.5 to 9.8 ± 3.0 ($P < 0.01$). The disc height (DH) increased from 8 ± 2 to 13 ± 2 mm ($P < 0.01$), the cross-sectional area (CSA) of spinal canal increased from 82 ± 24 to 138 ± 24 mm2 ($P < 0.01$), the foraminal height increased from 16 ± 2 to 22 ± 2 mm ($P < 0.01$) and the CSA of foramen increased from 93 ± 25 to 158 ± 33 mm2 ($P < 0.01$). Cage subsidence was observed in 1 case.
Conclusion Stand-alone OLIF demonstrates promising results in treating ASD, offering: - Reduced operative time and blood loss; - Minimally invasive approach; - Improved clinical outcomes; - Low complication rates

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PROSPECTIVE COMPARATIVE STUDY TO ASSESS THE CLINICO-RADIOLOGICAL ADEQUACY OF CORD DECOMPRESSION AFTER NAVIGATED VS NON-NAVIGATED LAMINECTOMY IN CERVICAL SPONDYLOTIC MYELOPATHY

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Introduction Cervical laminectomy has traditionally been performed non navigated. Use of navigation for laminectomy is emerging technique to improve outcome in decompression surgeries.
Methods Cervical Spondylotic Myelopathy treated with Navigated and Non-Navigated laminectomy was included in the study and the data was compared prospectively. Preop and Postop MRI and CT scans were used to assess radiological adequacy of cord.
Result Both navigated and non-navigated procedures showed improvement in 75 patients, with mean VAS scores decreasing. The mean pre operative mJOA improved in Navigated laminectomy, as indicated by a P-value of 0.0001. Mean Cord Compression (MCC) percentages decreased significantly ("<0.0001") in Navigated approach. Mean Spinal Cord Compression (MSCC) percentages decreased significantly overall (P-value 0.008), primarily in navigated surgeries. Non-navigated surgeries had longer operative times (144.51 minutes) than navigated (136 minutes). Navigated procedures had a lower incidence of facetal Breach (1) compared to non-navigated (5). Navigated procedures showed lesser mean blood loss of 263.7 ml compared to non-navigated procedures having 340.9 ml.
Conclusion Navigated surgical approach resulted in significant improvements in Functional and Clinico-radiological parameters post-surgery as compared to non-navigated approach. Use of Navigation exhibited lower rates of complications, better patients' satisfaction, and lesser chances of future instabilities, mainly because of limited bony excision.

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Navigation assisted Endoscopic excision of Lumbar vertebral Osteoid Osteoma in 21-year-old male

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Introduction There are various treatment options like Surgical excision, Radiofrequency Ablation (RFA), CT-guided cryoablation and MR-guided focused ultrasound. Navigation assisted Endoscopic Excision is a novel technique which appears to be an innovative with promising diagnostic and therapeutic option.
Objective To demonstrate more precise, effective, and potential advantages of navigation-assisted endoscopic excision technique for the treatment of osteoid osteoma.
Materials and Methods 21-year-old male with CT and MRI scans of Lumbar spine showing round lytic lesion with surrounding sclerosis at left lamina of L2 vertebra. The patient was planned for navigation assisted endoscopic resection in prone position as neural structure was 4mm away from tumour margin. 3D C-arm was used to scan the lumbar spine and data was analysed using Brainlabs Navigation System. With the help of Navigation probe accurate trajectory was confirmed for Endoscope to reach lamina of L2 from right side then with the help of navigated burr drilling of lamina was done and under visualisation nidus was removed en bloc. Traditional open surgical method may result in the absence of accurate localisation, excessive surgical resection of bone, spinal instability or approach related morbidity. New surgical modalities like RFA, cryoablation and MR guided ultrasound carry risk of damage to adjacent neural structures and lack histological diagnosis.
Conclusion Navigation assisted endoscopy offers advantage of minimal incision, better visualisation, protection of neural structures, histological diagnosis. It appears to be an innovative and potentially promising diagnostic and therapeutic approach as it is safe, effective and relatively low morbidity intervention.

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INTRAOPERATIVE 3D IMAGING WITH MRI FUSION-BASED NAVIGATION: A TRUE GPS IN SPINE SURGERY

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Introduction Spine surgery requires precise planning and execution to ensure optimal outcomes. This study explores the use of intraoperative 3D imaging with MRI fusion-based navigation (F-Navigation) to enhance accuracy and safety in various spine procedures.

Objective To evaluate the accuracy and safety of F-Navigation in spine surgery, including cervical laminectomy, posterior endoscopic cervical foraminotomy (PECF), spinal tumor excision, and infective thoracolumbar spondylodiscitis.
Methods A prospective review of 102 patients undergoing spine surgery with F-Navigation was conducted. A fusion software integrated intraoperative 3D images with preoperative MRI using predetermined protocols.
Results F-Navigation demonstrated high accuracy in identifying both bony and soft tissue anatomy. The system enabled precise localization of pathology in 98% of cases (100/102). F-Navigation facilitated: Precise decompression of the spinal cord in cervical laminectomy; Accurate targeting of the C junction in posterior endoscopic foraminotomy; Precise trajectory into the disc space for biopsy and debridement in spondylodiscitis; Complete resection of tumor margins while preserving critical neural structures
Conclusions Intraoperative 3D imaging with MRI fusion-based navigation (F-Navigation) is a valuable tool in spine surgery, enhancing accuracy, safety, and clinical outcomes. Further studies are necessary to evaluate long-term outcomes, compare F-Navigation with other navigation systems, and investigate cost-effectiveness.

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Prospective study to compare the outcomes ACDF vs posterior endoscopic cervical foraminotomy in surgical management of compressive unilateral cervical radiculopathy

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Introduction Unilateral cervical radiculopathy results due to the compression of a soft or hard disc on the cervical root. ACDF is the gold standard of cervical fusion surgeries. Posterior endoscopic cervical foraminotomy (PECF) is emerging as a minimally invasive approach to unilateral cervical radiculopathy nor responding to medical management.
Material and Methods Patients with compressive unilateral cervical radiculopathy treated with both ACDF and PECF were included in the study. Pre op and post op VAS, ODI scores, Macnab scores and return to work in days after surgery was used to compare the functional outcomes between the two groups.
Results 64 patients were included in the outcome analysis. Both the techniques showed comparable improvement in VAS and ODI scores in post operative follow up period. Macnab score was significantly better for PECF group suggestive better patients' satisfaction with endoscopic approach. Return to work after surgery was significantly early with the PECF group at 10.5 days compared to 22.76 days in ACDF patients.
Conclusion Both ACDF and posterior endoscopic cervical foraminotomy can result in good clinical outcomes in patients of compressive unilateral cervical radiculopathy. Use of endoscopic cervical foraminotomy can result in better patients' satisfaction and early return to work.

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Percutaneous endoscopic treatment for lumbar disorders as day surgery：A-2-Year Follow-Up Retrospective Cohort Study

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Purpose This study summarizes clinical data on daytime percutaneous endoscopic treatment for lumbar disc herniation and lumbar spinal stenosis, comparing outcomes with those of matched hospitalized patients, aiming to analyze its clinical efficacy and identify associated challenges.
Methods Retrieve clinical data from the shared database of orthopedic cases, which contains a total of 5,793 cases. Among them, 2,592 cases involve lumbar spine diseases, with some of these patients having undergone daytime percutaneous endoscopic surgery for LDH or LSS by the same team. Match these with hospitalized patients at a 1:2 ratio. A total of 478 patients were recruited, of which 164 underwent daytime surgery and 314 underwent inpatient surgery. All patients were followed with 2 years; a set of clinical outcomes were extracted and analyzed.
Results Compared to the inpatient surgery group, the day surgery group demonstrated significantly reduced hospitalization duration and costs ($P<0.05$). However, the incidence of worsened symptoms after discharge was significantly lower in the PEID-A group compared to the PEID-D group ($P<0.05$). Compared to hospitalized surgical patients, there is no significant difference in the recurrence rate among day surgery patients（$P>0.05$）.
Conclusion The therapeutic effect of percutaneous endoscopic treatment for lumbar spine diseases performed as day surgery is satisfactory. While offering advantages such as lower costs and shorter hospital stays, daytime percutaneous endoscopic surgery requires enhanced preoperative preparation, postoperative medication, patient guidance, and rehabilitation.

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Intraoperative changes in modified coronal root angle following biportal endoscopic lumbar decompressive foraminotomy for lumbar foraminal disc disease

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Introduction/Objectives Although paraspinal decompressive foraminotomy (PDF) is the gold standard for lumbar foraminal disc disease (LFDD), unsatisfactory outcomes have been reported in 20% of cases. The coronal root angle (CRA) has emerged as a key prognostic factor, with previous evidence suggesting it reflects ventral decompression. This study investigates intraoperative changes in modified CRA (mCRA), defined as the acute angle between the exiting nerve root and the vertebral endplate plus 90°, during biportal endoscopic PDF (BE-PDF) and their correlation with clinical improvement.
Materials/Methods This retrospective study included 89 patients who underwent BE-PDF for LFDD. Intraoperatively, mCRA was measured immediately after flavectomy (mCRA1) and again after removal of the ventral pathologies (mCRA2). Patients were stratified into two groups based on the minimal clinically important difference (MCID), defined as an ODI improvement of ≥13 points. Statistical analysis was conducted to compare the differences in mCRA and other radiographic parameters, including lumbar lordotic angle (LLA), disc lordotic angle (DLA), and posterior disc height (PDH), between the two groups.
Result/Discussion Patients were categorized into Group A (n=71), who achieved the MCID, and Group B (n=18), who did not. The mean mCRA1 was comparable between the two groups, with values of 120.17° in Group A and 118.25° in Group B ($p=0.25$). However, the mean mCRA2 demonstrated a statistically significant difference, measuring 128.03° in Group A compared to 122.03° in Group B ($p=0.01$). Furthermore, the intraoperative change in mCRA (mCRA2–mCRA1) was significantly greater in Group A (7.86°) than in Group B (3.75°; $p<0.001$). Preoperative LLA, DLA, and PDH were similar between the two groups ($p>0.05$)

Conclusions Our results indicate that intraoperative changes of mCRA and the mCRA2 were significantly associated with clinical outcomes. These findings suggest the potential utility of mCRA as an intraoperative marker for evaluating the adequacy of direct foraminal decompression.

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Lumbar Interbody Fusion Using a Robot Assisted Spine Surgery: A Comparative Study of Two Surgical Techniques Performed in the Early Phase

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Objective We have performed lumbar interbody fusion using a spinal surgical assistance robot, performing posterior lumbar interbody fusion (PLIF) with cortical bone trajectory technique and extraforaminal lumbar interbody fusion (ELIF) using PPS. This study aimed to evaluate pedicle screw accuracy between these two procedures.
Methods A total of 45 patients who underwent lumbar interbody fusion using the Mazor X Stealth Edition® were included (PLIF: 20 cases; ELIF: 25 cases). All procedures were performed by the same surgeon from the initial introduction. In PLIF group, the mean age was 77.4 years with 86 screws placed. In ELIF group, the mean age was 74.5 years with 108 screws placed. Screw deviation was assessed using the Gertzbein–Robbins classification, with Grade 2 (≥2 mm) or higher. Operation time and radiation exposure time per level were also evaluated.
Results No Grade 2 or higher were observed in PLIF group, whereas three breaches occurred in ELIF group, all of which were lateral deviations. The operation time was significantly shorter in ELIF group (68 minutes) compared with PLIF group (88 minutes). Radiation exposure time was 6.9 seconds in PLIF group and 7.1 seconds in ELIF group, with no significant difference between groups.
Discussion A higher incidence of screw deviation was observed in the ELIF group, in which screws were inserted using PPS. This may be attributable to soft tissue tension and skiving associated with the minimal skin incision. However, ELIF does not require manipulation within the spinal canal, allowing for a shorter operative time. Furthermore, robotic assistance eliminated the need for radiation exposure during screw placement, limiting radiation use to cage insertion only. Consequently, both techniques achieved substantial reduction in intraoperative radiation exposure.

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A Comprehensive Protocol for Neural Safety in Severe Spinal Deformity Surgery

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Introduction/Objectives Severe spinal deformity (Cobb angle >90) presents a significant surgical challenge with a reported 6.3% risk of catastrophic spinal cord injury. This study presents a multi-pillar "Marathon Strategy" designed to minimize neurological complications through a comprehensive perioperative safety protocol.
Materials and Methods The protocol integrates three key phases:
1. Pre-operative Risk Stratification: Utilizing advanced imaging parameters like the Deformity Angle Ratio (DAR) and MRI-based classifications to identify high-risk patients (e.g., S-DAR >22 or Spinal Cord Angle <95). Pre-operative Halo traction is employed to improve vital capacity and reduce the need for high-grade osteotomies. 2. Intra-operative Precision: Implementing 3D-printed models, personalized surgical guides, and robotic assistance. Innovative "tension-distributing" techniques, such as Multiple Asymmetric Ponte Osteotomies (MAPO) and modified Posterior Vertebral Column Resection (mPVCR), are used to protect the spinal cord. 3. Anesthesia & Monitoring: Maintaining Mean Arterial Pressure (MAP) at 85-90 mmHg and multimodal IONM (SSEP+MEP) with a 3-minute "Golden Window" response protocol for alarms.
Result/Discussion Clinical application of this protocol demonstrates significant deformity correction (up to 71-81%) and height gains while maintaining neural integrity. Pre-operative Halo Pelvic Traction (HPT) reduced the requirement for three-column osteotomies by 63.6%. The use of MAPO effectively dispersed corrective strain, providing a wider epidural space for the spinal cord compared to traditional PVCR.
Conclusion Neural safety in severe spinal deformity surgery is achieved not through a single technique, but through a systematic "Marathon" approach. By combining predictive risk modeling, innovative osteotomy techniques, and vigilant 24-hour post-operative monitoring of the "5 Red Flags," surgeons can significantly mitigate the risk of catastrophic injury.

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SURGICAL STRATEGIES AND OUTCOMES OF ONE-STAGE POSTERIOR RESECTION FOR CONGENITAL CERVICOTHORACIC JUNCTION (CTJ) DEFORMITIES

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Introduction/Objectives The cervicothoracic junction (CTJ) is an anatomical "no-man's land" characterized by a transition from mobile cervical lordosis to rigid thoracic kyphosis. Surgical intervention in this "minefield" faces significant risks, including vertebral artery injury and C8/T1 nerve root damage. This study evaluates the efficacy and safety of one-stage posterior hemivertebra resection and short-segment fusion for treating congenital CTJ deformities.
Materials and Methods A retrospective cohort study was conducted on 19 patients (selected from an initial 29) treated between January 2018 and March 2022. Inclusion criteria required a congenital hemivertebra at C6–T4, one-stage posterior resection with short-segment fixation, and a minimum 2-year follow-up. Preoperative planning utilized 3D digital simulation and CTA to map vascular variations.
Result/Discussion Significant corrections were achieved in both coronal and sagittal planes. The local Cobb angle improved from 50.20° to 20.87° (58.4% correction), and segmental kyphosis decreased from 31.21° to 16.40° ($P < 0.001$). Sagittal balance (SVA) improved from 56.89 mm to 32.47 mm. SRS-22 scores showed marked improvements in pain and self-image. Critical success factors included total intraoperative neuromonitoring (IONM) and prophylactic foraminotomy to prevent the "guillotine effect" on the C8 nerve root during osteotomy closure.

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Innovation of Osteotomy Techniques for Severe Spinal Deformity

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Background Surgical correction of severe, rigid spinal deformities presents significant challenges, including high neurological complication rates (2%–17.1%) and substantial blood loss. Traditional techniques like Posterior Vertebral Column Resection (PVCR) are effective but technically demanding with high risks.
Methods:This study evaluates three innovative osteotomy techniques developed by the Beijing Chaoyang Hospital team:
1. Multiple Asymmetric Ponte Osteotomy (MAPO): A multi-level approach for rigid adult idiopathic scoliosis. 2. Modified PVCR (mPVCR): A technique for severe post-tuberculous kyphosis that preserves posterior elements (lamina and spinous processes) to enhance stability and safety. 3. Posterior Trans-Intervertebral Osteotomy with Anterior Support (PTIOAS): A novel method for kyphosis secondary to ankylosing spondylitis (AS) utilizing intervertebral space approach and cage placement.
Results * MAPO: Compared to single-level PVCR, MAPO showed reduced operation time and blood loss while effectively addressing rigid curves.
* mPVCR: In a comparative study of 62 patients, the modified group achieved significantly better focal kyphosis correction (62.20% vs. 51.46%, P=0.001) and a lower incidence of neurological complications (16.1% vs. 38.7%, P=0.046). * PTIOAS: In 45 AS patients, PTIOAS provided comparable radiographic correction to Pedicle Subtraction Osteotomy (PSO) but with significantly less blood loss (600.9 mL vs. 1088.7 mL, $P=0.009$) and fewer neurological complications (5.3% vs. 15.4%, P=0.003).
Conclusion Innovative osteotomy techniques such as MAPO, mPVCR, and PTIOAS provide safer, less invasive alternatives for severe spinal deformities. By preserving anatomical structures or utilizing intervertebral approaches, these methods significantly reduce blood loss and neurological risks while maintaining excellent deformity correction.

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A Single Portal Non-Coaxial Endoscopic Technique (SP-NCET) for Treatment of L5 Double Crush Syndrome ： A Novel Technique Note
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A 73-year-old man presented with severe left L5 and S1 radiculopathy due to double crush of L5 traversing nerve root (TNR) and exiting nerve root(ENR) combined with compression of S1 TNR. In this study, we described a novel single-portal non-coaxial endoscopic technique (SP-NCET), of which a single oblique incision centered around the L5 isthmus combined with a non-coaxial endoscopic system to sequential decompression of L5 TNR, ENR and S1 TNR. The procedure was successful with resolution of radicular pain and significant improvement in disability scores. In conclusion, the novel SP-NECT offers a less invasive and effective option for L5 DCS combined with S1 TNR compression

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Unilateral Biportal Endoscopic (UBE) Posterior Foraminotomy for Cervical Radiculopathy: A Retrospective Clinical Analysis of 30 Consecutive Cases
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Introduction Unilateral Biportal Endoscopy (UBE) has emerged as a promising minimally invasive technique for lumbar spine disorders. Its application in the cervical spine, particularly for radiculopathy, is less documented. This study aims to evaluate the clinical efficacy and safety of UBE posterior cervical foraminotomy and discectomy in patients with cervical radiculopathy.
Materials and Methods A single-center, retrospective analysis was conducted on 30 consecutive patients with cervical radiculopathy refractory to conservative treatment, who underwent UBE posterior foraminotomy with a minimum of 6 months of follow-up were assessed using the Visual Analog Scale (VAS) for arm and neck pain and the Neck Disability Index (NDI) for function recovery. Operative time, estimated blood loss (EBL), hospital stay, and complications were recorded.
Results All 30 procedures were successfully completed without conversion to open surgery. The mean follow-up period was 7.8 ± 2.1 months. Significant improvements were observed in VAS and NDI scores at all postoperative time points (1-day, 3-months, and final follow-up) compared to preoperative values. The mean VAS for arm pain decreased from 7.8 ± 1.2 preoperatively to 1.3 ± 0.9 at the final follow-up ($p < 0.001$). The mean NDI improved from 65.5 ± 12.4% to 14.2 ± 6.1% ($p < 0.001$). According to the modified MacNab criteria, 93.3% of patients reported excellent or good outcomes. The mean operative time was 78.4 ± 16.2 minutes, mean EBL was 35.5 ± 10.8 mL, and the mean hospital stay was 1.8 ± 0.6 days. One patient experienced transient dysesthesia, which resolved within two weeks.
Conclusion UBE posterior cervical foraminotomy is a safe and effective minimally invasive surgical technique for the treatment of cervical radiculopathy. It provides significant and rapid relief of radicular pain and functional improvement with a low complication rate and short hospital stay. It represents a viable alternative to both traditional open and other endoscopic techniques.

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Flavum Shield Technique: A Novel Ligamentum Flavum–Preserving Method to Protect Neural Elements During Cage Insertion in Endoscopic Lumbar Interbody Fusion (EndoLIF)
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INTRODUCTION / OBJECTIVES Endoscopic lumbar interbody fusion (EndoLIF) is increasingly adopted for minimally invasive lumbar fusion. However, cage insertion remains a critical step where neural structures are vulnerable, often necessitating neural retraction or assistance for protection. We describe a novel technical modification—the Flavum Shield Technique—in which the ligamentum flavum and/or part of medial facet are temporarily preserved to function as a natural protective barrier during cage insertion.
MATERIALS AND METHODS Two patients undergoing single-level EndoLIF for degenerative lumbar pathology were treated using the Flavum Shield Technique. During decompression using a far lateral approach, the medial aspect of the inferior articular process and ligamentum flavum were intentionally preserved to create a protective anatomical barrier over the dura and traversing nerve root. Disc preparation and endplate work were completed endoscopically. Cage insertion was performed while the flavum–facet complex remained intact, thereby avoiding direct neural manipulation. The remaining ligamentum flavum was subsequently removed to complete decompression.

RESULTS / DISCUSSION Both procedures were successfully completed without intraoperative neural injury or the need for neural retraction. The preserved flavum–facet complex provided a stable protective layer over the neural elements during cage insertion. This technique maintained a safe working corridor and reduced reliance on an assistant for neural protection. Postoperative imaging confirmed satisfactory cage positioning and adequate decompression. The technique demonstrates a simple anatomical strategy that enhances neural safety during EndoLIF.
CONCLUSION The Flavum Shield Technique represents a novel ligament-preserving strategy during EndoLIF that uses native anatomy to protect neural elements during cage insertion. This approach may reduce neural manipulation and simplify cage placement. Further studies are required to validate its safety and reproducibility.

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Evaluation of the Safety and Efficacy of Modified Single-Portal Split Endoscopic Surgery in 154 Patients with Lumbar Degenerative Disc Disease
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Objective This study aims to assess the safety and efficacy of a modified single-portal split endoscopic technique for treating LDDD, focusing on clinical outcomes in a cohort of 154 patients.
Methods A total of 154 patients diagnosed with LDDD were treated using the modified single-port endoscopic technique from May 2023 to January 2026. Among them, 133 cases with lumbar disc herniation underwent single-level or two level discectomy, while 21 were treated with spinal fusion and internal fixation due to lumbar spondylolysis or unstable. Clinical outcomes were evaluated based on the Visual Analog Scale (VAS) for pain, the Oswestry Disability Index (ODI) for functional status, and complication rates within a follow-up period of 6-12 months.
Results Recurrent of lumbar disc herniation rate was 2.2%. Notable absence of: intra-operative nerve root or dural tear and post-operative hematoma requiring surgery. There were no infection and other major complication. Preliminary findings indicate significant postoperative improvements in VAS scores, with an average reduction of 80% in pain levels among discectomy patients and 70% among fusion patients. The fusion rate was about 90%. The ODI also showed marked enhancement in functional recovery, with an average improvement of 75% in both groups. There were no instances of screw fractures or pullout, rod fractures, or prosthesis displacement.
Conclusion The modified single-port split endoscopic technique demonstrates promising safety and efficacy for treating lumbar degenerative disc disease. The reduction in pain and improvement in functional outcomes, combined with a low incidence of complications, suggest that this approach may serve as a viable alternative to traditional surgical methods. Further studies with larger cohorts and longer follow-up periods are warranted to validate these findings and optimize surgical protocols in the management of LDDD.

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UBE-eXTLIF with endoscopic unilateral pedicle screw fixation for lumbar degenerative diseases
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Objective The aim of the study was to investigate the feasibility and clinical effects of unilateral biportal endoscopic extreme transforaminal lumbar interbody fusion (UBE-eXTLIF) combined with endoscopy-assisted percutaneous unilateral pedicle screw fixation for the treatment of single level lumbar degenerative diseases.
Materials and Methods Patients with single level lumbar degenerative diseases who received UBE-eXTLIF combined with endoscopy-assisted percutaneous unilateral pedicle screw fixation from June 2022 to September 2022 were retrospectively analyzed. We recorded operation time, length of postoperative hospital stays and complications. Visual Analogue Scale (VAS), Oswestry Disability Index (ODI) and modified Macnab scale were used to evaluate the clinical effects.
Results The operation was successfully completed in all cases. The operation time was (155.0±11.6) min. The postoperative hospital stay was (5.1±2.2) days. No serious complications such as dural tears, vascular and nerve injury occurred during operation. Preoperative VAS scores of low back pain were (4.9±0.8) and respectively decreased to (2.1±0.6), (1.3±0.5),(1.1±0.4)and (1.3±0.5) at postoperative 1month,3months, 6months and 1 year, and the difference was statistically significant (P<0.05). Preoperative VAS scores of lower limb pain were (5.1±0.6) and respectively decreased to (1.6±0.5),(1.3±0.5),(1.1±0.4)and (0.9±0.4) at postoperative1month,3months, 6months and 1 year, and the difference was statistically significant (P<0.05). Preoperative ODI scores were (64.2±3.8) and respectively decreased to (30.3±8.0),(28.6±7.3),(22.6±5.5)and (20.7±7.1) atpostoperative1month,3months, 6months and 1 year, and the difference was statistically significant (P<0.05). According to the modified Macnab criteria, the final outcomes were excellent in 6 cases, good in 1 case, fair in 1 case.
Conclusions UBE-eXTLIF combined with endoscopy-assisted percutaneous unilateral pedicle screw fixation can achieve excellent clinical results and may become a new minimally invasive endoscopic fusion method for lumbar degenerative diseases.

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The possibility and safety for percutaneous lumbar cortical bone trajectory screws insertion-A morphometric study using computed tomography
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Objective To simulate the placement of percutaneous cortical bone trajectory (CBT) screws using reconstructed lumbar CT images and three-dimensional lumbar models, and accurately measure the key morphometric parameters to provide a reliable anatomical reference for guiding clinical percutaneous CBT screw implantation.
Method CT images of 100 adult patients with lumbar spine diseases were collected and reconstructed by Mimics software. The projection point on the lamina at the junction of the inner edge and lower edge of the smallest coronal section of lumbar pedicle was defined as the standard entry point. Multiple parameters were measured, including cephalad angle, lateral angle, maximum screw length and diameter, trajectory-spinous process distance and superior endplate ratio, and the spatial relationship between the trajectory and spinous process was observed via 3D reconstructed images.
Result For L1-L5, lateral angles (9.29±0.67° to 13.46±1.50°) and screw diameters (5.65±0.49 to 8.35±0.90mm) rose gradually, with significant diameter differences across most levels except L1 and L5; cephalad angles (26.58±1.17° to 23.97±1.84°) declined slightly at lower segments, and screw lengths peaked at L4 (37.75±0.81mm). Superior endplate ratio had statistical differences between L1-L2 and L2-L5, while trajectory-spinous process distance showed no inter-segment difference. 3D models clearly revealed no spinous process obstruction to simulated screws, and the trajectory tips were stably located near the posterior two-fifths of the superior endplate of the instrumented level.

Conclusion Percutaneous implantation of lumbar CBT screws is clinically feasible with no obstruction from the spinous process during the operation. The spinous process and superior endplate can be served as important and easy-to-identify anatomical landmarks to guide the accurate and safe placement of percutaneous CBT screws in clinical practice

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OLIF vs TLIF for Degenerative spondylolisthesis with spinal stenosis ： a subgroup analysis based on stenosis severity

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Introduction TLIF is widely used for the treatment of degenerative lumbar spondylolisthesis with spinal stenosis. However, it often requires extensive posterior muscle dissection. OLIF has emerged as a minimally invasive alternative that may reduce surgical trauma and restore spinal alignment. Nevertheless, the effectiveness of OLIF in patients with different degrees of lumbar spinal stenosis remains controversial.
Methods This retrospective study included patients with degenerative lumbar spondylolisthesis combined with spinal stenosis who underwent surgical treatment in our hospital. Two groups were divided: the OLIF group and the TLIF group. Clinical outcomes were evaluated using the VAS, ODI and JOA score. Radiographic parameters including intervertebral disc height IDH, foraminal height, lumbar lordosis, and cross-sectional area of the spinal canal were analyzed. In addition, OLIF group were further stratified into mild–moderate and severe stenosis subgroups to evaluate the influence of stenosis severity on surgical outcomes.
Results A total of 90 patients were included in this study (45 of OLIF and 45 of TLIF). Both groups demonstrated significant improvement in clinical outcomes scores after surgery ($P < 0.05$). Compared with the TLIF group, the OLIF group showed significantly lower blood loss and shorter hospital stay ($P < 0.05$). Radiographic analysis revealed greater restoration of intervertebral disc height and lumbar lordosis in the OLIF group ($P < 0.05$). Subgroup analysis showed that both mild–moderate and severe stenosis patients treated with OLIF achieved significant clinical improvement, although the improvement in radiographic parameters was more pronounced in the mild–moderate stenosis subgroup.
Conclusions Both OLIF and TLIF are effective surgical techniques for the treatment of degenerative lumbar spondylolisthesis with spinal stenosis. OLIF may provide advantages in terms of reduced surgical trauma and improved sagittal alignment. Furthermore, OLIF appears to be effective for patients with different degrees of spinal stenosis, although the outcomes may vary according to stenosis severity.

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The Radiographic Outcomes of Cannulated Screws Insertion with Robotic-Assisted Navigation in Lenke Type 1 Adolescent Idiopathic Scoliosis

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Objectives Pedicle screw systems play a critical role in the surgical management of adolescent idiopathic scoliosis (AIS). This study aimed to evaluate the radiographic outcomes of cannulated screw insertion with robotic-assisted navigation for Lenke type 1 AIS.
Methods A total of 144 patients with Lenke type 1 AIS were retrospectively enrolled. The patients were divided into three groups based on the surgical technique:
Group A (n = 64): Uniplanar cannulated screws inserted at periapical levels under robotic-assisted navigation, with multiaxial cannulated screws inserted at other levels via the freehand technique. Group B (n = 50): Uniplanar cannulated screws inserted at periapical levels and multiaxial cannulated screws at other levels, both via the freehand technique. Group C (n = 30): Routine multiaxial pedicle screws inserted at all levels via the freehand technique. Patient characteristics, operative details, radiographic parameters, and pedicle screw insertion accuracy were recorded and analyzed.
Results Postoperatively, Groups A and B showed significantly better outcomes than Group C in terms of Cobb angle ($P = 0.03$), coronal correction rate ($P < 0.001$), and apical vertebral derotation rate ($P = 0.009$). No significant differences were observed in other radiographic parameters among the three groups. At periapical levels, 427 uniplanar cannulated screws were inserted in Group A, 266 in Group B, and 187 routine multiaxial screws in Group C. The screw misplacement rate was significantly lower in Group A (4.7%) than in Group B (10.5%, $P = 0.005$) and Group C (11.2%, $P = 0.003$), with no significant difference between Groups B and C ($P = 0.812$).
Conclusion The robotic system achieves higher pedicle screw insertion accuracy at periapical levels in AIS compared with the traditional freehand technique. Uniplanar cannulated pedicle screws provide superior coronal correction and derotation effects in AIS. Additionally, the robotic system reduces radiation exposure to surgeons

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Comparison of clinical results between cervical endoscopic foraminotomy and anterior cervical decompression and fusion for cervical radiculopathy

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Introduction As a surgical procedure for cervical radiculopathy, anterior cervical decompression and fusion (ACDF) or posterior foraminotomy is generally performed. Recently, the efficacy of minimally invasive cervical posterior foraminotomy has been reported.
Objectives The purpose of this study was to clarify the efficacy of cervical microendoscopic foraminotomy (CMEF) compared with ACDF for the treatment of cervical disorders with radiculopathy.
Materials and Methods This study design is a retrospective sub-group analysis of a prospectively collected cohort analysis. Consecutive patients with cervical radiculopathy who required surgical treatment were enrolled. All enrolled patients (n = 79) underwent CMEF or ACDF. All patients were reviewed postoperatively for greater than 1 year. The preoperative and 1-year follow-up evaluations included neurological assessment. The primary outcome measure was the numeric rating scale (NRS) for neck and arm pain with a minimal clinically important difference defined as >15%. Secondary outcomes were assessed with additional patient reported outcomes measures (PROMs). All parameters were analyzed statistically ($p<0.05$).
Results CMEF was performed in 55 patients and 24 patients underwent ACDF. In both groups, their NRS improved significantly 1 year after surgery ($p<0.05$), and there were no significant differences between the groups ($p>0.05$). The VAS of surgical satisfaction was 82 mm in the CMEF group and 83 mm in the ACDF group ($p>0.05$). There was no significant difference between the groups in SF-36. As for perioperative complications, in the CMEF group, 3 patients had temporary muscle weakness over MMT1 grade, and 2 patients had temporary progressive numbness. In the ACDF group, 1 patient had a temporary dysphagia.

Conclusions Patients with cervical disorders with radiculopathy were clinically improved in both groups, at 1-year follow-up, which were comparable. However, the transient neurological deterioration had clinically important differences in each group. CMEF had some complications related to nerve root, and ACDF had dysphagia.

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Postoperative Seizure Following Unilateral Biportal Endoscopic Lumbar Decompression in a Patient With an Unrecognized Intracranial Lesion

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Introduction / Objectives Unilateral biportal endoscopy (UBE) is performed under continuous saline irrigation and may increase epidural pressure, with a possible effect on intracranial pressure. Therefore, known intracranial lesions are generally regarded as a relative contraindication to UBE. However, perioperative neurological events potentially related to intracranial pathology have rarely been described. We report a case of postoperative seizure after UBE lumbar decompression in a patient with an unrecognized intracranial lesion.
Materials and Methods This was a retrospective review of a single case, including clinical presentation, perioperative course, postoperative neurological event, laboratory findings, and cranial imaging.
Results / Discussion An 84-year-old woman underwent left-sided UBE decompression at L4/5 for lumbar canal stenosis with bilateral leg pain and intermittent claudication. Her preoperative Japanese Orthopaedic Association score was 14/29. Operative time was 127 minutes. No apparent dural tear or other intraoperative complication was identified. Approximately 3 hours after surgery, she became unresponsive to verbal stimulation and subsequently developed clonic seizures, which resolved promptly after intravenous diazepam. Laboratory testing showed no electrolyte abnormality or hypoglycemia. Urgent head computed tomography revealed a frontal lobe intracranial lesion. Subsequent inquiry clarified that the lesion had previously been identified and followed at another hospital, although this history had not been recognized preoperatively. Brain magnetic resonance imaging showed no new lesion or acute intracranial abnormality. She resumed ambulation the following morning and was discharged on postoperative day 4. No recurrent seizure was observed. At 4 months, her score improved to 27/29 without residual neurological symptoms.
Conclusion Although a causal relationship cannot be determined from a single case, this event highlights the importance of careful preoperative history-taking and perioperative attention to possible neurological deterioration in patients undergoing UBE.

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Irrigation Fluid Pressure Regulation and Spinal Cord Protection in Cervical Spinal Endoscopic Surgery

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Introduction/Objectives Cervical Spinal Endoscopic Surgery (CSES) is widely used for cervical degenerative diseases, but balancing clear surgical field via irrigation and spinal cord protection by controlling Irrigation Fluid Pressure (IFP) is a key challenge. This study aims to summarize the physiological basis of Cervical Epidural Pressure (CEP), its dynamic changes during surgery, and clinical evidence, and propose IFP management strategies to improve CSES safety.
Materials and Methods We reviewed relevant clinical studies, animal experiments, and computational fluid dynamics (CFD) models on CEP and IFP in spinal endoscopic surgery, analyzed CEP physiological range, intraoperative pressure fluctuation factors, and safety thresholds, and summarized evidence-based clinical operation strategies.
Result/Discussion Static basal CEP is estimated at 14-27 cmH_2O (10-20 mmHg). Intraoperative CEP fluctuation is mainly caused by outflow obstruction, especially working channel (WC) blockage by instruments. Lumbar studies confirmed unobstructed outflow maintains CEP at physiological level with 30 mmHg pump pressure; cervical clinical and animal studies showed 30-40 mmHg IFP is safe, while ≥50 mmHg significantly increases spinal cord injury risk. CFD models help optimize WC design and avoid blockage.
Conclusion Systematic IFP management including setting 30-40 mmHg basal pump pressure, ensuring unobstructed irrigation outflow, alerting to transient pressure shocks, and adopting individualized pressure strategies for high-risk patients can significantly reduce spinal cord injury risk in CSES, achieving dual protection of clear surgical field and spinal cord safety.

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Real Time Location System Assessment of Early Postoperative Recovery After Lumbar Decompression According to Surgical Approach

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Objective To evaluate early postoperative mobility after lumbar decompression using real time location system (RTLS)–derived objective metrics and to explore differences in mobility patterns between biportal endoscopic decompression and open decompression.
Methods This retrospective cohort study included 323 patients who underwent lumbar decompression for degenerative lumbar spinal stenosis between March 2020 and May 2024. RTLS sensors embedded in wristbands continuously recorded patient mobility during postoperative days (POD) 1–4. Primary RTLS-derived outcomes included total walking distance, mean walking speed, and active movement ratios (top 20% and top 50%). Between-group comparisons were performed using nonparametric tests. Propensity score matching and multivariable median quantile regression adjusting for age, ASA classification, and preoperative mobility were conducted.
Results RTLS identified differences in early postoperative activity patterns between surgical approaches. In adjusted analyses, activity-intensity–based metrics, particularly the top 20% activity ratio, remained significantly higher in the biportal endoscopic decompression group across multiple postoperative days. Subgroup analyses demonstrated minimal differences after single-level decompression, whereas activity-based differences were more frequently observed in multilevel procedures.
Conclusions RTLS based continuous monitoring detected differences in early postoperative activity patterns following lumbar decompression. These findings support the role of RTLS as an objective tool for assessing early functional recovery in spine surgery.

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Real-world outcomes of surgery for spinal metastases in the modern era of lung cancer treatment —A single-centre retrospective study—

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Introduction Advances in molecularly targeted therapy and immunotherapy have prolonged survival in patients with lung cancer, resulting in more diverse presentations of metastatic spinal tumours. Because conventional surgical indications were based on an anticipated short-term prognosis, reassessment of the role of surgery is warranted in the modern treatment era. This study examined the clinical outcomes and survival of patients who underwent surgery for spinal metastases from lung cancer.
Materials and Methods We retrospectively reviewed 18 consecutive patients who underwent surgery for spinal metastases from lung cancer. Neurological status was assessed using manual muscle testing (MMT), and systemic function was evaluated using performance status (PS). Surgical invasiveness and postoperative survival were also analysed. Changes before and after surgery were calculated as ΔMMT and ΔPS.
Results The median preoperative MMT was 3 (range, 1–5), and the cohort included patients with preoperative neurological deficits. Neurological improvement, defined as ΔMMT ≥1, was observed in 3 patients (17%), all of whom had preoperative deficits. The median preoperative PS was 2, and postoperative PS remained unchanged in most cases, with a median ΔPS of 0. No significant postoperative deterioration in PS was observed. Surgical invasiveness was limited, with a median operative time of approximately 130 minutes and median blood loss of approximately 250 mL. Although survival varied, the 6-month survival rate was 78% (14/18) and the 1-year survival rate was 56% (10/18), indicating that many patients survived beyond the short-term prognosis traditionally expected.
Conclusion In the lung cancer treatment era, surgery for spinal metastases may contribute to recovery of neurological dysfunction and preservation of function. Survival outcomes were heterogeneous, and a substantial proportion of patients were not limited to the short-term prognosis traditionally anticipated. These findings support a role for surgery within individualized multidisciplinary treatment strategies aimed at maintaining function as well as prolonging survival.

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Arthroscopic-assisted Uniportal Spinal Surgery for Resection of a Thoracic Spinal Gouty Tophus

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Introduction A 60-year-old male presented to the emergency department with acute onset paraplegia of the lower extremities of 1-day duration. Physical examination revealed muscle strength grade 0/5 in both lower limbs, impaired pain sensation below the umbilical level, diminished knee and ankle reflexes, and negative pathological signs. Thoracic spine magnetic resonance imaging (MRI) with and without contrast revealed an epidural cystic lesion at the T7-T8 level. Computed tomography (CT) findings were unremarkable.
Materials and Methods The patient underwent arthroscopic-assisted uniportal spinal surgery under general anesthesia through a 1.5 cm skin incision. A high-speed drill was used to perform a laminotomy involving the lower two-thirds of the T7 lamina and the upper edge of the T8 lamina, preserving approximately half of the inferior articular process laterally and exposing the base of the spinous process medially. Under endoscopic visualization, the cranial, caudal, and lateral margins of the soft tissue mass were identified. A neural dissector was used to separate the dura mater from the lesion. During dissection, the mass ruptured, discharging yellowish-white flocculent material. The lesion was completely resected, achieving satisfactory decompression of the neural elements.
Result Histopathological examination revealed fibrofatty tissue containing amorphous eosinophilic deposits surrounded by chronic granulomatous inflammation, consistent with a gouty tophus. At three-month follow-up, the patient's lower limb muscle strength had improved to grade 3/5, enabling ambulation with crutches.
Conclusion Spinal epidural gouty tophi causing acute paraplegia are exceedingly rare. This case demonstrates clear endoscopic visualization of urate crystals and the associated tophus, with satisfactory postoperative outcome following uniportal spinal resection. To our knowledge, this represents the first reported case of a thoracic spinal epidural gouty tophus managed with endoscopic spine surgery.

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Retrospective Review on the Trend of Lumbar Spinal Decompression Surgery in a Single Tertiary Centre

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Objective Spinal stenosis and degenerative spinal disorders are increasingly prevalent and significantly impact quality of life. Surgical decompression, performed through either open microscopic or endoscopic approaches, remains central to management. This study investigates evolving trends in single-level lumbar spinal decompression procedures at a tertiary academic hospital in Singapore.
Methods A retrospective observational study involving 588 patients (endoscopic spine surgery (ESS): n=364; microdecompression: n=224) undergoing single-level spinal decompression between 2021 and 2024 was conducted. Primary outcome measures included changes in 36-Item Short Form Health Survey (SF-36) and Visual Analogue Scale (VAS) scores at 3 months, 6 months, and 2 years postoperatively. Secondary outcomes were length of hospital stay, reoperation rates, and operative time. Patient demographics, level and pathology characteristics, surgical techniques, and postoperative outcomes were analyzed. Difference-in-differences (DID) analysis compared outcomes between both groups.
Results Both groups showed significant improvements in SF-36 and VAS scores postoperatively. At 2 years, Short Form Health Survey Physical Function (SFPF) improved (MD: +18.6, SD=21.7, p=0.064) in the endoscopic group and (Mean Difference (MD):+36.7, SD=20.9, p=0.007) in the open group, with a non-significant DID of −18.1 (p=0.155). No DID comparisons across domains reached statistical significance. Mean operative time for endoscopic cases decreased from 249 minutes in 2022 to 145 minutes in 2024, reflecting a learning curve. Surgeons with higher endoscopic caseloads demonstrated greater improvements in functional outcomes.
Conclusion Both endoscopic and open microscopic decompression achieve comparable short- and long-term outcomes. Endoscopic spine surgery offers comparable outcomes with shorter recovery and hospital stay. Further research is warranted to identify factors associated with incomplete symptom resolution or revision surgery.

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Integrated Optical and Magnetic Navigation for Simplified Percutaneous Transforaminal Endoscopic Lumbar Discectomy: A Novel Approach

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Objective This study aims to evaluate the clinical benefits of the integrated optical and magnetic surgical navigation system in assisting transforaminal endoscopic lumbar discectomy (TELD) for the treatment of lumbar disc herniation (LDH).
Methods A retrospective analysis was conducted on patients who underwent TELD for LDH at our hospital from November 2022 to December 2023. Patients treated with the integrated optical and magnetic surgical navigation system were defined as the navigation-guided transforaminal endoscopic lumbar discectomy (Ng-TELD) group (30 cases), while those treated with the conventional X-ray fluoroscopy method were defined as the control group (31 cases). Record and compare baseline characteristics, surgical parameters, efficacy indicators, and adverse events between the two patient groups.
Results The average follow-up duration for the 61 patients was 11.8 months. Postoperatively, both groups exhibited significant relief from back and leg pain, which continued to improve over time. At the final follow-up, patients' lumbar function and quality of life had significantly improved compared to preoperative levels ($P < 0.05$). The Ng-TELD group had significantly shorter total operation time (58.43±12.37 vs. 83.23 ± 25.90 min), catheter placement time (5.83 ± 1.09 vs. 15.94 ± 3.00 min), decompression time (47.17 ± 11.98 vs. 67.29 ± 24.23 min), and fewer intraoperative fluoroscopies (3.20 ± 1.45 vs. 16.58 ± 4.25) compared to the control group ($P < 0.05$). There were no significant differences between the groups in terms of efficacy evaluation indicators and hospital stay. At the final follow-up, the excellent and good rate of surgical outcomes assessed by the MacNab criteria was 98.4%, and the overall adverse event rate was 8.2%, with no statistically significant differences between the groups ($P > 0.05$).
Conclusion This study demonstrates that the integrated optical and magnetic surgical navigation system can reduce the complexity of TELD, shorten operation time, and minimize radiation exposure for the surgeon, highlighting its promising clinical potential.

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Optical–Electromagnetic Navigation-Guided Biportal Endoscopic Unilateral Laminotomy for Bilateral Decompression in Lumbar Spinal Stenosis: Improving Precision and Efficiency

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Study Design Retrospective case-control study.
Purpose To evaluate the clinical efficacy and advantages of integrated optical and magnetic navigation-assisted biportal endoscopic unilateral laminotomy for bilateral decompression (Ng-ULBD) in patients with lumbar spinal stenosis (LSS).
Overview of Literature The application of surgical navigation enhances surgical precision and helps reduce operation time and fluoroscopy frequency. However, the currently commonly used navigation systems have several limitations, such as optical navigation being affected by line-of-sight obstruction and electromagnetic navigation being susceptible to interference from metallic instruments.
Methods A retrospective analysis was conducted on patients who underwent ULBD for LSS at our hospital between August 2023 and June 2025. Patients treated with an integrated optical and electromagnetic surgical navigation system were assigned to the Ng-ULBD group (n=84), while those treated under conventional C-arm fluoroscopy guidance were assigned to the C-arm-alone-guided ULBD (C-ULBD) group. Baseline characteristics, operative time, number of fluoroscopy shots, clinical outcomes, and complications were recorded and compared between the two groups.
Results The total operative time for single- and two-level decompressions was significantly shorter in the Ng-ULBD group (81.40 min and 144.56 min, respectively) compared to the C-ULBD group (88.79 min and 159.53 min, respectively; $P<0.05$), with the most notable difference observed in catheter placement time. The total number of fluoroscopy shots was also significantly lower in the Ng-ULBD group ($P<0.05$). Postoperatively, both groups experienced significant pain relief, functional recovery, and high patient satisfaction. However, no significant differences were found in decompression time, complication rates (Ng-ULBD: 3.6% vs. C-ULBD: 7.3%), postoperative pain/functional improvement, or length of hospital stay ($P>0.05$).
Conclusions The integrated optical and electromagnetic surgical navigation system significantly reduces radiation exposure and operative time, enhancing surgical efficiency and safety. These findings suggest promising clinical applicability for this technology in minimally invasive spine surgery.

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Comparison of Navigation-Assisted and C-Arm Fluoroscopy-Guided Unilateral Biportal Endoscopy versus Paravertebral Approach for Lumbar Foraminotomy and Discectomy

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Study Design Retrospective Cohort Study.
Objective To evaluate the efficacy and clinical value of navigation-assisted unilateral biportal endoscopy versus the paraspinal approach for lumbar foraminotomy and discectomy.
Methods A retrospective analysis was conducted on 129 patients with single-level lumbar degenerative disease who underwent unilateral biportal endoscopic lumbar foraminotomy and discectomy at our institution. Patients were divided into two groups according to whether intraoperative navigation was applied: the navigation group (n = 63) and the C-arm group (n = 66). Baseline characteristics, perioperative parameters, clinical outcomes, radiological parameters (sagittal canal diameter, intervertebral disc height, foraminal height, and foraminal width), and postoperative complications were recorded. Differences within and between groups were statistically analyzed.
Results The navigation group demonstrated significantly shorter operative time (94.09 ± 21.45 vs 110.94 ± 38.94 minutes) and fewer intraoperative fluoroscopy exposures (3.18 ± 0.86 vs 9.91 ± 1.83 times) compared with the C-arm group. There were no significant differences between groups in clinical efficacy outcomes or complication rates ($P > 0.05$). At final follow-up, foraminal height and width were significantly improved in both groups compared with preoperative values. Notably, the navigation group achieved greater foraminal height than the C-arm group (19.49 ± 1.32 vs 18.91 ± 1.38 mm, $P < 0.05$). No significant intergroup differences were observed in other radiological parameters.

Conclusion Navigation-assisted unilateral biportal endoscopy for lumbar foraminotomy and discectomy in single-level lumbar degenerative disease significantly reduces operative time and intraoperative radiation exposure, while providing superior improvement in foraminal height compared with conventional C-arm guidance.

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Impact of Type 2 Diabetes Mellitus on Outcomes Following Single-Level Endoscopic Posterior Lumbar Interbody Fusion: A Global Propensity-Matched Cohort Study

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Background Type 2 diabetes mellitus (T2DM) has been linked to impaired bone healing and may increase the likelihood of nonunion after lumbar fusion. Evidence regarding its influence on clinical outcomes following single-level endoscopic posterior lumbar interbody fusion (Endo-PLIF) remains limited. This study examined whether T2DM is associated with perioperative events, healthcare utilization, and the long-term risk of pseudarthrosis after Endo-PLIF.
Methods Using the TriNetX Global Collaborative Network, we identified adults who underwent single-level Endo-PLIF between 2015 and 2025. Patients with and without T2DM were matched 1:1 using propensity scores based on demographic and clinical characteristics, generating two balanced cohorts of 755 individuals each. The primary endpoint was pseudarthrosis within three years. Secondary endpoints included 90-day postoperative complications and one-year healthcare encounters. Group differences were assessed with χ^2 tests, and cumulative pseudarthrosis incidence was analyzed using Kaplan–Meier curves and log-rank testing.
Results Baseline characteristics were well balanced after matching. Early postoperative complications and one-year healthcare utilization were comparable between groups ($p > 0.05$). Pseudarthrosis occurred more often in patients with T2DM at 6 months (9.7% vs 5.3%), 12 months (10.1% vs 5.7%), and 36 months (11.5% vs 6.2%), all $p < 0.01$. Kaplan–Meier analysis showed a higher three-year cumulative risk of pseudarthrosis in the T2DM cohort ($p = 0.0003$; hazard ratio 1.90, 95% CI 1.34–2.71).
Conclusions T2DM is associated with an increased three-year risk of pseudarthrosis after single-level Endo-PLIF. Whether perioperative metabolic optimization can modify this risk requires further investigation.
Keywords: Posterior lumbar interbody fusion; Type 2 diabetes mellitus; Pseudarthrosis; Propensity score matching; Endoscopic spine surgery

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Screw head–only removal to prevent vertebral fracture after implant removal for osteoporotic vertebral fractures

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Background Percutaneous pedicle screw (PPS) fixation is widely used for osteoporotic vertebral fractures. Since this technique does not involve interbody bone grafting, implants are routinely removed after fracture healing. Standard implant removal, however, carries a risk of new vertebral fractures, particularly at the screw-inserted vertebrae. To address this, we developed a strategy in which only the screw heads are removed, leaving the screws in place, to potentially reduce post-removal fracture risk.
Methods This study included patients who underwent PPS fixation for osteoporotic vertebral fractures and subsequently received implant removal between May 2022 and January 2026. Two early cases with screw back-out within 4 months were excluded. Of the remaining 44 patients, 27 underwent complete screw removal, and 17 underwent head-only removal with screws retained. All loosened screws were removed. After either full or head-only removal, patients wore a brace for two weeks. Postoperative evaluation included X-ray imaging to detect new vertebral fractures. Mean patient age was 79 years (range, 58–93), with 15 males and 29 females. The mean number of fixed levels was 3.3. Fracture locations included Th10-L3.
Results In the head-only group, only 1 patient experienced a new vertebral fracture(5.8%), whereas in the full screw removal group, 5 fractures(18.5%) were observed. Fractures occurred within 12–35 days post-removal. The patient who suffered the fracture had not fallen or experienced any other accidents.
Conclusions Screw head–only removal prevents the formation of post-removal screw tracts, reducing vertebral fracture risk and preserving options for future revision in patients with osteoporotic vertebral fractures. This technique is a feasible and promising strategy for post-fixation implant management. Further studies with larger cohorts and longer follow-up are warranted.

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Intramedullary Lesion Length Is A Robust Imaging Biomarker In Predicting Presenting Motor And Functional Scores Amongst Acute Traumatic Central Cord Syndrome Patients.

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Introduction Acute traumatic central cord syndrome (ATCCS) has been reported to be the most common form of acute, incomplete spinal cord injury. Much has been published about ATCCS but this data is predominantly from North America, and the generalizability of these recommendations to Asian populations are still under investigation. In the literature, intramedullary lesion length has been found to be a useful imaging biomarker.
Material and Methods We conducted a retrospective cohort study in two tertiary specialist centers in Singapore from 2010 to 2023. Imaging biomarkers were measured on magnetic resonance imaging (MRI) scans on admission. Multivariate linear regression was performed to ascertain the relationship of imaging biomarkers with presenting motor and functional scores.
Results One-hundred-and-sixteen patients were included in our study. The mean age was 64.7 (SD: 12.9) years, and 100 (86.2%) patients were male. Sixty-five (56.0%) of patients underwent operative management, with the median time to operation being 4.0 (IQR: 10.0) days. The mean mid-sagittal diameter of the spinal canal on the mid-sagittal scans was 9.0mm (SD 1.1), the mean maximum canal compromise was 84.8 (SD 4.6) and the mean maximum spinal cord compression was 80.0 (SD 5.5). The mean intramedullary lesion length on MRI was 21.6mm (SD 18.3). Multivariate analysis showed that intramedullary lesion was negatively correlated (Beta -0.2, 95% CI -0.5 – 0.0, p = 0.027) with AMS on presentation, was negatively correlated (Beta -0.2, 95% CI -0.3 – 0.0, p = 0.025) with upper extremity motor score on presentation and was also negatively correlated (Beta -0.2, 95% CI -0.1 – 0.0, p = 0.017) with mJOA on presentation. No imaging biomarkers were found to correlate with FIM score on admission.

Conclusion Intramedullary lesion length was found to predict the presenting motor and functional scores well, corroborating the literature about its efficacy as a prognostic tool for ATCCS patients.

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Imaging biomarkers and early surgery are predictive of FIM recovery but not motor outcomes in acute traumatic central cord syndrome patients.

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Introduction Acute traumatic central cord syndrome (ATCCS) has been reported to be the most common form of acute, incomplete spinal cord injury. The use of imaging biomarkers has been shown to correlate with motor recovery and has been purported to prognosticate recovery. Early surgery, within 24 hours, has also been shown to lead to better motor outcomes.
Material and Methods We conducted a retrospective cohort study in two tertiary specialist centers in Singapore from 2010 to 2023. Imaging biomarkers were measured on magnetic resonance imaging (MRI) scans on admission and on follow-up, when available. Outcomes were significant improvement in ASIA Motor Score (AMS) at 6 and 12 months, and significant improvements in and Functional Independence Measure (FIM) and modified Japanese orthopedic association score (mJOA) at 6-months.
Results One-hundred-and-sixteen patients were included in our study. Sixty-five (56.0%) of patients underwent operative management, with the median time to operation being 4.0 (IQR: 10.0) days. Of the patients who underwent operative management, 17 (26.2%) underwent early surgery, within 24 hours. Median AMS at 12-months was 100.0 (IQR: 10.3), with median improvement at 12-months being 93.4% (IQR: 53.8). The median FIM score at 6-months was 99.0 (IQR: 56.0) and the median FIM improvement rate was 36.0% (IQR: 74.7). The median mJOA at 6-months was 17.0 (IQR: 5.0) with a median mJOA recovery rate of 66.7% (IQR: 77.0). Univariate and multivariate analysis revealed that early surgery within 24 hours was negatively correlated (OR 0.1, 95% CI 0.0 – 0.5, p = 0.005) and spinal cord diameter at the level of stenosis on admission was positively correlated (OR 2.1, 95% CI 1.0 – 4.3, p = 0.044) with significant improvement in FIM at 6-months.
Conclusion In our local population, early surgery and imaging biomarkers had moderate correlations with FIM improvement but not with other motor or functional outcomes.

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Per-Level Analysis of Assisted Full-Endoscopic Spine Surgery Versus Conventional Laminectomy: Unmasking Intrinsic Procedural Invasiveness

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Introduction Comparisons between endoscopic and open decompression are often biased by multilevel procedures, which may mask true procedural invasiveness. This study aimed to reassess surgical invasiveness using per-level normalization to clarify the intrinsic differences between Assisted Full-Endoscopic Spine Surgery (AFESS) and conventional laminectomy (LAM).
Methods We retrospectively analyzed 15 AFESS and 12 LAM cases. To eliminate learning-curve bias, only AFESS cases performed after procedural standardization were included. Blood loss, hemoglobin decrease (Hb), and operative time were normalized per decompressed level. Hospital stay and 6-month reoperation rates were also assessed.
Results Total and per-level blood loss were significantly lower in AFESS ($P < 0.05$), indicating superior intrinsic hemostasis. While absolute ΔHb was lower in AFESS, normalization removed this significance. AFESS required longer operative time per level ($P < 0.05$) but significantly shortened hospital stays. Notably, the LAM group had a 25% (3/12) reoperation rate within 6 months due to index-level issues, whereas the AFESS group had zero reoperations (0/15).
Discussion Per-level analysis reveals that conventional laminectomy often underestimates procedural trauma due to "multilevel bias," where speed masks cumulative blood loss. Our findings demonstrate that AFESS provides a significantly lower "bleeding burden" per level, which likely contributes to faster recovery and shorter hospitalization. Furthermore, the absence of reoperations in AFESS, despite the endoscopic approach, underscores its safety and decompressional adequacy compared to open surgery.
Conclusion Per-level evaluation is essential for an unbiased assessment of surgical invasiveness. AFESS offers a high-quality, low-bleeding alternative to laminectomy, providing superior short-term safety and efficiency when analyzed on a per-segment basis.

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The MRI-based Vertebral Bone Quality (VBQ) Score as a Predictor of Correction Loss Following Balloon Kyphoplasty

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Introduction Balloon kyphoplasty (BKP) effectively restores vertebral height; however, post-operative correction loss (CL) remains a concern. Conventional DXA often overestimates bone quality due to degenerative changes. The MRI-based Vertebral Bone Quality (VBQ) score offers opportunistic bone assessment without additional radiation. We evaluated the VBQ score's predictive value for CL following BKP.
Methods We retrospectively reviewed 26 patients who underwent single-level BKP with a minimum 1-year follow-up. CL was defined as meeting any of the following criteria between post-operative and final radiographs: 1) height decrease > 3mm, 2) vertebral kyphosis angle increase > 5°, or 3) A/P ratio decrease > 10%. Parameters were compared between CL and non-CL (NCL) groups.
Results Nine patients (34.6%) were in the CL group. The VBQ score was significantly higher in the CL group than in the NCL group (4.47 vs. 3.66, $P < 0.05$). While not statistically significant, the NCL group trended toward higher cement volume and a higher incidence of subsequent adjacent vertebral fractures ($P < 0.1$).
Discussion A higher VBQ score indicates poor bone quality and serves as a robust predictor of CL. Notably, our cohort's VBQ values (4.47 in CL) significantly exceeded previously reported osteoporotic thresholds (e.g., 3.0–3.2), highlighting the high-risk nature of BKP candidates. The trend toward more adjacent fractures in the NCL group suggests a clinical trade-off: rigid height maintenance in patients with poor VBQ may increase mechanical stress on adjacent segments. As an opportunistic screening tool, VBQ may overcome DXA limitations in preoperative planning.
Conclusion The VBQ score is a useful preoperative predictor for CL. Utilizing this score may help optimize surgical strategies, such as adjusting correction goals or intensifying post-operative osteoporosis treatment to prevent both CL and adjacent fractures.

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3D-Printed Bioactive PEEK Composites for Next-Generation Spinal Implants: Balancing Mechanics, Biology, and Radiological Precision

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Introduction The rising burden of osteoporosis and metastatic spinal disease demands implants that extend beyond structural support to address biological integration and radiological compatibility. Conventional materials such as titanium and CFR-PEEK are limited by imaging artefacts, radiotherapy dose perturbation, or bioinertness. We present a novel 3D printing–enabled strategy to engineer bioactive PEEK-based composites with optimized mechanical, biological, and radiological performance.

Methods Using a pellet-based extrusion additive manufacturing platform, polyetheretherketone (PEEK) was compounded with hydroxyapatite (HAp) and magnesium orthosilicate (Mg_2SiO_4) at varying ratios to create bespoke composite formulations. Mechanical performance was evaluated via tensile, compressive, and flexural testing. Biocompatibility was assessed through in vitro cell culture assays. Prototype pedicle screws were fabricated and tested according to ASTM F543 standards. Radiological performance was evaluated using CT and MRI imaging quality, alongside radiotherapy dosimetric accuracy.

Results Incorporation of HAp enhanced osteoconductive potential but demonstrated a dose-dependent trade-off with mechanical integrity, with higher concentrations leading to increased brittleness. Mg_2SiO_4 showed a threshold-dependent effect, where excessive loading adversely impacted cellular viability. Optimized composite formulations achieved a favorable balance, maintaining structural integrity while enhancing biological response. Critically, all composite variants demonstrated superior radiological performance compared to conventional metallic implants, with reduced imaging artefacts and improved radiotherapy dose fidelity.

Conclusion This study establishes a scalable, 3D printing–driven framework for the development of next-generation spinal implants. By enabling precise tuning of composite composition, we demonstrate the feasibility of achieving a synergistic balance between mechanical strength, biological activity, and radiological compatibility. This approach represents a significant step toward patient-specific, functionally optimized spinal implants, with strong translational potential in oncologic and osteoporotic spine surgery.

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FUSE-6: A Novel Six-Unit Radiographic Scoring System for Reliable and Early Detection of Lumbar Interbody Fusion

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Introduction Reliable assessment of spinal fusion remains a fundamental yet unresolved challenge in spine surgery. Existing radiographic grading systems are subjective and poorly reproducible, while computed tomography, although more sensitive, is limited by cost and radiation exposure. We introduce FUSE-6 (Fusion Unit Spatial Evaluation-6), a geometry-based scoring system, alongside a novel Spatial Fusion Index (SFI) to enable objective, reproducible, and quantitative fusion assessment using standard radiographs.

Methods We retrospectively analyzed 46 patients (90 levels) who underwent transforaminal lumbar interbody fusion between 2018 and 2023. Each interbody space was divided into six anatomically defined fusion units across anteroposterior and lateral radiographs. Fusion of the level was defined as trabecular bridging in ≥4 of 6 units. The Spatial Fusion Index (SFI) was calculated as the proportion of fused units, allowing continuous assessment of fusion progression. Two independent observers evaluated radiographs at 1, 3, 6, and 12 months. Interobserver reliability was assessed using Cohen's κ, and agreement with Bridwell grading was evaluated using McNemar's test.

Results FUSE-6 demonstrated substantial-to-almost-perfect interobserver reliability, with κ values of 0.845 at 3 months, 0.824 at 6 months, and 0.851 at 12 months (all $p < 0.001$). Compared to Bridwell grading, FUSE-6 identified higher fusion rates at 3 months ($p = 0.003$–0.012), suggesting greater sensitivity to early fusion. This difference diminished over time, with convergence between methods by 12 months ($p = 0.045$). Fusion rates increased from 0% at 1 month to >95% at 12 months, reflecting expected biological consolidation.

Conclusion FUSE-6 provides a simple, objective, and highly reproducible framework for radiographic fusion assessment. The Spatial Fusion Index enables continuous tracking of fusion progression and enhances clinical interpretability. This approach offers a scalable and standardised pathway for improving consistency in postoperative fusion evaluation across clinical practice and research.

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Intraoperative breakage of carbon fiber-reinforced pedicle screw in the thoracic spine: a case report and review of literature

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Introduction Carbon Fiber-Reinforced Polyether Ether Ketone (CFR-PEEK) pedicle screws are being increasingly used in cases of spinal tumors where tumour surveillance may be required. In such cases, CFR-PEEK screws offer significant benefits due to their properties such as radiolucency and modulus of elasticity. However, there are only few reports on the hardware complications associated with the use of these CFR-PEEK screws.

Materials and Methods In this case report, we have highlighted a rare case of intraoperative CFR-PEEK pedicle screw breakage. A 31-year-old male patient diagnosed with aggressive T7 vertebral body hemangioma underwent T7 vertebroplasty and T5-T9 posterior instrumentation and fusion with CFR-PEEK Pedicle Screws. During the insertion of right T8 pedicle screw, there was inadvertent breakage of the screw, with retained 25mm broken screw fragment. Postoperatively, the patient recovered well with resolution of symptoms.

Results and Discussion The potential reasons for the screw breakage include reduced surgeon awareness of the torque needed to insert the screw, altered bone density (due to tumor) and implant factors such as notch sensitivity, or manufacture variability. We propose several specific recommendations for the insertion of CFR-PEEK pedicle screws, to minimize the risk of screw breakage or loosening: 1. Full-length tapping into the vertebral body. 2. The tap should closely match the screw diameter to ensure a precise fit. 3. Ensuring the CFR-PEEK screw strictly follows a pre-drilled path, and checking with a probe. 4. The recommended torque for CFR-PEEK screws can be achieved with increased familiarity by the surgeon, or with torque-limiting screwdrivers.

Conclusion Iatrogenic screw breakage, even though rare, should be recognized as a potential complication for CFR-PEEK pedicle screws. In this case report, we have highlighted a case of intraoperative CFR-PEEK pedicle screw breakage, described key biomechanical properties of CFR-PEEK pedicle screws and put forth recommendations for the insertion of CFR-PEEK screws.

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Radiological Cut-off Values for Patient Selection in Intravertebral Cage Augmentation for Osteoporotic Vertebral Fractures: A Preliminary Study

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Objective Transpedicular intravertebral cage augmentation is a less invasive alternative to corpectomy for osteoporotic vertebral fractures (OVF) with neurological deficits. However, the intravertebral cage relies on the residual vertebral shell for support, and objective patient selection criteria remain undefined. This study aimed to identify preoperative cut-off values that predict mechanical failure.
Methods Twenty-four patients who underwent transpedicular intravertebral cage insertion with posterior instrumentation for OVF or Kümmell's disease were divided into a mechanical complication (MC, n = 9) and non-MC group (n = 15). ROC curve analysis was performed to determine preoperative cut-off values.
Results The MC group had lower preoperative index height (13.9 ± 4.2 vs. 16.5 ± 2.9 mm, p = 0.043) and greater PI-LL mismatch (33.1 ± 17.3° vs. 19.0 ± 11.7°, p = 0.026). Preoperative index height ≤ 12.7 mm (AUC = 0.756, specificity 1.000, p = 0.003) and PI-LL mismatch ≥ 22.9° (AUC = 0.756, OR = 12.0, p = 0.033) were significant predictors. All patients with index height ≤ 12.7 mm experienced failure. The MC group achieved greater height restoration (47.4% vs. 22.7%, p = 0.017) yet reached the same postoperative height (~20 mm, p = 0.811), with a strong inverse correlation between preoperative height and restoration ratio (r = −0.804, p < 0.001). Only the MC group showed significant loss of correction during follow-up (p = 0.020).
Conclusions Preoperative index height ≤ 12.7 mm and PI-LL mismatch ≥ 22.9° are preliminary thresholds indicating the biomechanical limits of intravertebral cage augmentation. Severely collapsed vertebrae require correction that the intravertebral cage cannot sustain, and these patients may benefit from corpectomy.
Keywords: osteoporotic vertebral fracture; intravertebral cage; Kümmell's disease; mechanical failure; sagittal imbalance

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Extraforaminal lumbar disc herniation and Unilateral Biportal Endoscopy (UBE), a way to treat it safely

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Introduction/Objectives Lateral disc herniations (LDH) and foraminal stenosis are usually treated with open surgery, however the approach is technically difficult. Unilateral biportal endoscopy (UBE) can be used to treat these pathologies through the paraspinal approach.
Material and Methods This is a retrospective study that included all the patients (n = 83) that were operated on with an extraforaminal approach, from January 2019 until December 2024. The patients were divided in two groups: Tube (surgery with a tubular retractor system) and UBE (endoscopic surgery). Patient information and postoperative outcome data such as ODI, visual analog scale (VAS) for lumbar (VAS-L) and radicular (VAS-R) pain where collected.
Results/Discussion The amount of extraforaminal approaches in relation to the total amount of surgeries performed at the center increased from 0.3% to 2.2% following the introduction of UBE. The ODI at 3 months postop was 13.8 (±15.6) and 19.7 (±17.6) for Tube and UBE group respectively (p = 0.085) and 15.2 (±15.6) and 17.5 (±18.7) (p = 0.611) at 12 months postop. One (4%) patient from the Tube group was reoperated for hematoma, and three (5.2%) from the UBE group: two for hernia recurrence and one with same-level fixation. Foraminal stenosis and LDH are currently treated at our institution exclusively using the paraspinal UBE approach. This technique offers a more straightforward approach, achieving outcomes comparable to those of the tubular technique.

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Spinal Instability Spondylodiscitis Score (SISS) as a Predictor of Reoperation After Surgical Treatment for Pyogenic Spondylodiscitis

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Introduction/Objectives Surgery is indicated for pyogenic spondylitis with neurological deficits, abscess formation, or spinal instability; however, postoperative complications and reoperations, particularly due to mechanical failure, remain concerns. The Spinal Instability Spondylodiscitis Score (SISS) has been introduced to evaluate instability. This study aimed to determine the incidence, causes, and risk factors for reoperation, focusing on preoperative instability assessed by SISS.
Materials and Methods This multicenter retrospective study included 107 patients who underwent surgery for thoracolumbar pyogenic spondylitis at six hospitals between 2013 and 2025 (mean age 73.1 years; 42.1% female). Initial surgery involved decompression or irrigation in 18, posterior spinal fixation (PSF) in 9, and PSF with interbody fusion in 80. Clinical and radiographic variables were compared between patients with and without reoperation. Patient-related, infection-related, including SISS, and surgery-related factors were analyzed. Causes and types of reoperations were also evaluated.
Results/Discussion Reoperation was required in 13 patients (12.1%). Mechanical failure was the primary cause (61.5%), followed by postoperative hematoma in 2, surgical site infection in 1, adjacent segment infection in 1, and screw malposition in 1. In mechanical failure cases, fixation was extended in 5, reduced in 1, re-fixed in 1, or implants removed in 1. The reoperation group had more instrumented segments (4.8 vs. 3.0, p=0.003) and higher SISS (10.6 vs. 8.2, p<0.001). Mechanical failure cases also showed more infected segments (2.3 vs. 1.4, p=0.002), more instrumented segments (4.5 vs. 3.0, p=0.03), and higher SISS (10.6 vs. 8.2, p=0.004).
Conclusion Reoperation occurred in 12.1% of patients, mainly due to mechanical failure. Higher preoperative SISS and more instrumented segments were associated with reoperation, suggesting that instability plays a key role. Preoperative SISS assessment may help optimize fixation range and reduce reoperation risk.

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The utility of real time monitoring during navigated endoscopic lumbar interbody fusion : comparison of Point and Brainlab navigation system

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Introduction The endoscopic spine surgery (ESS) is rapidly developed and Transforaminal lumbar interbody fusion(TLIF) assisted with ESS(endo-TLIF) is the state of art. However. The cons of Endo-TLIF including overdose of radiation, overtime of bony work and steep learning curve become the largest obstacle for development of Endo-TLIF.

Method Total 81 cases (female was 62) receiving transKambin(TK)Endo-TLIF at 119 levels excluding Posterolateral EndoTLIF were enrolled from Jan. 2025 to Dec. 2025. We utilized robotic 3-D cone-beam CT(Philips Azurion) to obtain intraoperative tomographic images and uploaded to the navigation system (Point Taiwan or Brainlab German). We registered not only instruments for insertion of pedicular screws (drill-guide, pointer probe) but also instruments for Endo-TLIF. The instruments of navigated Endo-TLIF were power burr adapted by the universal registered frame(Point/Brainlab) and a unique preregistered probe(Point) able to pass through working channel of the endoscope. These registered instruments achieved fantastic benefits to anatomic identification, disc preparing, bony drilling and fusion procedures under ESS.

Result The total levels of TK endoTLIF were 119. For extreme stenotic levels we preformed interlaminar ULBD additionally. There was no postoperative neurogenic injury. The exposure of radiation was significantly reducing than non-navigated Endo-TLIF(>100 shots to 20 shots per level). There was no breech of pedicular screws insertion or malposition of cage implantation. The benefits of navigated TK endoTLIF are assurance of foraminoplasty, creating the safe quadrangular space, precise tract of inserting cage and adequate neurological decompression. The preregistered prove was only available in the Point navigation system and was easily pass through uniportal endoscopic working canal and alloyed to achieve real-time monitoring. The procedure could assure real-time anatomy without fluoroscope.

Discussion Navigated endoTLIF reduces the radiation exposure and consumption of operative time. Registered endoscope instruments offer precise endoscopic docking point, effective bony work, disc preparation and adequate neurological decompression.

Conclusions Navigated EndoTLIF could achieve excellent clinical results and provides accurate intraoperative real-time guidance and precise bony works.

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Evaluation of imaging artefacts and high precision radiotherapy techniques with 3D-printed PEEK-HA-Mg2SiO4 composites for spine tumour surgery implants

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Introduction/Objective Pedicle-screw fixation is widely used in spinal tumor surgery to maintain neurological function and spinal stability, but standard implant materials can degrade postoperative imaging and compromise radiotherapy accuracy. Titanium alloy (Ti6Al4V) commonly produces pronounced CT/MRI artefacts that obscure the spinal cord and treatment targets and may distort planned dose delivery. Carbon-fiber–reinforced PEEK (CFR-PEEK) improves radiolucency but is bioinert and can still contribute to imaging and dosimetric uncertainty. This study evaluates a 3D-printable, osteoconductive PEEK–hydroxyapatite–magnesium orthosilicate (PEEK-HA-Mg2SiO4) composite as a potential next-generation spinal implant material, compared with Ti6Al4V, CFR-PEEK, and pure PEEK.

Materials and Methods Pedicle screws fabricated from each material were assessed on clinical CT and 3T MRI using standard sequences, including STIR and metal artefact reduction techniques. Radiotherapy impact was tested in a dedicated phantom using film-based gamma analysis for both multi-field proton therapy plans and photon VMAT plans representative of SBRT. Monte Carlo (SRIM) simulations were conducted to evaluate proton Bragg peak shifts and lateral scattering across clinically relevant material thicknesses.

Results PEEK-HA-Mg2SiO4 produced minimal CT/MRI artefacts, offering clearer visualization than pure PEEK and substantially reducing artefacts relative to Ti6Al4V. In dosimetric testing, the composite showed the strongest agreement between planned and delivered dose and satisfied clinical gamma criteria of 3%/3 mm for both proton and photon irradiation. Compared with Ti6Al4V and CFR-PEEK, it also reduced the formation of dose hot and cold spots.

Conclusion The findings indicate that PEEK-HA-Mg2SiO4 is a clinically promising spinal implant material that can enhance postoperative imaging surveillance and improve the reliability of high-precision spine radiotherapy planning and delivery, including SBRT and proton therapy. Osteoconductive PEEK-based composites may offer an advantage over CFR-PEEK by combining improved biological potential with superior imaging and radiotherapy compatibility.

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Does pelvic incidence modify outcomes after lumbar decompression with or without interlaminar devices

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Introduction/Objectives Lumbar spinal stenosis is a major cause of disability. Decompressive surgery is the standard treatment for refractory symptoms but concerns remain regarding postoperative instability and symptom relief. Interlaminar devices provide “indirect decompression” by limiting extension, increasing foraminal height and unloading facet joints. As outcomes remain variable, response may be influenced by patient-specific morphology. This study evaluates whether spinopelvic parameters, particularly pelvic incidence, modify the comparative effectiveness of decompression alone versus decompression with interlaminar stabilization.

Materials and Methods A retrospective single-centre study of patients undergoing posterior lumbar decompression with or without interlaminar stabilization between 2011 and 2018 was analysed. Demographics, radiological parameters and clinical outcomes (ODI, VAS, and EQ-5D) were collected. MCID was defined as ≥12-point ODI improvement, ≥20-mm (2-point) VAS reduction and ≥0.10 EQ 5D gain. Multivariable logistic regression (adjusted for age, sex, and operative level) assessed MCID achievement and interaction effects between intervention and spinopelvic parameters (PI, LL, PI–LL mismatch, foraminal height). Penalized firth regression was used for modest event counts.

Results/Discussion A total of 108 patients were included (decompression n=49 and interlaminar stabilization n=59). Both groups showed significant postoperative improvement, with MCID rates of ODI (84–86%), VAS (78%) and EQ-5D (71–80%). Increasing pelvic incidence was associated with higher odds of improvement following interlaminar stabilization across all outcomes (interaction OR 1.11–1.17, all $p<0.05$). Lumbar lordosis, pelvic incidence–lumbar lordosis mismatch, and foraminal height showed no significant interactions but demonstrated directional trends. Threshold analysis identified pelvic incidence values between 49.8° and 54.9° above which interlaminar stabilization showed greater predicted benefit. Subgroup analysis using pelvic incidence ≥55° supported this finding for ODI improvement.

Conclusion Pelvic incidence appears to modify the relative benefit of interlaminar stabilization compared with decompression alone in lumbar spinal stenosis. Higher pelvic incidence may favor use of interlaminar device.

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Endoscopic-Assisted Lumbar Interbody Fusion for the Treatment of Isthmic Lumbar Spondylolisthesis: Clinical Outcomes and Technical Points

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Objective To analyze the clinical efficacy of PE-PLIF in the treatment of isthmic lumbar spondylolisthesis and to summarize the relevant technical points.
Methods From August 2023 to September 2025, 28 patients with isthmic lumbar spondylolisthesis underwent PE-PTLIF surgery in our department, including 16 males and 12 females, aged 44–69 years. 25 cases involved a single segment, and 3 cases involved two segments. Postoperative lumbar anteroposterior and lateral radiographs and lumbar CT were performed to evaluate decompression and internal fixation. The clinical outcomes were assessed using the ODI, VAS for low back pain and leg pain, and the JOA score before surgery, after surgery, and at the final follow-up. Lumbar CT was reviewed at 6 months postoperatively to assess fusion status according to the Bridwell criteria.
Results All patients successfully underwent the surgery as planned. After endoscopic bilateral lateral soft tissue release, all patients achieved complete reduction. The mean operative time was 157.2 ± 20.2 minutes. The mean hospital stay was 14.0 ± 3.3 days, with a mean postoperative hospital stay of 9.4 ± 3.8 days. The ODI, VAS, and JOA at postoperative and final follow-up were significantly improved compared with preoperative values ($P < 0.01$). The segmental lordotic angle at the spondylolisthesis level was significantly improved postoperatively compared with preoperatively ($P < 0.01$). Except for one patient who experienced postoperative exiting nerve root irritation symptoms (quadriceps muscle strength decreased to grade IV), no other serious intraoperative or postoperative complications occurred. At the final follow-up (＞6 months), all patients achieved solid bony fusion.
Conclusion PE-PTLIF is a minimally invasive, safe, and effective surgical option for the treatment of isthmic lumbar spondylolisthesis. It can achieve clinical outcomes similar to those of open surgery. Moreover, the endoscopic approach allows adequate release of bilateral lateral soft tissues, enabling complete reduction of the spondylolisthetic segment.

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Preoperative Coronal MRI: A Critical Evaluation of the Kambin's Triangle for TLIF procedure

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Introduction Previous studies on large cages or extreme TLIF have proposed methods, using axial view MRI, for preoperative measurement of Kambin's triangle. However, no study has evaluated the accuracy or reliability of these methods, which can be particularly challenging in cases of severe stenosis. The objective of this study is to compare the correlation and accuracy between MRI measurements of the Kambin's triangle in coronal and axial cuts with the intraoperative width.
Methods A prospective study was conducted involving patients who underwent TLIF surgery. Demographic data and the surgical approach were collected. Coronal MRI and axial MRI measurements were taken for the width of the Kambin's triangle at the upper and lower endplates according to the side of the surgery. Intraoperative measurements of the corridor were measured. The relationship between MRI measurements and intraoperative measurements was analyzed.
Results Among 60 patients, coronal MRI measurement of the width of Kambin's triangle from both endplates demonstrated a strong correlation with intraoperative distances. In contrast, axial MRI showed a weak correlation for the upper endplate and a moderate correlation for the lower endplate. The mean absolute error (MAE) was significantly lower with coronal MRI compared to axial MRI for both the upper (0.70 ± 0.61 mm vs. 2.69 ± 2.90 mm, $p < 0.001$) and lower endplates (1.00 ± 0.98 mm vs. 5.53 ± 4.58 mm, $p < 0.001$). Inter- and intra-observer reliability were higher for coronal MRI.
Conclusions The study result indicates that coronal MRI measurements of the Kambin's triangle are more accurate and reliable than axial measurements. The high reliability of coronal MRI for preoperative assessments in patients undergoing TLIF allows for improved surgical planning for appropriate interbody selection.

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CERVICAL VERTEBRAL CORTEXPLASTY TECHNIQUE IN ANTERIOR CONTROLLABLE ANTIDISPLACEMENT AND FUSION FOR OSTEOPOROTIC CERVICAL-OPLL

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Objectives Anterior controllable antedisplacement and fusion (ACAF) is an effective strategy in treating cervical ossification of the posterior longitudinal ligament (C-OPLL). The controllable antidisplacement of vertebrae-OPLL complex (VOC) through screws is both the most critical and technically challenging procedure, especially in osteoporosis (OP) condition. This study aims to introduce a novel cervical bone cement augmentation technique ---Cervical Vertebral Cortexplasty (CVC) with a simple and lower cost instrument to significantly improve the procedure of VOC antidisplacement in ACAF.
Methods In the CVC technique, the bone cement was injected in to VOC by a simplified device composed of a 50 ml syringe needle and 1 ml syringe barrel. The ACAF with CVC technique was used to treat twenty-two patients both with C-OPLL and OP from January 2020 to January 2025. During this technique, unlike the traditional way, the modified grooving steps was design to improve the safety of operation. Japanese Orthopaedic Association (JOA) score, complications, fusion conditions were document.
Results Twenty-two C-OPLL patients were successfully implemented by the ACAF with CVC technique. All patients were followed up for 26.55 months on average. The JOA score with12.18 ± 1.68 at last follow-up was significantly improved (vs 8.59 ± 1.89, $P < 0.05$). No cement leakage was found during the augmentation, and 0.2 ml bone cement was injected in each VOC, which obviously enhanced screws anchorage. All VOCs were successfully hoisted after the augmentation without screw loosening. Twenty-two C-OPLL patients achieved satisfactory fusion at the last visit
Conclusions Bone cement augmentation can be performed by a simple and lower cost instrument from CVC technique. CVC with modified grooving steps can effectively assist the VOC antedisplacement in ACAF for C-OPLL in osteoporosis group. This technique also has obvious ability for several other ACAF issues related to small VOC dimensions, screw loosening and intraoperative VOC break in no-OP group.

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Risk Factors of Incomplete Clinical Improvement Following Microscopic and Endoscopic Lumbar Discectomy: An Analysis of 1-year Follow-up Prospective Data

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Introduction Minimally invasive discectomy (MIS discectomy), including Interlaminar endoscopic lumbar discectomy (IELD) and microdiscectomy (MD) is an effectively alternative treatment for lumbar disc herniation. However, some patients experience suboptimal outcomes. This study aims to analyze the clinical and radiographic risk factors associated with incomplete clinical improvement following MIS discectomy.

Material and Methods An analysis was conducted using prospectively collected data from two randomized controlled trials involving patients who underwent either IELD or MD for lumbar disc herniation, with a follow-up period of one year. Incomplete clinical improvement was defined as persistent significant pain or disability after surgery and was categorized as “fair” or “poor” outcome according to the modified Macnab criteria. Clinical and radiographic characteristics were evaluated to identify factors associated with poor outcomes.

Results A total of 71 patients who underwent MIS discectomy were analyzed. 20 patients (28%) demonstrated incomplete clinical improvement. The ODI, VAS for back pain and leg pain, and walkable time significantly improved over time postoperatively through the last follow-up. Radiographically, both segmental lordosis and whole lumbar lordosis showed significant postoperative improvement. Multivariate logistic regression analysis identified central disc herniation, preoperative moderate to severe canal compromise, and preoperative VAS for leg pain less than 7 as independent factors associated with incomplete clinical improvement following MIS discectomy.

Conclusion We identified independent risk factors for incomplete clinical improvement following MIS discectomy including central disc herniation, preoperative moderate to severe canal compromise, and preoperative VAS for leg pain less than 7. Awareness of these factors may assist in preoperative planning and patient selection to optimize surgical outcomes.

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Prioritisation for Lumbar Decompression by Patient Reported Outcome Measures

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Objective Prolonged outpatient waiting times for spinal clinics necessitate an efficient outpatient referral pathway. Symptomatic lumbar stenosis is a common referral to spinal services. PROM data is routinely collected by spinal units in the UK and has potential to optimise outpatient referral pathways. Our primary objective was to investigate the relationship between pre-operative PROM data and post-operative score difference (POSD).

Methods A retrospective review of ODI and EQVAS data was undertaken on patients who underwent lumbar decompressions at our institution. 1-year POSD was calculated for both EQVAS and ODI. Linear regression analysis was then undertaken to investigate the effect of patient demographics, medical history, and pre-operative PROM scores against the resultant POSD.

Results 179 cases eligible for screening were identified. Of these 179 records, 130 records met inclusion criteria and proceeded to data analysis. Linear regression of pre-op. ODI score vs 1yr POSD revealed a statistically significant relationship ($P = 0.00028$), with a linear regression coefficient of -0.32 (95% confidence interval (CI): -0.53, -0.12). Linear regression of pre-op. EQVAS score vs. 1yr POSD also yielded statistically significant results ($P < 0.0001$), with a coefficient value of -0.76 (95% CI: -0.94, -0.57). This study predicted a positive response to surgery at pre-operative ODI values >22 and EQVAS scores <60; and a 50% probability of achieving a MCID at ODI values >52.4 and EQVAS scores < 44.3.

Conclusions These results suggest possible cut-off values which could be used by referring clinicians or allied health professionals for surgical management of patients with single level lumbar stenosis. Larger studies are required to further validate these findings and better delineate the relationship between pre-operative PROM scores and their potential role in patient selection for lumbar decompression or referral to spinal services.

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Postoperative Spinal Epidural Hematoma(POSEH) in Full Endoscopic Spine Decompressive Surgery: A Case Series and Clinical Review on Drainage, Hemostasis, and Topical Sealants

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Introduction/Objectives Postoperative spinal epidural hematoma (POSEH) is a rare but clinically significant complication after lumbar decompression surgery. While the role of routine postoperative drainage remains controversial, the importance of intraoperative hemostasis and the implications of topical hemostatic agents deserve greater attention. This study aimed to present symptomatic POSEH after full-endoscopic unilateral laminotomy for bilateral decompression (FE-ULBD) and to highlight the clinical relevance of intraoperative bleeding control and hemostatic material use.

Materials and Methods We retrospectively reviewed 84 consecutive patients with symptomatic lumbar spinal stenosis who underwent FE-ULBD at a single center between January 2022 and January 2024 without routine postoperative drainage. Clinical outcomes included Oswestry Disability Index (ODI), visual analog scale (VAS) for leg pain, complications, and reoperation rates. Two patients with symptomatic POSEH requiring reintervention were analyzed in detail.

Results/Discussion Mean operative time was 137.4 minutes, estimated blood loss was 7.2 mL, and mean hospital stay was 2.3 days. ODI improved from 29.23 preoperatively to 11.3 at 12 months, and VAS leg pain improved from 7.0 to 1.09 (both $p<0.001$). The overall complication rate was 2.3% (2/84), and the reoperation rate was 4.7% (4/84). One patient developed delayed symptomatic epidural hematoma requiring urgent evacuation, whereas another developed recurrent claudication after intraoperative use of Floseal for persistent epidural venous and bony oozing. These cases highlight that postoperative compressive lesions may still occur after endoscopic decompression and that Floseal may complicate postoperative symptom and imaging interpretation.

Conclusion Symptomatic POSEH remains an uncommon but important complication after FE-ULBD. These cases underscore that meticulous intraoperative hemostasis is critical in endoscopic decompression and that topical hemostatic agents such as Floseal should be used judiciously. Careful postoperative assessment is essential, especially when recurrent symptoms and equivocal imaging findings are encountered. The preventive role of routine postoperative drainage remains uncertain.

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Skeletal Muscle-Specific Markers Reveal Significantly Lower Paraspinal Injury in Full-Endoscopic compared to Open Microscopic Lumbar Spine Surgery: A Prospective Observational Study

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Introduction/Objectives Minimally invasive spine surgery techniques have been developed to reduce approach-related muscle injury during lumbar decompression. Full-endoscopic lumbar surgery may lessen paraspinal muscle damage by avoiding extensive muscle dissection and retraction. This study compared postoperative changes in biochemical markers of skeletal muscle injury after open microscopic versus full-endoscopic lumbar decompression.

Materials and Methods This prospective observational study included adults undergoing lumbar decompression for degenerative lumbar spondylosis. Patients underwent either open microscopic surgery or full-endoscopic surgery according to surgeon preference. All procedures were performed through a unilateral posterior approach without fusion. Preoperative blood samples were obtained within 1 week before surgery, and postoperative samples were collected within 24 hours after surgery. Laboratory parameters included creatine phosphokinase (CPK), creatine kinase-MM (CK-MM), myoglobin, lactate dehydrogenase, aldolase, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, gamma-glutamyl transferase, and C-reactive protein. Changes were calculated as postoperative minus preoperative values.

Result/Discussion A total of 204 patients were included: 148 underwent open microscopic surgery and 56 underwent full-endoscopic surgery. Postoperative increases in skeletal muscle injury markers were greater after open surgery. The mean postoperative change in CK-MM was 38.0 ± 61.5 U/L in the open group versus −9.3 ± 46.9 U/L in the endoscopic group (mean difference 47.3 U/L, 95% CI 31.4–63.2; $p < 0.001$). Myoglobin increased by 72.0 ± 72.1 ng/mL after open surgery and 33.8 ± 31.8 ng/mL after endoscopic surgery (mean difference 38.2 ng/mL, 95% CI 23.0–53.4; $p < 0.001$). Other markers were not significantly different after false discovery rate correction. Single-level subgroup analysis showed similar findings.

Conclusion Full-endoscopic lumbar decompression was associated with smaller postoperative increases in CK-MM and myoglobin than open microscopic surgery, suggesting less paraspinal muscle injury.

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Short-Segment Fixation Using Cement-Augmented Fenestrated Pedicle Screws Combined with Vertebroplasty for Unstable Osteoporotic Vertebral Fractures

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Introduction Osteoporotic vertebral fractures (OVFs) with severe instability are associated with high rates of reoperation when treated with vertebroplasty alone, primarily due to progressive collapse or cement loosening. Posterior fixation is often combined; however, the optimal fixation range remains unclear. Cement-augmented fenestrated pedicle screws (CAFPS) have recently enabled short-segment fixation in osteoporotic patients.

Materials and Methods We retrospectively reviewed 71 patients with thoracolumbar OVFs and preoperative vertebral instability >14° who underwent vertebroplasty with posterior fixation between 2021 and 2025. Patients were divided into a conventional multi-segment fixation group using standard (non-cement-augmented) pedicle screws (PS group, n=43) and a short-segment fixation group using CAFPS (CAFPS group, n=28). Clinical outcomes, operative time, blood loss, and radiographic outcomes, including adjacent vertebral fracture (AVF), screw loosening, and correction loss within the fixed segments and semi-global alignment (defined as alignment across four vertebrae above and below the fractured level), were evaluated.

Result There were no significant differences in baseline characteristics or clinical outcomes between the two groups. The CAFPS group showed significantly shorter operative time ($p=0.01$) and less blood loss ($p<0.01$). The number of fused segments was significantly smaller in the CAFPS group ($p<0.01$). Although the incidence of AVF was similar, screw loosening was significantly higher in the PS group ($p=0.01$). No significant differences were observed in correction loss, both within the fixed segments and in semi-global alignment.

Conclusion Short-segment fixation using CAFPS provides comparable clinical and radiographic outcomes to conventional multi-segment fixation while reducing surgical invasiveness and screw-related complications. This approach may be particularly beneficial in elderly osteoporotic patients, in whom minimizing surgical invasiveness is critical. This technique may represent a useful alternative in the management of unstable OVFs

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Application of the far-lateral approach in uni-portal non-coaxial spinal endoscopic surgery: an evidence-based and Delphi consensus approach among Chinese expert opinions

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Objectives Degenerative lumbar spine diseases significantly affect patients' quality of life. The far-lateral approach (FLA) in uni-portal non-coaxial spinal endoscopic surgery (UNSES) offers a minimally invasive solution for complex lesions; however, a lack of expert consensus exists regarding its use. This study aimed to establish a consensus definition for the clinical application of FLA in UNSES by aggregating expert opinions through a modified Delphi method, thereby guiding clinical decision-making.

Methods A cross-sectional modified Delphi consensus survey was conducted. Seventy-eight spine endoscopy experts were invited to complete two rounds of anonymous questionnaires. The questionnaire covered six FLA-related categories: indications, advantages, preoperative evaluation, surgical details, complications, and postoperative rehabilitation. The consensus threshold was set at ≥ 70%.

Results The effective response rates for the two survey rounds were 94.87% and 97.44%, respectively. The expert authority coefficients were high (0.88-0.92), and Kendall's coefficients were 0.47 and 0.52, respectively. Grade A and grade B consensus were achieved for 89.5% (17/19) and 10.5% (2/19) of all items, respectively.

Discussion This study demonstrates a high degree of agreement among experts on the key aspects of using FLA in UNSES. It provides a framework for standardizing surgery, optimizing patient outcomes, guiding future research, and promoting safe and effective UNSES implementation.

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Early Comparative Outcomes of Three Endoscopic Spine Surgery Techniques by a Single Surgeon During Initial Adoption

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INTRODUCTION/OBJECTIVES Endoscopic spine surgery has evolved into multiple approaches, including microendoscopic discectomy (MED), full endoscopic spine surgery (FESS), and unilateral biportal endoscopy (UBE). In Japan, MED and FESS have been widely used, while UBE has rapidly expanded since its introduction in 2023. However, comparative data during the early adoption phase by a single surgeon remain limited. This study aimed to clarify the clinical characteristics and technical challenges of these three techniques during initial implementation.

MATERIALS AND METHODS MED and FESS were introduced in April 2023, followed by UBE in September 2023. A total of 150 consecutive cases (50 per technique) involving lumbar spinal stenosis or lumbar disc herniation were retrospectively analyzed. Surgical time, clinical outcomes (Macnab criteria), complications, and reoperation rates were evaluated.

RESULTS/DISCUSSION All three techniques demonstrated favorable clinical outcomes during the early phase of adoption. FESS tended to be the least invasive, particularly for simple disc herniation. MED showed consistent and stable results across a wide range of cases, reflecting its similarity to conventional open surgery. UBE provided a wider surgical field and greater flexibility, enabling broader applicability, including decompression and potential extension to fusion procedures. However, during the early learning phase, UBE tended to require longer operative time and showed a higher risk of technical-related complications. These findings highlight the distinct characteristics of each technique and the importance of appropriate case selection.

CONCLUSION MED is relatively more invasive but provides stable and reliable outcomes with a surgical feel similar to open procedures. FESS is the least invasive for simple disc herniation but has limited versatility. UBE requires careful attention to complications in the early phase; however, once performed safely, it offers a minimally invasive and highly versatile approach with potential for expansion to fusion surgery.

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Learning curve of arthroscopic-assisted uni-portal spinal surgery (AUSS) for the far-lateral approach in the treatment of degenerative lumbar diseases

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Objective To explore the learning curve of arthroscopic-assisted uni-portal spinal surgery (AUSS) for the far-lateral approach (FLA) in the treatment of degenerative lumbar diseases, and to provide clinical guidance for the standardized promotion and application of this technology.

Methods A retrospective analysis was performed on 60 consecutive patients. The operation time, intraoperative blood loss, fluoroscopy times, postoperative hospital stay, VAS for low back and leg pain, ODI, and complications were recorded and compared among groups. The learning curve was fitted by the cumulative sum method (CUSUM). The learning process was divided into the initial learning stage, the improvement stage and the proficiency stage.

Results With the increase of the number of operations, the operation time, intraoperative blood loss and fluoroscopy times showed a significant decreasing trend ($P<0.05$), while the postoperative VAS score and ODI showed a significant decreasing trend ($P<0.05$), and the postoperative hospital stay showed no significant difference ($P>0.05$). The CUSUM curve showed that the inflection point of the learning curve was at the 25th case. Before the 25th case, the curve was in an upward trend, indicating the initial learning stage and improvement stage; after the 25th case, the curve tended to be flat, indicating the proficiency stage. The total complication rate was 8.33% (5/60), including 2 cases of transient numbness of lower extremities, 2 cases of local pain at the incision, and 1 case of cerebrospinal fluid leakage. No severe complications such as nerve injury or infection occurred.

Conclusion The application of AUSS-assisted FLA has a certain learning curve, and the inflection point is about the 25th case. After mastering the key techniques such as anatomical positioning, endoscopic manipulation and hemostasis, the surgeon can gradually reach the proficiency stage, with significantly improved surgical efficiency and clinical efficacy, and controllable complications.

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What makes a difference? Return to driving after cervical disc replacement

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Introduction This study compares cervical spine range of motion (ROM) and patient reported outcomes against Neck Disability Index (NDI)-driving scores pre- and post-artificial disc replacement (ADR).

Materials and Methods Patients with cervical radiculopathy or myeloradiculopathy who underwent ADR and were primary drivers were identified. Outcomes including cervical spine ROM, visual analogue scale (VAS) neck pain, VAS limb pain, and Japanese Orthopaedic Association (JOA) scores were measured pre-operatively and 6 months post-operatively. Spearman's rho was used to assess the correlation of the outcomes against NDI-driving scores. Subgroup analysis was performed between the radiculopathy and myeloradiculopathy subgroups. Patients were also consulted at 3 weeks post-operatively to assess their function and wound.

Results 153 patients were included. At 6 months, cervical spine ROM was preserved, with significant reductions in lateral flexion (LF) (left LF MD 2.98°, $p<0.001$; right LF MD 2.81°, $p<0.001$). VAS neck pain improved significantly (MD 3.53, $p<0.001$), exceeding the minimal clinically important difference (MCID) of 2.6, while VAS limb pain improved overall (MD 3.60, $p<0.001$) but did not meet the MCID (4.1) except in the radiculopathy subgroup. In myeloradiculopathy patients, JOA scores improved by 2.02 points ($p<0.001$) but did not exceed the MCID of 2.5. Spearman's correlation showed no moderate or strong associations between the studied outcomes and NDI-driving scores, and no significant differences were found between radiculopathy and myeloradiculopathy groups. At 2 weeks post-operatively, all patients had confidently returned to driving.

Conclusion Patients with cervical radiculopathy and myeloradiculopathy who undergo ADR can safely return to driving 2 weeks post-operatively.

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Factors Associated With Deflation Effect During Balloon Kyphoplasty: An Intraoperative Fluoroscopic Analysis

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Background During balloon kyphoplasty (BKP) for osteoporotic vertebral fractures (OVFs), reduction achieved by balloon inflation may be partially lost after balloon deflation. This phenomenon, defined here as the deflation effect, remains poorly understood. We investigated factors associated with deflation effect and postoperative outcomes using intraoperative fluoroscopic and radiographic assessments.
Methods We retrospectively reviewed 61 patients who underwent BKP for OVFs between 2023 and 2025. Deflation effect was defined as a decrease of 2° or more in vertebral angle after balloon deflation, based on the cohort median. Patients were divided into the deflation-effect group and the non-deflation-effect group. Multivariable logistic regression was performed with deflation effect as the dependent variable. Independent variables were age, preoperative vertebral angle in the supine position, preoperative anterior vertebral height in the supine position, and balloon reduction angle. Postoperative radiographic parameters were compared between groups, and multivariable linear regression was performed for vertebral angle and anterior vertebral height at final follow-up.
Results The non-deflation-effect group included 28 patients and the deflation-effect group 33. On univariate analysis, the deflation-effect group had lower preoperative anterior vertebral height (p=0.0006), greater preoperative vertebral angle (p=0.0089), and greater balloon reduction angle (p=0.000002). On multivariable logistic regression, greater balloon reduction angle (OR 1.94, 95% CI 1.40-2.98; p=0.00001) and lower preoperative anterior vertebral height (p=0.0083) were independently associated with deflation effect. Although the deflation-effect group showed poorer postoperative radiographic alignment on univariate analysis, multivariable analysis showed that radiographic outcomes at final follow-up were mainly determined by baseline severity. No significant between-group differences were found in postoperative new vertebral fractures or cement leakage.
Conclusions Deflation effect during BKP is more likely in severely collapsed vertebrae and in cases with greater intraoperative reduction. It appears to be a fluoroscopic marker of severe fracture morphology rather than an independent cause of poor postoperative radiographic outcome.

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Comparison of Clinical Outcomes Between Unilateral Biportal Endoscopic and Microendoscopic Discectomy for Lumbar Disc Herniation

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Objectives With the increasing use of unilateral biportal endoscopic (UBE) discectomy as a minimally invasive alternative to microendoscopic discectomy (MED), this study aimed to compare perioperative and clinical outcomes between the two techniques for lumbar disc herniation.
Methods A retrospective comparative study was conducted on 226 patients who underwent discectomy (UBE: n=92; MED: n=134). Patients who underwent surgery between 2021 and 2025 were included, with a mean follow-up of 12 months. Demographic characteristics were comparable between groups except for sex distribution. Operative time, hospital stay, inflammatory markers (WBC, CRP), postoperative-to-preoperative CK ratio, clinical outcomes (NRS, ODI), and complications were evaluated.
Results Mean operative time was similar between groups (UBE: 79.7 min vs MED: 75.6 min, p=0.29). The UBE group had a significantly shorter hospital stay (3.3 vs 4.1 days, p<0.0001). The CK ratio was significantly lower in the UBE group on postoperative day 1 (2.02 vs 2.41, p=0.03) and day 3 (1.25 vs 1.97, p=0.004), suggesting reduced muscle injury. WBC and CRP levels showed no significant differences. Clinical outcomes were comparable, with no significant differences in NRS and ODI at 1 and 3 months. Recurrence rates were similar (UBE: 10.9% vs MED: 11.2%). Dural tears occurred in 1 case (UBE) and 3 cases (MED).
Conclusion UBE discectomy demonstrated comparable clinical outcomes to MED, with shorter hospital stay and lower CK levels. UBE may be a less invasive alternative for lumbar disc herniation.

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PL-TOSP, the Novel Entry Point in Transforaminal Endoscopic Spine Surgery

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The aim of this study was to analyze the variation in angulation of trajectories for various skin entry points in transforaminal endoscopic spine surgery, focusing on the impact of physical parameters such as weight, abdominal girth, and body mass index. We hypothesized that the posterolateral-tip of spinous process (PL-TOSP) entry would exhibit minimal variation in trajectory angle compared to existing skin entry points. The study also evaluated the functional outcomes in patients undergoing transforaminal endoscopy with the novel PL-TOSP technique, measuring improvements in pain and disability.
The methodology involved a radiological analysis and prospective evaluation of 50 symptomatic patients who had surgery using the PL-TOSP entry point. Preoperative assessments included a lumbar spine magnetic resonance imaging (MRI) with an abdominal perimeter evaluation. Relevant physical parameters were measured, and angulation trajectories from four standard entry points used in transforaminal endoscopic lumbar discectomy (TELD) were calculated. These included angles from the 45-degree, PL, TOSP, and the proposed PL-TOSP entry points at the L4-5 and L5-S1 levels.
Results revealed that the angle of trajectory for all entry points varied according to individual physical parameters, with the PL-TOSP entry demonstrating the least variation (21 to 29 degrees). Statistically significant improvements were noted in postoperative Visual Analogue Scale (VAS) scores and the Oswestry Disability Index (ODI) at 2, 6, and 12 weeks (p-value < 0.05), indicating reliable outcomes associated with the PL-TOSP approach.
In conclusion, the PL-TOSP entry point offers superior stability in trajectory angle, even amid variations in physical parameters, and is linked to significant functional improvements and pain reduction for patients with lower limb radiculopathy.

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FAPDIS algorithm for selection of full endoscopic approach for symptomatic Nerve root decompression

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Both Transforaminal and Interlaminar endoscopic approaches are established techniques of decompression for lumbar compressive radiculopathy. In the absence of adequate literature, there is always some dilemma in selecting the approach for endoscopic decompression leading to long learning curves and high chances of inadequate decompression, iatrogenic instability, dural tear, or dysesthesia. Hence authors propose an algorithm for selection of endoscopic approach.

Methods This retrospective study included 396 of 626 consecutive patients who met the inclusion criteria, who underwent either TF (n=302) or IL (n=202) full endoscopic spine surgery. MRI findings of every patient were classified as per FAPDIS (Facet angle, Anterior pathology, Posterior pathology, Dorsal, Inferior, and Superior migration) algorithm. Inter-observer variations were calculated. The targeted nomenclature was used to define the selection of endoscopic TF or IL approach for symptomatic nerve root decompression. All patients were followed up for preop and postop 6 months VAS and Oswestry Disability Index score for validation of FAPDIS algorithm.

Results Median age: 46.8 years; Sides and levels operated 330 single-level ipsilateral, 54 multiple-level ipsilateral, 6 single-level bilateral, and 6 multiple-level bilateral. Interobserver agreement in the selection of TF approach was 0.873 and IL approach was 0.882. Interobserver variability was also calculated for each FAPDIS factor, selection of P3 and P4 pathology was the main reason for disagreement. All other FAPDIS factors show good to excellent correlation. The overall VAS score decreased from a preoperative value of 9 to 1 at 6 months follow-up (p-value < 0.001), and the overall Oswestry Disability Index score improved from 89 to 12 (p-value <.001).

Conclusions The author's new FAPDIS surgical nomenclature and algorithm is a reliable tool for describing the symptomatic nerve root compression for the selection of endoscopic surgical approach to achieve adequate decompression of offending neural structure with minimum challenges to minimize perioperative complication rate.

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Standardized nomenclature of the maneuvers of Interlaminar endoscopic Spine Surgery & its implication in Contralateral decompression techniques.

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Lumbar endoscopic unilateral laminotomy for bilateral decompression (LE-ULBD) is a minimally invasive procedure designed to treat lum-bar spinal stenosis. While traditional uniportal endoscopic decompression already reduces tissue damage and promotes faster recovery compared to open surgery, this work introduces standardized terminology and specific endoscope-camera maneuvers to improve visual-ization and precision during both ipsilateral and contralateral decompression. By describing endoscope ("shaft") and camera head ("optic") rotations in a degree–degree format (e.g., 0–0, 90–0, 135–135, 180–180), the technique allows reproducible, targeted access to key anatomical areas while minimizing unnecessary bone removal. This systematic approach addresses the steep learning curve and tech-nical intricacies of lumbar endoscopy, aiding intraoperative communication and potentially decreasing complications from inadequate decompression or poor visualization. The method aims to improve training, safety, and consistency of outcomes in endoscopic lumbar decompression procedures stenosis.

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Skeletal Muscle-Specific Markers Reveal Significantly Lower Paraspinal Injury in Full-Endoscopic compared to Open Microscopic Lumbar Spine Surgery: A Prospective Observational Study

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Introduction/Objectives Minimally invasive spine surgery techniques have been developed to reduce approach-related muscle injury during lumbar decompression. Full-endoscopic lumbar surgery may lessen paraspinal muscle damage by avoiding extensive muscle dissection and retraction. This study compared postoperative changes in biochemical markers of skeletal muscle injury after open microscopic versus full-endoscopic lumbar decompression.

Materials and Methods This prospective observational study included adults undergoing lumbar decompression for degenerative lumbar spondylosis. Patients underwent either open microscopic surgery or full-endoscopic surgery according to surgeon preference. All procedures were performed through a unilateral posterior approach without fusion. Preoperative blood samples were obtained within 1 week before surgery, and postoperative samples were collected within 24 hours after surgery. Laboratory parameters included creatine phosphokinase (CPK), creatine kinase-MM (CK-MM), myoglobin, lactate dehydrogenase, aldolase, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, gamma-glutamyl transferase, and C-reactive protein. Changes were calculated as postoperative minus preoperative values.

Result/Discussion A total of 204 patients were included: 148 underwent open microscopic surgery and 56 underwent full-endoscopic surgery. Postoperative increases in skeletal muscle injury markers were greater after open surgery. The mean postoperative change in CK-MM was 38.0 ± 61.5 U/L in the open group versus −9.3 ± 46.9 U/L in the endoscopic group (mean difference 47.3 U/L, 95% CI 31.4–63.2; $p < 0.001$). Myoglobin increased by 72.0 ± 72.1 ng/mL after open surgery and 33.8 ± 31.8 ng/mL after endoscopic surgery (mean difference 38.2 ng/mL, 95% CI 23.0–53.4; $p < 0.001$). Other markers were not significantly different after false discovery rate correction. Single-level subgroup analysis showed similar findings.

Conclusion Full-endoscopic lumbar decompression was associated with smaller postoperative increases in CK-MM and myoglobin than open microscopic surgery, suggesting less paraspinal muscle injury.

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Endoscopic Lumbar Medial Branch Rhizotomy Utilizing 3D Navigation for Failed Back Surgery Syndrome

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Introduction Failed back surgery syndrome (FBSS) remains therapeutically demanding, with facet joint pain being a frequent but under-recognized etiology. This study retrospectively evaluated the outcomes of full-endoscopic lumbar medial branch rhizotomy for FBSS patients with facetogenic pain.

Materials and Methods We reviewed 20 adults treated between July 2020 and June 2025. Eligibility required ≥ 6 weeks of unsuccessful conservative management and a positive medial branch block. Procedures were performed under local anesthesia in a hybrid operating room using 3D navigation and a 30° endoscope. The targeted medial branch and the immediately cranial branch were ablated to ensure complete denervation. The primary endpoint was 12-month pain-free survival (PFS). Patients were classified into Instrumented-MIS, Instrumented-Open, and Non-instrumented subgroups.

Results The cohort had a mean age of 57 years and a mean BMI of 24.2 kg/m². The 12-month PFS rates were 20% (Instrumented-MIS), 54% (Instrumented-Open), and 71% (Non-instrumented), with no significant differences across subgroups (log-rank p = 0.88). Cox regression indicated a non-significant trend toward inferior PFS in instrumented patients (HR 2.49, p = 0.18). Overall, 50% of the patients achieved a durable 1-year PFS.
Conclusion Full-endoscopic lumbar medial branch rhizotomy is an effective, minimally invasive strategy for FBSS with facetogenic pain. Patients with prior instrumentation exhibited a trend toward poorer clinical outcomes. Further multicenter investigations with larger sample sizes are warranted to validate these findings.

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Robotic Assisted Percutaneous Iliac Fixation – Outcomes, History, and Review
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Introduction Long-construct fusions extending into the pelvis require durable sacropelvic fixation to withstand biomechanical forces. Traditional iliac screws provide strong fixation but are limited by wound complications, offset-connector requirements, and hardware prominence. S2-alar-iliac screws improve soft-tissue outcomes but may violate the sacroiliac joint, contribute to postoperative SIJ pain, and demonstrate variable fusion rates. With advances in robotics, medialized iliac trajectories may re-establish the advantages of iliac fixation while reducing complication profiles. This study evaluates the safety, accuracy, and perioperative outcomes of robotically placed iliac screws using a medialized, percutaneous technique.
Materials and Methods A retrospective review was performed of all patients who underwent robotically navigated iliac fixation between January 1, 2019 and January 1, 2025. Demographic, perioperative, and postoperative variables were collected, including sex, BMI, ASA class, blood loss, surgery duration, complications, opioid use, VAS pain scores, and primary versus revision status.
Results Twenty-eight patients met inclusion criteria (9 primary, 19 revision). Mean age was 67.21 years, mean BMI 26.77, and mean ASA of 2.07. Mean blood loss was 81.61 mL. Mean VAS scores improved by 2.11 points at 2 weeks. No surgical-site infections occurred. Two patients required revision for symptomatic hardware prominence, both with BMI <20. Two patients had 90-day complications unrelated to iliac fixation. Screw accuracy was 100%, with no cortical breaches or offset-connector requirements.
Conclusion Robotically placed medialized iliac screws appear to mitigate shortcomings of traditional iliac and S2AI fixation. This technique avoids SIJ violation, minimizes wound complications, and provides precise fixation, representing a safe and effective technique. These findings support further investigation through prospective, comparative studies with longer follow-up to validate the long-term durability and generalizability of this approach.

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Robotic-Assisted Posterior Cervical Fusion in Primary and Revision Surgery: Technique with Outcomes after 50 Screws
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The Steadman Clinic USA

Introduction/Objectives Posterior cervical instrumentation is technically challenging due to complex anatomy. Midline open approaches delineate anatomy but are are associated with significant blood loss, infection risk, and muscle injury. Robotic assisted techniques have emerged as a promising alternative, demonstrating potentially superior screw placement accuracy compared to fluoroscopy and computerized navigation while minimizing soft tissue disruption. This study evaluates the safety and efficacy of robotic assisted percutaenous posterior cervical instrumentation in both primary and revision settings, addressing a significant gap in the current literature.
Materials/Methods A retrospective review of all patients who underwent robotic assisted cervical spine surgery from January 1 2019 to January 1 2024 was performed. Demographic, intraoperative, and perioperative data of all patients who underwent cervical pedicle or lateral mass screw placement with minimally invasive navigated robotic guidance were analyzed. Pedicle screw malposition based on the surgeon's intraoperative radiographic observations was noted from operative reports. Secondary outcome measures included patient demographics and whether the surgery performed was a primary operation or a revision procedure.
Result/Discussion 9 subjects underwent posterior cervical fusion using percutaneous placement of hardware using a robotic system. Of the 9 included subjects, 5 (56%) underwent a primary surgery and 4 (44%) underwent revision surgery resulting in the placement of a total of 50 screws. Twenty-four screws were placed in the primary setting, and 26 in the revision setting. The most common level for screw placement was C7 followed by T1. No patients experienced complications defined as post-operative neurological deficits, bony breach, or vertebral artery injury. No patients experienced recurrence of preoperative symptoms at 2-week follow-up.
Conclusion The use of robotic assistance in the placement of posterior cervical instrumentation in both primary and revision settings may be performed safely with minimal risk of neurological deficit, bony breach, or vertebral artery injury.

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Efficacy of Intrathecal Morphine on Postoperative Analgesia and Early Ambulation in Endoscopic Lumbar Interbody Fusion: A Pilot Prospective Cohort Study
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Introduction Endoscopic lumbar interbody fusion (eLIF) has emerged as an alternative to open surgery, aiming to reduce tissue trauma and accelerate recovery. However, postoperative pain management remains a critical barrier in achieving early mobilization. Intrathecal morphine (ITM) has been shown to reduce systemic opioid requirements in open spine surgery, but its specific utility in the endoscopic setting for functional recovery requires further validation. Through this pilot prospective cohort study, we aim to evaluate the impact of intraoperative ITM on post-operative analgesic control, distance ambulated, and hospital length of stay (LOS).
Methods We compared a series of patients who underwent eLIF with and without ITM. Patients were divided into two groups: the ITM group receiving a single intraoperative dose of 100mcg of preservative-free morphine, and a control group receiving standard systemic analgesia intraoperatively. Postoperatively, Patient Controlled Analgesia (PCA) or tramadol are used to optimise postoperative pain control.
* Primary Endpoints: 24-hour post-operative opioid consumption in terms of Morphine Milligram Equivalents (MME).
* Secondary Endpoint: Postoperative pain score on post-operative days 1 (POD1p) and 2 (POD2p) , Distance ambulated on post-operative days 1 (POD1a) and 2 (POD2a), and total length of stay (LOS).

Results Patients who received ITM reported significantly reduced POD1p and POD2p while requiring less than half the MME compared to the group without ITM. However, there was no significant difference in POD1a, POD2a and LOS between the group that received ITM and those who did not respectively.
Conclusion ITM in eLIF has significantly improved postoperative pain control and reduced postoperative opioid consumption, thereby reducing opioid-related complications. However, we acknowledge that a larger sample size might be necessary to accurately determine significant difference in postoperative ambulation and LOS between the two groups. These findings support the proposal of integrating low-dose ITM into Enhanced Recovery After Surgery (ERAS) protocols for endoscopic spinal procedures.

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Full-Endoscopic Direct Pars Repair With Bone Grafting and Temporary Percutaneous Pedicle Screw Fixation for Adult Lumbar Spondylolysis
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Introduction / Objectives Direct repair of lumbar spondylolysis is well established in adolescents; however, its role in adults remains controversial due to degenerative changes and concerns regarding healing potential. We present a minimally invasive hybrid strategy combining full-endoscopic preparation of the pars defect, bone grafting, and temporary percutaneous pedicle screw (PPS) fixation for adult lumbar spondylolysis.
Materials and Methods A 40-year-old male with chronic low back pain was diagnosed with bilateral L5 spondylolysis. Diagnostic blocks demonstrated significant pain relief after pars infiltration, confirming the pars defect as the primary pain generator. Full-endoscopic preparation of the pars defect, including debridement of fibrous tissue and refreshing of the bony surface, was performed. Autologous iliac bone graft was harvested through the PPS incision using a microendoscopic discectomy (MED) tubular retractor system. The graft was then implanted into the pars defect under direct full-endoscopic visualization. Temporary stabilization was achieved using PPS fixation at L5–S1.
Results / Discussion The patient returned to work 3 weeks postoperatively without complications. Computed tomography demonstrated disappearance of the pars gap at 2 days and solid bony union at 6 months. Implant removal is planned after confirming persistent union. This technique integrates precise endoscopic preparation, accurate graft placement under direct visualization, and temporary stabilization without extensive muscle dissection. Unlike conventional direct repair techniques requiring compression across the defect, PPS fixation in this approach may provide temporary biological stabilization, facilitating bone healing while preserving motion.
Conclusion This hybrid minimally invasive direct repair strategy may represent an effective motion-preserving treatment option for selected adult patients with lumbar spondylolysis.

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Post-Operative Outcomes In Patients Undergoing Novel C3 Dome – C7 Reverse Dome Open-Door Laminoplasty.
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Introduction/Objectives A recent pilot study on C3 dome – C7 reverse dome open-door laminoplasty (C3DC7RDOL) technique, which aims to reduce postoperative complications through preserving dorsal musculature attached to C3 and C7 had been reported. The aim of this study is to validate the pilot study through a larger cohort of patients.
Materials and Methods A retrospective, single-centre study of all patients who underwent C3DC7RDOL performed was conducted. Patient demographics, clinical and radiological data, surgical details, complications and outcome data; Patient Reported Outcome Measures (PROMs) and modified Japanese Orthopaedic Association (mJOA) scores were reviewed. Statistical analyses were performed with R software.
Result/Discussion 104 patients were included, with a mean follow-up of 2 years and mean age of 63.3 ± 9.4 years and 76.0% being males. Most patients were K-line positive (93.0%). Significant improvements were observed from pre- to post-operatively in mJOA score (12.5→15.7, $p < 0.001$), Neck Disability Index (26.2→12.2, $p < 0.001$), SF-36 physical component score (38.1→46.9, $p < 0.001$), and neck VAS (3.6→1.0, $p < 0.001$). Cervical lordosis (9.5°→7.5°, $p = 0.109$) and cervical range of motion (36.7°→34.3°, $p = 0.148$) were maintained at the final follow-up. The MCID for mJOA recovery rate was achieved in 75.4% of patients, neck VAS pain reduction in 60.4%, SF-36 physical in 50.8%, and SF-36 mental scores in 45.7%. No cases of C5 palsy or reoperation for surgical failure were observed; one patient (1.2%) developed a postoperative superficial surgical site infection which was treated successfully through antibiotics. Medical complications included acute retention of urine (n=3), hospital acquired pneumonia (n=2) and urinary tract infection (n=1).
Conclusion C3DC7RDOL is a safe and reproducible technique with low complication rate. We recommend this technique as an alternative to traditional laminoplasty. Larger multicentre comparative trial will be beneficial to validate the adaptability of this technique.

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A Comparison of Gait Kinematic and Muscular Activity Between Walking Cane and a Walker in The Elderly with Sagittal Imbalance
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Background Adult spinal deformity (ASD) patients demonstrate an altered gait pattern, often requiring gait aids. However, there is a lack of information about the benefits of walking sticks versus a walker on the trunk and lower extremity muscular control in ASD patients who have sagittal imbalance.
Objective The purpose of this study is to compare muscle activity of ASD patients with sagittal imbalance who use walker and walking stick while walking. We hypothesized that walking stick promotes muscular activity better than walker during walking.
Methods A randomized crossover controlled trial was conducted in 20 ASD patients with sagittal imbalance. Participants were evaluated under three walking conditions: no device (ND), walking stick (WS), and walker (WR). Surface electromyography assessed trunk and lower-extremity muscle activity during overground walking. Outcomes included %RMS, timing of peak activation, muscle duration, onset, and integrated EMG (iEMG).
Results Walking stick use showed significantly higher %RMS in trunk and lower-extremity muscles, including external oblique, thoracic erector spinae (T12), gluteus maximus, sartorius, rectus femoris, gastrocnemius, and tibialis anterior ($p < 0.05$). Walker use demonstrated higher iEMG in erector spinae, lumbar erector spinae (L5), gluteus maximus, and sartorius, suggesting greater sustained activation. The walking stick group demonstrated higher velocity, cadence, and stride length, with a shorter

acceptance phase. Walker use was associated with increased trunk flexion and anterior pelvic tilt, indicating a more kyphotic posture. In contrast, walking stick use resulted in greater hip flexion, knee flexion, and ankle dorsiflexion.
Conclusion Walking stick use promotes greater dynamic muscle activation, improved gait parameters, and a more upright posture compared to walker use in ASD patients. In contrast, the walker, while stable, is associated with a more kyphotic posture and less efficient gait.

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Endoscopic Cervical Laminoplasty Preserving the Spinous Process Fulcrum and Posterior Tension Band in Cervical Myelopathy (Uniportal and Biportal)
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Introduction/Objectives Endoscopic spine surgery has emerged as an effective treatment option for cervical stenotic myelopathy, offering several advantages over conventional approaches. In multilevel cervical myelopathy, conventional posterior microscopic laminoplasty requires muscle dissection along the spinous process, which serves as the insertion point for stabilizing muscles, thereby disrupting the posterior tension band. Recently, endoscopic laminoplasty techniques have been explored; however, these often involve detaching the spinous tip from the lamina, compromising the cervical fulcrum. This study aims to introduce a novel technique using uniportal and unilateral biportal endoscopy (UBE) systems that preserves key cervical structures typically damaged in conventional open or endoscopic laminoplasty.
Materials and Methods Patients with progressive paralysis due to multilevel cervical myelopathy were treated using uniportal and biportal endoscopic systems. Maintain anatomy-preserving laminoplasty was performed while preserving both the posterior tension band and the spinous process fulcrum.
Result/Discussion Postoperatively, the modified Japanese Orthopaedic Association and Numeric Rating Scale scores improved.
Conclusion Uniportal and unilateral biportal endoscopic cervical laminoplasty is a safe and effective minimally invasive technique that achieves complete decompression in multilevel cervical stenotic myelopathy while preserving critical anatomical structures.

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Uniportal full endoscopic decompression for thoracic meningioma and primary dural repair
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Introduction/Objectives Endoscopic spinal surgery has continued to evolve, and its effectiveness has already been established in degenerative spinal pathologies. However, its application to spinal tumors remains limited, and the advantages of endoscopic techniques in this field have not been fully discussed. This study aims to report two cases of thoracic meningioma successfully removed using a uniportal full endoscopic system.
Materials and Methods Two female patients presented with bilateral leg pain and weakness, showing rapid progression of symptoms. Magnetic resonance imaging revealed thoracic intradural extramedullary tumors. Tumor removal was performed using a uniportal full endoscopic system, followed by primary dural repair.
Result/Discussion Both patients showed recovery with improvement in bilateral leg pain and weakness. Endoscopic treatment of intradural lesions has been technically demanding due to the water-based surgical environment and the need for dural repair.
Conclusion This study demonstrates that endoscopic surgery can overcome the challenges associated with spinal tumors and may provide the benefits of minimally invasive techniques to patients with intradural pathology.

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Predictive Factors of MIS Decompression in Lumbar Spinal Stenosis with Degenerative Lumbar Scoliosis
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Introduction/Objectives Degenerative lumbar scoliosis commonly coexists with lumbar spinal stenosis and is a significant source of pain and disability. Minimally invasive (MIS) decompression emerged as a less invasive option, but outcomes remain inconsistent in this condition. This study aims to identify factors associated with poor outcomes following decompression alone in degenerative scoliosis patients with lumbar spinal stenosis.
Materials and Methods This retrospective cohort study analyzed patients with lumbar spinal stenosis and degenerative deformity who underwent MIS lumbar decompression at Seoul St. Mary's Hospital between January 2013 and May 2025. Inclusion criteria include preoperative coronal Cobb angle>10°, one- or two-level microtubular, uniportal, or biportal endoscopic decompression, and more than 3 months of follow-up. Demographic, operative, clinical, and radiographic data were collected. Poor outcome was defined as postoperative ODI>22, NRS back pain>3, or NRS leg pain>3. Univariable and multivariable regression identified factors associated with poor outcomes after decompression alone.
Result/Discussion A total of 35 patients were included, with a mean follow-up time of 3.4 years. ODI improved significantly by 23 ± 19.2 points, with substantial reductions in back and leg pain (all $p < 0.01$). No significant progression was observed in sagittal listhesis, PI-LL mismatch, coronal or sagittal SVA, or Cobb angle. Lateral listhesis showed a small change without clinical significance. On univariate analysis, a higher age-adjusted CCI, decompression on the convex side of the curve, neurogenic claudication, and preoperative PI-LL mismatch were associated with worse outcomes. Multivariate analysis demonstrated that convex-side surgery remained the only independent predictor of poor postoperative outcome ($p = 0.029$).
Conclusion MIS decompression alone provides significant clinical improvement without meaningful deformity progression in selected patients with lumbar spinal stenosis and degenerative scoliosis. However, decompression on the convex side of the curve was independently associated with poor outcomes, highlighting the importance of careful case selection.

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Randomized controlled trial of endoscopic vs microscopic discectomy in lumbar disc herniation
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Introduction/Objectives Microscopic discectomy (MD) has long been considered the gold standard, while Unilateral Biportal Endoscopic (UBE) discectomy is an emerging minimally invasive alternative with potential advantages such as improved visualization and reduced tissue damage. However, existing literature shows conflicting evidence regarding superiority. This randomized controlled trial aimed to compare the clinical and functional outcomes of UBE versus MD in single-level lumbar disc herniation with a 1-year follow-up.

Merials and Methods A randomized controlled trial was conducted on 100 patients diagnosed with single-level lumbar disc herniation, divided equally into two groups: UBE (n=50) and MD (n=50). Patients were allocated using automated randomization. Inclusion criteria included single-level disease, while cases with calcified discs, foraminal/extraforaminal involvement, and recurrent discs were excluded. Outcome measures included VAS scores for back and leg pain, Oswestry Disability Index (ODI), SF-36 scores, operative duration, complications, and length of hospital stay. Follow-up assessments were performed up to 12 months postoperatively.

Result/Discussion Both groups showed significant postoperative improvement. UBE demonstrated superior early postoperative outcomes, with significantly lower VAS scores for leg and back pain on day 1 and at 1 month. ODI scores were significantly better in the UBE group at 3, 6, and 12 months ($p<0.001$). SF-36 scores were comparable initially but showed significant improvement at 12 months in the UBE group. Hospital stay was significantly shorter in the UBE group ($p=0.038$). Long-term pain outcomes at 6 and 12 months were comparable between groups. These findings suggest that UBE offers advantages in early recovery and functional improvement while maintaining similar long-term outcomes.

Conclusion Unilateral biportal endoscopic discectomy is a safe and effective alternative to microscopic discectomy, offering better early postoperative pain relief, shorter hospital stay, and improved functional outcomes, with comparable long-term results.

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Unilateral Biportal Endoscopy for Unilateral Laminotomy and Bilateral Decompression in Two Levels Lumbar Canal Stenosis: A Prospective Study

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Introduction/Objectives Multilevel lumbar canal stenosis is a common degenerative condition leading to significant pain and disability. Traditional decompression techniques may cause soft tissue damage and postoperative instability. Unilateral Biportal Endoscopy (UBE) offers a minimally invasive alternative with improved visualization and preservation of posterior elements. This study aimed to evaluate the safety and efficacy of UBE for unilateral laminotomy and bilateral decompression in multilevel lumbar canal stenosis, focusing on adequacy of decompression, facet preservation, and postoperative stability.

Materials and Methods A prospective single-center study was conducted on patients undergoing multilevel UBE decompression by a fellowship-trained spine surgeon. Operative parameters, including blood loss, operative time, and hospital stay, were recorded. Radiological outcomes included MRI-based dural expansion and facet preservation, while dynamic radiographs assessed postoperative instability. Clinical outcomes were evaluated using Visual Analog Scale (VAS) for back and leg pain and Oswestry Disability Index (ODI), recorded preoperatively and during follow-up.

Results/Discussion A total of 47 patients (29 females, 18 males) underwent multilevel UBE decompression, most commonly at L3–L5 and L4–S1 levels. Mean operative time was 120 ± 15 minutes, with average blood loss of 90 ml and hospital stay of 2.5 days. Mean dural expansion was 55 mm^2 per level, with facet resection limited to 22.5%. No postoperative instability was observed. Significant clinical improvement was noted, with VAS back improving from 7.0 to 4.0, VAS leg from 8.0 to 3.4, and ODI from 70 to 25. No complications or reoperations were reported.

Conclusion Multilevel UBE is a safe and effective minimally invasive technique that achieves adequate decompression, preserves spinal stability, and provides significant improvement in pain and functional outcomes.

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Unilateral Biportal Endoscopic Versus Minimally Invasive TLIF: A Prospective Comparison of Perioperative and Functional Outcomes

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Introduction/Objectives Transforaminal lumbar interbody fusion (TLIF) is a standard procedure for degenerative lumbar spine disorders. Minimally invasive TLIF (MIS-TLIF) reduces muscle injury compared to open surgery, while Unilateral Biportal Endoscopic TLIF (UBE-TLIF) is an evolving technique offering enhanced visualization and minimal soft tissue disruption. This study aimed to compare perioperative, clinical, and radiological outcomes between MIS-TLIF and UBE-TLIF.

Materials and Methods A prospective comparative study was conducted on 60 patients undergoing single-level TLIF, divided into MIS-TLIF (n=30) and UBE-TLIF (n=30). Indications included degenerative spondylolisthesis and lumbar canal stenosis. Mean follow-up was 12 months. Parameters assessed included operative time, blood loss, hospital stay, and complications. Clinical outcomes were measured using Visual Analog Scale (VAS) for back and leg pain and Oswestry Disability Index (ODI). Radiological evaluation included fusion rates.

Results/Discussion Mean operative time was slightly higher in the UBE group (150 ± 20 min) compared to MIS-TLIF (130 ± 15 min). However, mean blood loss was significantly lower in UBE-TLIF (120 ± 30 ml) versus MIS-TLIF (220 ± 50 ml). Hospital stay was shorter in the UBE group (3.0 ± 0.8 days) compared to MIS-TLIF (4.5 ± 1.2 days). Early postoperative VAS back pain improved from 7.2 to 3.5 in UBE-TLIF and from 7.0 to 4.5 in MIS-TLIF. At final follow-up, VAS and ODI scores were comparable (ODI: 22 vs 24). Fusion rates were similar (UBE 93% vs MIS 90%). Complication rates were low and comparable in both groups.

Conclusion UBE-TLIF is a safe and effective alternative to MIS-TLIF, offering reduced blood loss, shorter hospital stay, and better early pain relief, with comparable fusion rates and functional outcomes at 1 year.

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Post-Transforaminal Endoscopic Lumbar Surgery Infection: Role of Instrumented Fusion in Definitive Management

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Introduction/Objectives Transforaminal endoscopic lumbar discectomy (TELD) is a minimally invasive procedure with low complication rates. However, deep infections such as spondylodiscitis, though rare, can lead to severe pain and potential instability. Optimal management remains unclear. This study evaluates the role of surgical debridement and instrumented fusion in treating post-TELD infections.

Materials and Methods A retrospective analysis of five patients with deep infection following TELD was performed. All patients presented with persistent back pain, elevated inflammatory markers, and MRI-confirmed spondylodiscitis, with epidural collection in some cases. Initial conservative management with intravenous antibiotics failed in all patients. Surgical treatment included posterior debridement, decompression, and pedicle screw fixation with interbody fusion. Clinical outcomes were assessed using Visual Analog Scale (VAS) and Oswestry Disability Index (ODI), along with radiological evaluation for infection resolution and fusion.
Results/Discussion The mean age was 52 years, with L4–L5 being the most commonly involved level. Mean preoperative VAS was 8.2 and ODI was 68. Postoperatively, VAS improved to 3.1 and ODI to 28 at a mean follow-up of 12 months. Infection resolved in all patients, with normalization of inflammatory markers within 6–8 weeks. Culture positivity was noted in three cases. Radiological assessment showed successful fusion in all patients. No recurrence, implant failure, or major complications were observed.
Conclusion Post-TELD infection, though uncommon, requires timely intervention. Surgical debridement with instrumented fusion provides effective infection control, spinal stability, and significant functional recovery.

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A Journey from Traditional Open Surgery to Endoscopic Spine Surgery: Bridging Innovation and Tradition
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Introduction/Objectives The transition from traditional open spine surgery to minimally invasive spine surgery (MISS) represents a significant shift in both philosophy and technique. This paper discusses the personal journey of a spine surgeon with 20 years of experience in open surgery who recently ventured into endoscopic techniques. The goal is to explore the integration of these two approaches to optimize patient outcomes.
Materials and Methods The study includes a comprehensive review of clinical cases performed over the last two years, transitioning from open surgeries to endoscopic procedures. The analysis includes various conditions such as lumbar disc herniation, cervical radiculopathy, and degenerative spine diseases. The surgical approaches used, such as the Wiltse approach for open surgery and transforaminal endoscopic techniques, are discussed.
Results/Discussion The results of transitioning to MISS demonstrate reduced surgical trauma, shorter recovery times, and improved patient satisfaction. The learning curve involved in adopting endoscopic techniques, the challenges encountered, and the role of modern technologies such as endoscopic systems and navigation tools are discussed. Comparative results between traditional open surgery and MISS highlight the advantages and limitations of both methods, stressing the importance of individualized treatment planning.
Conclusion Minimally invasive surgery is primarily a guiding concept rather than merely a specific tool. This study concludes that the fusion of traditional open surgery with endoscopic techniques provides a comprehensive approach to spine surgery, catering to diverse patient needs. The integration of these techniques enhances surgical precision and safety, allowing for a more personalized treatment approach. This hybrid model contributes to the evolving landscape of minimally invasive spine surgery, ensuring better clinical outcomes while maintaining the essence of the surgical profession.

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Safety And Efficacy Evaluation Of Injectable Bonegraft Made From HPMC/E-NHA (Hydroxypropylmethyl Cellulose/Eggshell Nanocrystalline Hydroxyapatite) Composite For Bone Defect Therapy; Animal Study
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Introduction/Objective Mechanical stability treatment should be combined with biological inducing material such as Hydroxyapatite (HA). The combination of HA with polymers such as HPMC creates injectable form bone grafts, offering several advantages, including a stable composite structure, increased bioactivity through a hydrophilic environment that supports cell proliferation, and flexible application that can be tailored to individual needs. This study aimed to determine the safety and efficacy evaluation of injectable bone grafts made from HPMC/e-NHA composites in animal bone defect.
Materials and Methods This research using New Zealand white rabbits (Oryctolagus cuniculus). We carried out a bone defect simulation by drilling the distal femur. The subjects divided into three treatment groups namely the control group without treatment, group 1 with HPMC: e-NHA 20:80 and group 2 with HPMC: e-NHA 15:85, each of group consists of 4 animals and observed for 28 days. Safety evaluation is carried using the blood parameters, which include Hb, Platelets, and Leukocytes, BUN, Creatinine, AST, and ALT. The efficacy of bone formation was evaluated by observing the defects using X-ray and ImageJ program to measure bone formation rate. Statistical analysis measured using one-way ANOVA with post-hoc analysis.
Result/Discussion Safety evaluation results using blood parameters showed no toxicity to HPMC/e-NHA at both concentrations. Neither post-treatment comparison nor intergroup comparison show significant differences in safety measure ($p>0,05$). Efficacy evaluation results using ImageJ showed identifiable bone formation. Treatment groups 1 and 2 demonstrated significantly better bone formation than the control group ($p<0,05$). However, the difference between group 1 and 2 was not significant ($p>0,05$). Considering the material feasibility, the HPMC/e-NHA 15:85 concentration is more comfortable for injection into bone defects.
Conclusion Injectable HPMC/e-NHA bone graft demonstrated safety in this study. The injectable HPMC/e-NHA bone graft aided bone formation more than the control group.

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Hyperselective Segmental Fusion Deformity Correction Technique for Adolescent Idiopathic Scoliosis: A Technical Note with Case Series
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Introduction Surgical intervention is often required for Adolescent Idiopathic Scoliosis (AIS) curves exceeding 40° to restore spinal alignment and improve quality of life. Current selective fusion technique stabilizes the spine but still limit the flexibility. Hyperselective segmental fusion deformity correction offers a novel approach by targeting only the primary structural curve, preserving motion segments while achieving optimal correction. This study aims to present practical approach for performing hyperselective segmental fusion deformity correction technique.

Material and Methods Our study included patients diagnosed with adolescent idiopathic scoliosis (AIS) Lenke 5. Our technique followed simplified, six-steps protocol for hyperselective segmental fusion, focusing on key aspects to consider before performing the procedure: scoliosis classification, clinical criteria requirement, radiological requirement, defining upper instrumented vertebra (UIV), defining lower instrumented vertebra (LIV), and follow up. Hyperselective segmental fusion aims on fusing only the primary structural curve, allowing compensatory curves to realign naturally. In the conventional selective fusion, UIV is often at upper end vertebra (UEV) of the main curve. Our study demonstrated that a hyperselective fusion strategy, in which UIV is one level caudal to UEV, is a reasonable alternative in the treatment of AIS. Data on surgical outcomes and complications were collected and analyzed.

Result The surgical outcome from the patients have shown a significant correction result on structural lumbar curve cobb's angle and good correction on compensatory main thoracic curve. Proper patient selection is critical, considering factors such as curve classification, curve flexibility, skeletal maturity, and sagittal alignment. Radiological outcomes in this case series demonstrated successful deformity correction without compromising sagittal balance or neurological function.

Conclusion Hyperselective segmental fusion is an effective surgical option for Adolescent Idiopathic Scoliosis, achieving significant deformity correction while preserving motion segments. This technique able to preserve motion following post-operative and maintain daily functionality. Making it a promising treatment option.

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Full-Endoscopic trans-Kambin's triangle lumbar interbody fusion for Pyogenic Spondylodiscitis: A Case Series with Minimum 1-Year Follow-up

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Introduction/Objectives Full-endoscopic discectomy and drainage (FEDD) is effective for pyogenic spondylodiscitis (PYO), improving pain control, enabling pathogen identification, and promoting early infection control. However, additional stabilization may be required in refractory or structurally unstable cases. This study evaluated the clinical outcomes of full-endoscopic trans-Kambin's triangle lumbar interbody fusion (Fullend-KLIF; FE-KLIF).

Materials and Methods Four patients (mean age 69.0 years; range 35–91; 1 male, 3 females) with PYO who underwent FE-KLIF and were followed for ≥1 year were retrospectively analyzed. Parameters included prior FEDD, causative organisms, surgical level, preoperative C-reactive protein (CRP), indications for fusion, and fusion status at 1 year. All procedures were performed under general anesthesia with MEP monitoring via a transforaminal approach with sufficient foraminoplasty. Titanium cages and artificial bone grafts were used in all cases.

Results Pathogens were identified in 3 patients (75%): methicillin-sensitive Staphylococcus aureus, Escherichia coli, and Streptococcus species. Two patients underwent prior FEDD, and two had single-stage FE-KLIF. Surgical levels were L3/4 (n=2) and L4/5 (n=2). Mean preoperative CRP was 1.0 mg/dL. Indications for fusion were radicular symptoms (n=2) and progressive bone destruction (n=2). Solid bony fusion was achieved in all cases (100%) at 1 year, with no reoperations or infection recurrence.

Discussion and Conclusions FE-KLIF allows extensive irrigation and simultaneous stabilization. It may be particularly useful in cases with anterior bone defects or instability where FEDD alone is insufficient. This minimally invasive approach achieved favorable outcomes without major complications, suggesting FE-KLIF as a promising treatment option for PYO.

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Preoperative Facet Arthropathy and Cage Subsidence After Oblique Lumbar Interbody Fusion

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Introduction Facet arthropathy alters posterior load sharing and may predispose to cage subsidence after interbody fusion. Its specific contribution to disc-height maintenance following OLIF—particularly when combined with posterior pedicle-screw fixation—remains unclear.

Methods We retrospectively reviewed 151 patients (237 fused motion segments) who underwent OLIF with bilateral pedicle-screw fixation between 2018 and 2024. Facet degeneration was graded on preoperative CT/MRI using the Weishaupt system (0–3). Subsidence was defined by the Marchi classification (0–3) on immediate postoperative and 6-month standing radiographs. Disc-height ratios (anterior (ADH), mean (MDH), posterior (PDH)) were calculated, and Δ values derived for immediate-to-preoperative (Δ(i–p)) and 6-month-to-immediate (Δ(i–6m)) comparisons. Multivariable multinomial logistic regression was performed at the motion-segment level, retaining ΔMDH(i–p) as the single distraction covariate due to collinearity among height measures.

Results Subsidence incidence increased progressively with facet grade. Six-month disc-height ratios (ADH, MDH, PDH) decreased significantly with higher grades ($p < 0.05$). Δ(i–p) gains were similar across grades, but Δ(i–6m) losses were greater in grades 2–3 than 0–1 ($p < 0.05$). In multivariable analysis, facet grade was the strongest independent predictor (grade 1 vs 0: OR 2.50, 95% CI 1.62–3.85; grade 2 vs 0: OR 4.82, 95% CI 2.07–11.27; both $p < 0.001$). Greater ΔMDH(i–p) independently increased subsidence risk (OR 1.94, 95% CI 1.40–2.67).

Conclusion Preoperative facet arthropathy and greater mid-disc distraction are robust, independent predictors of postoperative disc-height loss and cage subsidence after OLIF, even with posterior fixation. These findings support a load-transfer mechanism in which degenerative facets concentrate stress at the cage–endplate interface and underscore the need for facet assessment and restrained distraction in surgical planning.

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Perioperative Outcomes and Complication Profiles of Octogenarian Patients Undergoing Oblique Lumbar Interbody Fusion

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Introduction The global aging population has driven a marked increase in lumbar fusion surgery among elderly patients, including octogenarians. While oblique lumbar interbody fusion (OLIF) offers minimally invasive decompression and stabilization with reduced soft-tissue disruption, age-specific perioperative risk profiles in patients aged ≥80 years remain poorly characterized. This study aimed to evaluate perioperative outcomes and complication patterns in octogenarians undergoing OLIF compared with a septuagenarian cohort.

Materials and Methods This IRB-approved retrospective cohort study included 104 consecutive patients who underwent OLIF for degenerative lumbar pathology (November 2016–May 2025): 41 octogenarians and 63 septuagenarians. Demographic data, comorbidities, surgical characteristics, serial hemoglobin and C-reactive

protein (CRP) levels, opioid exposure (converted to intravenous morphine milligram equivalents), length of hospital stay, and incidence of postoperative ileus, delirium, and respiratory infectious complications were collected. Intergroup comparisons were performed using independent-samples t-tests, and predictors of postoperative ileus were identified through multivariable binomial logistic regression.

Results Octogenarians demonstrated significantly longer hospital stays (12.54 ± 6.52 vs. 10.18 ± 4.62 days; p=0.036) and higher CRP levels on postoperative day (POD) 3 (11.66 vs. 9.16 mg/dL; p=0.024). Postoperative ileus occurred significantly more frequently in octogenarians (17.1% vs. 4.8%; p=0.038), while rates of delirium and respiratory complications were comparable between groups. On multivariable analysis, octogenarian status (OR 2.31; 95% CI 1.03–5.13; p=0.043), lower POD0 hemoglobin (OR 1.08; p=0.032), and elevated POD3 CRP (OR 0.69; p=0.048) independently predicted postoperative ileus. Perioperative opioid exposure was not an independent predictor.

Conclusion OLIF is a viable surgical option in carefully selected octogenarians; however, advanced age independently increases postoperative ileus risk. Immediate physiologic stress and heightened inflammatory activation — rather than opioid exposure — appear to be primary drivers. Age-specific perioperative strategies targeting hemodynamic preservation, inflammatory modulation, and proactive bowel management are essential in this super-aged population.

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From thyroid to spine, mapping the outcomes of spinal metastasis in thyroid cancer

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Introduction/Objectives Spinal metastases from differentiated thyroid carcinoma (DTC) are uncommon but clinically significant due to neurological compromise, pain secondary to pathological fracture and/or intractable pain with impact on survival. Owing to the rarity of spinal metastasis from thyroid cancers, optimal multimodal management remains debated. Particularly regarding indications for surgery, stereotactic radiotherapy and potent systemic therapies. This study aims to evaluate the clinical characteristics, treatments and outcomes of patients with spinal metastases from thyroid cancer managed at our institution.

Materials and Methods We performed a retrospective review of patients with histologically confirmed thyroid carcinoma and radiologically or pathologically proven spinal metastases treated at the National University Hospital, Singapore between 2005 to 2025. Demographic data, tumor subtype, extent of spinal disease, operative data, patient outcome scores, treatment modalities, complications and overall survival data were collected. Descriptive statistics and Kaplan–Meier survival analyses were performed. Ethical approval for this study was obtained from the National Health Group domain specific review board 2021/00831.

Results/Discussion A total of 13 patients were included, median age 63 years; 53.8% female; 46.2% make. The thoracic spine was most frequently involved (38.5%) and 61.5% patients presented with epidural spinal cord compression. Surgical decompression and stabilization were performed in 69.2% pateints. Surgery was most commonly for mechanical instability or progressive neurological deficit. Adjuvant radiotherapy was performed for 53.8% of patients (including stereotactic techniques) and radioactive iodine treatment was started for 61.5% of patients. Median overall survival was 21 months, with better outcomes observed in patients who underwent post-operative adjunctive therapy. Our findings support current recommendations for individualized and multidisciplinary management for each patient.

Conclusion Spinal metastases from thyroid cancer, while rare, shoulder undergo multidisciplinary evaluation. In appropriately selected patients, combined thyroid and spinal metastases surgery with adjunct therapies can decrease morbidity and mortality.

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Improved Efficiency in Unilateral Biportal Endoscopic Spine Surgery Using an Ultrasonic Bone Drill

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OBJECTIVE This study aims to evaluate the safety and efficacy of the ultrasonic bone drill (UBD) in facilitating decompression in Unilateral Biportal Endoscopic Spine Surgery (UBESS), compared to the conventional decompression technique.

METHODS A retrospective analysis was conducted on patients undergoing UBESS between April 2024 and April 2025. The patients were divided into 2 groups based on the tools used for decompression: UBD and Non-UBD. Data on surgical duration, estimated blood loss, facet joints destructed incidence, cerebrospinal fluid leakage (CFL), and neurological status measured by the Japanese Orthopedic Association score, and all data were collected and analyzed.

RESULTS 151 patients received UBESS via UBD, while 138 were treated in Non-UBD group. The UBD group showed a significant reduction in operation time compared to the Non-UBD group ($P < 0.001$). No spinal cord occurred in either group, and 2 cases occurred CFL in the Non-UBD group. 4 cases occurred facet joints destruction in the Non-UBD group while it was 0% in UBD group. Both groups demonstrated significant improvements in Japanese Orthopedic Association scores with no intergroup difference.

CONCLUSIONS UBD is a viable alternative decompression tool for UBESS, associated with shorter operation time and low complication and spinal structure protection, while achieving comparable clinical outcomes to the conventional decompression method. Nevertheless, further research with a larger sample size is needed.

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Utilising Multimodality Intraoperative Neuromonitoring When Performing Percutaneous Intra-Discal Procedures Under General Anaesthesia

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Introduction Percutaneous intradiscal procedures like laser discectomies and nucleoplasty are occasionally performed under general anaesthesia in patients with intractable pain preventing a prone habitus, severe anxiety, difficult airway maintenance unsafe for sedation, multiple level involvement and with anatomically unforgiving levels like lower thoracic and upper lumbar discs. This study focuses on the reliability of multimodality intraoperative neuromonitoring (IONM) in such situations.

Materials and Methods Motor Evoked Potential (MEP), free-running electromyogram (frEMG) and Somatosensoty Evoked Potential (SSEP) recorded waveforms in 46 cases of percutaneous laser disc decompression (PLDD) – performed between March 2022 and November 2025, were reviewed and compared against commonly adopted alarm criteria to predict post-operative neurological deficit. Total intravenous Anaesthesia (TIVA) with propofol and remi-fentanyl were used, omitting any muscle relaxant.

Results Forty-four cases (95.7%) showed no significant changes in recorded waveforms compared with assigned baseline; MEP changes (>50% amplitude reduction) were present in one case, thus 2.2% (1/46), frEMG muscle group-level events in 3 muscle groups yielded 1.3% (3/229 95% exact CI 0.27-3.78%) showing transient root irritation, and SSEP changes (>10% latency delay) were noted in another case, thus 2.2% (1/46). No patient had post-operative sensory or motor deficit. The observed neurological deficit rate was 0% (0/46, 95% CI 0-6.5%). IONM demonstrated a negative predictive value (NPV) of 100% (95% CI 93.5%-100%) with a false positive rate of 4.3% (2/46). No false negative events were observed (0%. 95% CI 0-6.5%).
Conclusions IONM in general anaesthesia for minimally invasive PLDD procedure shows reliable specificity in our series, reflected in the confidence interval values. The absence of true positive, however, limits any sensitivity or positive predictive value estimation. To achieve greater statistical relevance, we continue to audit this streak of reliability, reflecting upon the versatility of IONM when general anaesthesia is truly called for.

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Robotic-Assisted Screw Placement for Early-Onset Scoliosis: Accuracy and Efficiency

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Objective The objective of the study was to explore the accuracy and efficacy of robotic-assisted screw placement in the surgical treatment for Early-Onset Scoliosis (EOS).
Methods A total of 60 patients participated in this prospective cohort study. 30 patients were allocated into Robotic-assisted group, and 30 patients were in non-robotic assisted group. The demographic data, radiological spinal parameters were documented and analyzed. Each pedicle screw insertion was classified as satisfactory insertion or unsatisfactory insertion based on Gertzbein-Robbins classification. The primary outcome was the accuracy of pedicle screw placement. The secondary outcomes were the rate of puncturing screws, estimated blood loss, surgical time, correction rate and other radiological parameters.
Results A total of 55 eligible patients completed the study. 30 patients were in Robotic-assisted group, and 25 patients were in the other group. The accuracy of pedicle screw placement in Robotic-assisted Group and Non-robotic assisted group were (92.0 ± 5.5) % and (82.6 ± 8.3) % ($P < 0.05$), and the rate of puncturing screws were (0 (0-0)) % and (0 (0-6.25)) % ($P < 0.05$). The median surgical time were 280.0 (IQR: 260.0-300.0) min and 310 (IQR: 267.5-390.0) min in two group and showed significant statistic difference ($P < 0.05$).
Conclusions Robotic-assisted screw placement has good feasibility and can gain a more accurate and reliable instruments fixation, with which spine surgeons can make a detailed and personalized screw planning during the correction surgery for EOS to achieve satisfying screw placement.

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Assessment of Mental Status in Patients Undergoing Minimally Invasive Lumbar Spine Surgery

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Objective To investigate the mental status of patients undergoing minially invasive lumbar spine surgery compared to traditional open surgery.
Methods A retrospective analysis was conducted on 151 patients received minimally invasive lumbar spine surgery and 161 patients received traditional open surgery from September 2024 to September 2025. All patients were diagnosed as lumbar stenosis and lumbar disc herniation. Psychological distress and anxiety were assessed using the Distress Management Screening Measure (DMSM) and Self-Rating Anxiety Scale (SAS) at the following time points as before and after the surgery.
Results Among the patients received minimally invasive lumbar spine surgery, the operation time was (76.4 ± 9.8) mins which showed significant difference compared to traditional group (134.5± 9.5) mins ($P< 0.05$). The significant difference also showed in blood loss and hospital stay time ($P<0.05$). The Distress Thermometer (DT) score was (7.3 ± 2.4) and the SAS score was (69.8 ± 7.0), which showed significant difference between the two groups The top three distress-related problems before surgery were difficulty in daily activities due to illness (79.3%), operation time (72.4%), and sadness (65.5%). DT and SAS scores were significantly reduced in minimal invasive surgery group. Correlation analysis showed a significant negative correlation between the type of operation and operation time for both DT and SAS scores ($P < 0.05$).
Conclusion The development of minimally invasive spinal surgery has made the operation more convenient and easier for patients to accept. Shorter operation time, faster recovery and shorter hospital stay are the advantages of minimally invasive spinal surgery, and accordingly, patients are less likely to experience anxiety.

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Utility of Intraoperative Neuromonitoring in Oblique Lumbar Interbody Fusion: A Retrospective Cohort Analysis

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Introduction Lumbar interbody fusion is a well-established technique for treating degenerative pathology, deformity, and instability. Lateral approaches were developed to reduce morbidity associated with traditional posterior techniques. While the transpsoas approach carries a risk to the lumbar plexus and routinely utilises intraoperative neuromonitoring (IONM), oblique lumbar interbody fusion (OLIF) employs an anterior-to-psoas corridor that may reduce this risk. As such, the necessity of routine IONM in OLIF remains controversial. This study evaluates the utility of IONM in OLIF by analysing intraoperative signal changes and postoperative neurological outcomes.
Materials and Methods A retrospective cohort study was conducted on patients undergoing L1–5 OLIF with IONM by a single surgeon at a single institution between 2017 and 2025. A total of 201 patients (381 operative levels) were included. Cases utilising a transpsoas approach, combined approaches, or with incomplete operative documentation were excluded. IONM modalities included motor evoked potentials (MEP), somatosensory evoked potentials (SSEP), and electromyography (EMG). Significant IONM events were defined as a ≥50% intraoperative signal drop from baseline suggestive of neural irritation.
Results IONM signal changes were observed in 4 patients (2.0%), involving 10 operative levels (2.6%). All events were transient and resolved intraoperatively following corrective measures, including retractor repositioning and cage adjustment. Signal changes occurred predominantly at the L4–5 level. No cases of permanent postoperative neurological deficit were observed.
Conclusion IONM signal changes during OLIF were infrequent and transient, with no lasting neurological sequelae. These findings suggest that routine neuromonitoring may not be necessary in standard OLIF cases. However, selective use of IONM in higher-risk scenarios, particularly at L4–5 and in deformity cases, may provide additional intraoperative safety.

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Fix and Treat vs Treat and Fix: Navigating Osteoporotic Spine Surgery with Timely Intervention and Targeted Therapy

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Introduction Osteoporosis and spinal degeneration frequently coexist, forming a compounding cycle of mechanical instability and biological fragility. As spinal instrumentation in osteoporotic bone presents increased risk of construct failure, the sequencing of pharmacologic and surgical interventions has gained prominence. However, consensus on optimal strategy remains lacking. In this study, we aim to critically evaluate the evolving paradigms of 'Fix and Treat' versus 'Treat and Fix' in osteoporotic spine pathologies and propose a conceptual framework to guide clinical decision-making.

Materials and Methods A scoping review was conducted using PubMed, Scopus, MEDLINE, and Cochrane Library databases through 28 February 2026. Studies were included if they examined surgical outcomes in osteoporotic spine patients treated with antiresorptive or anabolic therapies either pre- or postoperatively. Supplementary insights were derived from the senior authors' clinical experience in treating high-risk osteoporotic cases.

Result/Discussion Fifty-five articles were included. The "Fix and Treat" strategy is commonly adopted in urgent scenarios involving neurological compromise, instability, or deformity, with postoperative teriparatide or romosozumab improving fusion and reducing complications. In elective cases, the "Treat and Fix" approach shows promise. Preoperative short-course anabolic therapy (≥3 months) improves bone–implant integration, screw pullout strength, and construct stability. Finite element models support this approach in patients undergoing long constructs, osteotomies, or revision surgeries.

Conclusion This review is the first to comprehensively outline the clinical considerations underpinning the "Fix-and-Treat" and "Treat-and-Fix" paradigms in osteoporotic spine surgery. These approaches are complementary rather than opposing, reflecting a spectrum of decision-making that balances surgical urgency, bone quality, and pharmacologic optimisation to achieve durable outcomes.

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Preventing Inferior Anchor Canal Breach at C3–C4 ACDF: An Observational Study of a Novel Inversion Technique

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Introduction Zero-profile anchored cages such as the Coalition™ are widely used in anterior cervical discectomy and fusion (ACDF). However, C3–C4 presents unique anatomical and positional challenges. Mild C3 retrolisthesis and extension-induced lordosis can cause the anterior cortex of C3 to lie posterior to C4 during cage insertion. When the implant references C3, this offset may result in deeper cage seating and posterior violation of the C4 body wall during inferior anchor deployment.

Methods We retrospectively reviewed 14 consecutive patients undergoing C3–C4 ACDF (2020–2024) using standard C3-referenced insertion. Radiographs were analyzed for preoperative retrolisthesis and postoperative inferior anchor position. Based on observed violations, a novel inversion technique was developed: the cage–holder construct is inserted inverted, allowing the positive stop to reference C4 rather than C3, without altering implant mechanics or workflow.

Results Preoperative C3 retrolisthesis was present in 8/14 patients (57%). Inferior anchor posterior wall breach occurred in 5/14 cases (36%), exclusively in the retrolisthesis subgroup (5/8 vs. 0/6). No neurological deficits occurred. After adopting the inversion technique, no further posterior wall violations were observed. The modification required no additional equipment or operative time.

Conclusion C3-referenced insertion predisposes to inferior anchor canal encroachment at C3–C4 in the presence of retrolisthesis or extension-related lordosis. Referencing C4 through a simple inversion technique provides predictable cage depth and eliminates posterior wall violations. This reproducible modification enhances safety in upper cervical ACDF.

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Accelerating implant material development with particle-based modelling

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Introduction Mechanical complications after spinal instrumentation remain common in patients with osteoporosis, metastatic disease, or long-segment constructs. Although modern implants undergo mechanical testing and finite element analysis (FEA), these methods primarily evaluate stress distributions under idealized conditions and have limited ability to simulate progressive bone failure, migration, loosening, or fatigue over time. As a result, implant behavior in real-world clinical scenarios may be difficult to predict preoperatively. Hence, we present a novel application of particle-based modeling (PBM) as an advanced biomechanical tool for more realistic simulation of material damage in our efforts to develop spinal implant materials.

Materials and Methods We focused on a 3D-printed Polyetheretherketone (PEEK) composite with hydroxyapatite and magnesium orthosilicate additives. The porosity of the 3D-printed structures was scanned by μCT to deliver a digital twin in PBM simulations. Simulation validation was achieved through concordance checks of compression testing and pedicle screw mechanical characterization (ASTM F543). This subsequently enabled the leapfrog into predicting implant performance in validated material libraries of boney structures, particularly compromised bone quality.

Results Experimental and numerical comparisons show good concordance in relation to porosity with a consistent trend in showcasing lower strength with high porosity. Material deformations during loading were also in agreement with simulated end-states, allowing PBM to provide realistic simulations of material damage evolution. These validations enabled predictive simulation and dynamic visualization of bone-implant interaction and damage evolution, particularly bone fragmentation, screw pullout, and implant failure under physiological loading before clinical use.

Conclusion By improving preclinical prediction of implant-related complications, PBM has the potential to enhance implant safety, reduce revision surgery, and accelerate the development of more durable spinal instrumentation systems. This innovation represents an important step toward reliable, evidence-driven spine implant engineering. The platform also supports patient-specific modeling, opening the possibility of tailoring constructs to individual bone quality and anatomy.

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Interspinous devices as a minimally invasive fusion option for degenerative lumbar disorders

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Introduction / Objectives Interspinous devices (ISDs) have emerged as a motion-modulating and stabilizing option for degenerative lumbar disorders. Rather than relying on pedicle-based fixation, ISDs achieve stabilization through posterior element anchorage, offering a potentially less invasive strategy. This study aims to evaluate the clinical utility of ISDs as an adjunct or alternative fixation method in lumbar fusion procedures, particularly in cases of low-grade instability such as spondylolisthesis.
Materials and Methods A retrospective review was conducted on patients with degenerative lumbar pathology treated using interbody fusion techniques supplemented with ISDs. Clinical outcomes, perioperative variables, and radiographic fusion status were assessed. Indications included lumbar stenosis, degenerative disc disease, and low-grade spondylolisthesis. Fusion was determined through postoperative imaging, and complications were recorded.
Results / Discussion ISDs provided effective posterior stabilization while minimizing disruption to surrounding structures. Favorable fusion rates were observed, comparable to those reported with pedicle screw systems. In addition, reduced operative time, less intraoperative blood loss, and decreased surgical morbidity were noted. Biomechanically, ISDs contribute to indirect decompression by enlarging foraminal dimensions and reducing disc loading. Their facet-preserving nature may help mitigate adjacent segment degeneration. However, appropriate patient selection remains critical, as higher-grade instability and structural defects are not suitable indications.
Conclusion ISDs represent a viable, less invasive alternative to conventional screw-based fixation in selected lumbar fusion cases. When applied under appropriate indications, they can achieve satisfactory stabilization and fusion outcomes with reduced surgical burden. Further long-term studies are warranted to clarify their durability and optimal role in spine surgery.

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What Are The Best Indications for Annulus Fibrosus Suture in Spinal Endoscopic Surgery? A Novel Score System Evidence-based and Expert Consensus-Based Validation Study

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Introduction Lumbar disc herniation (LDH) significantly affects patients' quality of life, and approximately 10% of patients require surgical treatment. Annulus fibrosus suture (AFS) can restore anatomical integrity, reduce reherniation, and improve long-term outcomes. Currently, AFS selection is mostly surgeon-dependent, lacking a unified classification integrating defect morphology, endoscopic features, and suture feasibility. The aim of current study is to develop a clinically applicable scoring criteria as Yueyang Hospital of Shanghai University of Traditional Chinese Medicine (YY-SHUTCM) score system to decide whether a patient needs to undergo AFS in order to obtain the maximum clinical therapeutic benefit.
Materials and Methods The development of YY-SHUTCM score system followed a two-step process, one designing the instrument and the other obtaining judgemental evidence. For judgemental evidence a panel of experts was appointed to make appropriate modifications and content validation for finalizing the scoring instrument. This score was applied on 30 patients and receiver operating characteristic (ROC) curves were drawn for sensitivity and specificity analysis.
Results The comprehensive scoring criteria was approved after three rounds of expert panel discussions with an index of content validation more than 0.75 after final round of panel discussion. On case-based validation after plotting ROC curves, sensitivity and specificity for suturing and basing on experience at a cut-off score of 6 was 92.9% and 86.8% respectively whereas for basing on experience and not suturing at a cut-off score of 10 was 94.3% and 81.9%, respectively.
Conclusion YY-SHUTCM score system is a comprehensive scoring system integrating demographic, anatomical, clinical, and radiological factors aimed at deciding whether a patient needs to undergo AFS.

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ERAS in Spine Surgery: Our Institutional Experience and Lessons Learned

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Introduction Enhanced Recovery After Surgery (ERAS) protocols aim to optimise peri-operative care through patient education, multimodal analgesia with reduced opioid use, early mobilisation, and faster functional recovery. Since 2024, our institution has implemented a structured ERAS pathway for patients undergoing elective one- or two-level lumbar fusion surgery. This study presents our institutional experience, key protocol components, and its impact on peri-operative outcomes.
Methods All eligible elective lumbar fusion patients were enrolled, while emergency and revision cases were excluded. The ERAS pathway consisted of standardised pre-operative counselling, intra-operative strategies, fixed analgesic regimens, and a structured post-operative mobilisation program. Primary objectives were to promote early ambulation, reduce hospital length of stay (LOS), minimise complications, and improve overall patient outcomes. Measured outcomes included LOS (target <7 days), time to ambulation, 30-day blood transfusion rate, complication rate, return to operating theatre (OT) rate, readmission rate, and inpatient mortality.
Results Following implementation, the average LOS decreased significantly from 8.9 days (2014–2022) to 4.83 days in 2025, with a median of 4 days. The proportion of patients discharged within 7 days improved from 50.9% to 95.7%. No patients required blood transfusion or reoperation within 30 days, and inpatient mortality remained at 0%. Early mobilisation improved substantially, with 82.9% of patients ambulating on post-operative day 1 and 97.9% by day 3. Reported readmissions were largely unrelated to surgical complications.
Conclusion Overall, our Spine ERAS protocol was associated with enhanced recovery, improved pain control, earlier mobilisation, and reduced LOS, without compromising patient safety or surgical outcomes. These findings underscore the importance of multidisciplinary collaboration and adherence to standardised, evidence-based care pathways. While further refinement and long-term evaluation are needed, ERAS represents an effective framework for improving patient-centered care and optimising healthcare resource utilisation.

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A retrospective pilot study assessing the use of PathKeeper 3D optical system navigation system in pediatric and adolescent scoliosis patients undergoing spinal surgery.

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Introduction Scoliosis is a common spinal deformity in the pediatric and adolescent population, associated with patient morbidity and impaired quality of life. While surgical intervention is frequently required, the operative risk carries increased surgical challenges due to its complexity and neurological associations. Recent technological advancements in surgery, including robotic-assisted approaches and other imaging technologies have enhanced surgical precision and safety. Among these, computer-assisted navigation systems have emerged as valuable tools. The PathKeeper computer guided navigation system provides real-time, radiation-free, three-dimensional optical guidance. However, its clinical role in complex deformity correction such as scoliosis has yet to be defined. This study aims to evaluate the feasibility, accuracy of the PathKeeper 3D optical navigation system in pediatric and adolescent patients undergoing scoliosis surgery.
Material and Methods We conducted a pilot retrospective analysis of patients undergoing spinal scoliosis surgeries at Hadassah Medical Center using the PathKeeper computer-assisted navigation system. Patient demographic data, data regarding planned versus registered vertebral levels, and observed complications were reported and documented.
Results Twelve patients aged 12–20 years (mean BMI 19.7) underwent scoliosis surgery using the PathKeeper system during the year 2025. Accurate registration was achieved for multiple planned vertebral levels across all study cases, including T4–T12, L1–L5, and one case at S1, with L1 being the most frequently registered level. Notably, no major malfunctions or adverse events occurred during the system use, and the system required no additional training due to its user friendly interface.
Conclusion Our findings demonstrated the feasibility and accuracy of the PathKeeper optical spine navigation system in pediatric and adolescent patients with scoliosis undergoing spine surgery. The system achieved successful registration across all cases. These preliminary findings highlight the potential of this technology to enhance navigation in scoliosis surgery, improving surgical accuracy and patient safety in this high-risk population.

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Patient Factors Influencing Pain Improvement Following Endoscopic Spine Surgery at a Tertiary Centre

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Background Unilateral biportal endoscopic (UBE) spine surgery has demonstrated favorable clinical outcomes in lumbar degenerative disease. However, the influence of patient-related factors on postoperative pain improvement remains incompletely defined.
Methods This retrospective single-centre cohort study evaluated patients undergoing UBE lumbar decompression and discectomy at a tertiary hospital. Postoperative pain improvement was assessed using changes in Visual Analogue Scale (VAS) scores at 1 and 6 months. Associations between demographic, clinical, and operative variables and pain improvement were analysed using correlation testing, t-tests, and ANOVA. Operative time trends were examined to characterize the surgical learning curve.
Results Patients demonstrated significant improvements in both back and leg pain at all postoperative time points ($p < 0.001$). At 1 month, non-smokers experienced significantly greater improvement in back ($p = 0.028$) and leg pain ($p = 0.013$) compared to smokers. This association attenuated at 6 months and was no longer statistically significant. Age, sex, body mass index (BMI), and common metabolic comorbidities were not significantly associated with pain improvement at either time point. Higher BMI was independently associated with longer operative time ($p = 0.023$) but not with pain outcomes. Operative time demonstrated a modest but significant reduction with increasing cumulative case experience ($p = 0.0187$), without corresponding differences in postoperative pain improvement.
Conclusion UBE spine surgery provides consistent and meaningful pain relief across diverse patient populations. Smoking influences early recovery but does not appear to compromise medium-term outcomes. Age, BMI, and common comorbidities do not meaningfully limit pain improvement. The learning curve of UBE ESS primarily reflects procedural efficiency gains rather than variability in clinical effectiveness, supporting its broad applicability in real-world practice.

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Can Achieving the Proposed Ideal Alignment per "Roussouly Classification" Help Predict Mechanical Complications When Treating Adult Spinal Deformity with the "SIMPLER" CMIS Technique?

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Introduction While Spino-Pelvic parameters help define ideal spinal alignment, it remains unclear if the Roussouly classification accurately predicts mechanical complications in adult spinal deformity patients treated with the SIMPLER CMIS technique. This study evaluates that predictive power within this specific minimally invasive approach.
Methods A database of ASD patients who underwent SIMPLER CMIS technique from Jan2011 to Jan2024 was retrospectively examined. Inclusion criteria: ASD (Cobb>20°,SVA>50mm,PI-LL>10°), fusion 6 levels, UIV L1 or above, LIV: L5 or below. The Roussouly et al method was used to classify patients into 5 types. Post-operatively, Sebaaly et al method was used to categorize the patients into 2groups: patients who achieved their proposed Roussouly classification ("restored") and the patients who did not ("non-restored"). A mechanical complication was defined as PJK, PJF, rod fracture, reoperation due to hardware failure, pseudoarthrosis or screw loosening.
Result 188pts with a mean age of 66.4yrs (22-84years) and mean FU of 103.4months(27-179.7) were identified: 105pts were corrected to their ideal Roussouly class (restored) and 83pts were not (non-restored). A total of 24(12.7%) mechanical complications were noted:8 of them were asymptomatic and did not require any revision surgery (Table 3 and 4). 4pts(3.8%) with restored spine shape and 12pts(14.5%) with non-restored spine shape required revision surgery. A multivariable proportional odds model showed 4.2 times increased odds of mechanical complication requiring revision surgery (95%CI:1.32–13.77,P=0.009) in the "non-restored" group. Furthermore, the non-restored patients had a significant 11.1 times increased odds of PJK requiring revision surgery (95%CI:1.36–90.59, P<0.0001) postoperatively.

Conclusion Our study suggests that achieving the ideal sagittal shape based on the Roussouly classification after SIMPLER CMIS correction of ASD is associated with a reduced risk of postop mechanical complications and subsequent revision surgeries. This highlights the importance of restoring appropriate spinal alignment during surgery for better long-term outcomes.

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Cement-augmented Pedicle Screws Complication Study -The Study Using a Questionnaire in JSSR(The Japanese Society for Spine Surgery and Related Research)

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Introduction The use of cement-augmented pedicle screws for fixation is increasing. The purpose of this study is to understand the current situation regarding the extent to which spinal surgeons belonging to this society experience cement leakage when using these screws and how they respond to it.
Materials and Methods The survey was conducted as a web-based questionnaire targeting spinal surgeons belonging to the society. The survey period was from April 1, 2025, to April 30, 2025.
Result Responses were obtained from 878 participants. Fifty-five percent reported experience using these screws, and 61% reported experiencing cement leakage during surgery. Additionally, approximately 80% of surgeons confirmed cement leakage on postoperative CT scans. Cement leakage most frequently occurred within blood vessels (particularly the segmental vein). The most common cement volume used was 0.5 to 1.0 ml. Countermeasures included increasing cement viscosity before use or injecting in small increments. Nine cases of vital sign abnormalities were noted. The response to detecting leakage was mostly observation, but complications were observed in three cases.
Discussion There have been reports of cement leakage and cardiopulmonary cement embolism following the use of cement-augmented pedicle screws. Although many Japanese spinal surgeons understand the complications associated with cement leakage and have tried various approaches, preventing cement leakage has proven difficult.
Conclusion Spine surgeons must exercise caution regarding the risk of intravascular leakage when using cement-augmented pedicle screws, as they may cause serious complications in some patients.

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Navigation-Assisted Full-Endoscopic Rhizotomy and Ablation for Coccydynia: Singlecenter retrospective study

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Background Coccydynia, characterized by pain and tenderness in the coccyx region, often arises from trauma, repetitive strain, childbirth, degenerative joint disease, infections, tumors, obesity, poor posture, or idiopathic causes. Conservative treatments are usually effective, but some patients require interventional therapies or surgery.
Objectives This study aimed to evaluate the clinical efficacy and feasibility of a novel fullendoscopic rhizotomy and ablation (FERA) technique, assisted by a three-dimensional (3D) robotic C-arm navigation system, in treating coccydynia.
Study Design A retrospective review of 13 consecutive patients who underwent FERA for coccydynia between September 2019 and August 2023.
Setting The study was conducted at Changhua Christian Hospital, utilizing a hybrid operating room equipped with a 3D robotic C-arm system (ARTIS pheno, Siemens Healthineers).
Methods Patients included had coccydynia for at least 3 months, were unresponsive to conservative treatments, and showed significant pain relief after ultrasound-guided coccygeal nerve block. The FERA procedure was performed under local anesthesia using the 3D robotic C-arm for precise navigation. Pain severity and functional disabilities were assessed using the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) scores, respectively, at multiple follow-up points up to 12 months postoperatively.
Results Thirteen patients (3 males, 10 females, mean age 49.6 years) completed the follow-up. The mean operation time was 56 ± 28.85 minutes. All patients were discharged the next day without complications. VAS scores decreased significantly from 7.38± 1.85 preoperatively to 0.77± 1.24 at 12 months. ODI scores also showed significant improvement from 24.08± 5.44 preoperatively to 2.38± 4.38 at 12 months. The patient satisfaction rate was 100%.
Limitations This study was retrospective with a small sample size and short-term follow-up. Patient heterogeneity and reliance on self-reported outcomes may have influenced the results.
Conclusion The FERA technique, utilizing 3D robotic C-arm navigation, demonstrated significant pain relief and improved

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Multilevel Full Endoscopic Lumbar Decompression Guided by the FAPDIS Algorithm: A Retrospective Analysis of 100 Patients

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Background Lumbar disc herniation and spinal stenosis often coexist, leading to back pain, radiculopathy, and neurogenic claudication. The optimal treatment for multilevel disease remains controversial. Full endoscopic decompression offers a minimally invasive alternative, and the FAPDIS algorithm provides a structured method for selecting the appropriate surgical approach.
Objective To evaluate the clinical outcomes of multilevel full endoscopic decompression using the FAPDIS algorithm for approach selection.
Methods This retrospective study included 100 patients with multilevel lumbar stenosis and/or disc herniation treated with transforaminal (TELD) and/or interlaminar (IELD) endoscopic decompression based on the FAPDIS algorithm. A total of 223 levels were decompressed. Clinical outcomes were assessed using Visual Analog Scale (VAS) for back and leg pain and Oswestry Disability Index (ODI) preoperatively and up to 12 months postoperatively.
Results Ninety patients underwent two-level and ten underwent three-level decompression. A total of 142 TELD and 81 IELD procedures were performed. Single-stage surgery was performed in 88 patients, while 12 required staged procedures. Mean hospital stay was 1.4 days. VAS for back pain improved from 7.9 to 1.7 and leg pain from 8.6 to 1.3 at 12 months. ODI improved from 38.1 preoperatively to 4.2 at 12 months. The overall complication rate was 5%, including recurrent herniation (2%), dural tear (1%), transient quadriceps weakness (1%), and instability (1%).

Conclusion The FAPDIS algorithm is a reliable and reproducible tool for approach selection in multilevel lumbar pathology. Full endoscopic decompression guided by this algorithm provides excellent clinical outcomes with minimal morbidity and low complication rates.

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Multiple Endoscopic Access Lumbar Interbody Fusion (MALIF): A New Technique for Unilateral Biportal Endoscopic Lumbar Interbody Fusion Using Monoportal Endoscopic Spine Surgery Techniques

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Introduction This study introduces a novel minimally invasive spinal fusion method—Multiple Endoscopic Access Lumbar Interbody Fusion (MALIF). This technique integrates Assisted Full-Endoscopic Spine Surgery (AFESS) into the unilateral biportal endoscopic lumbar interbody fusion (UBE-LIF) framework. AFESS enhances UBE by utilizing a monoportal endoscope in the camera portal, offering increased visualization stability, muscle-preserving irrigation, and neural structure protection.
Methods MALIF was performed on 15 consecutive patients with symptomatic lumbar spondylolisthesis unresponsive to conservative treatment and radiographic instability. The approach involved a unilateral percutaneous pedicle screw (PPS) incision, minimal exposure of the lateral facet joint, resection of the superior articular process (SAP), and placement of an interbody cage for indirect decompression and fusion. All procedures were conducted using biportal access with a monoportal endoscope (AFESS).
Results Mean operative time: 97.4 ± 17.5 minutes (range: 70–129 minutes). Mean blood loss: 24.3 ± 13.8 ml. Mean hospital stay: 15.0 ± 3.5 days
Complications One case of transient dysesthesia, resolved within 2 weeks. All patients experienced postoperative symptom improvement without major complications.
Conclusion MALIF offers three notable advantages: Multi-angle endoscopic access, Precise endoscopic discectomy, Enhanced neural safety via monoportal sleeve protection of the exiting nerve root. These preliminary results support MALIF as a safe and effective minimally invasive option for lumbar interbody fusion.

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Advancement in Full Endoscopic Spine Surgery; Trends and Clinical Insights

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Introduction Lumbar spinal canal stenosis (LSCS) is a leading cause of pain and disability in the aging population. Conventional open decompression, though effective, is associated with extensive tissue disruption, blood loss, prolonged hospital stay, and delayed rehabilitation. With advances in optics, instrumentation, and surgical techniques, endoscopic spine surgery has emerged as a minimally invasive alternative, aiming to reduce morbidity while ensuring adequate decompression.
Material and Methods 227 cases of Endoscopic Decompression cases were analyzed. Parameters analyzed included operative time, blood loss, hospital stay, complication rates, and functional outcomes such as Visual Analog Scale (VAS) for pain and Oswestry Disability Index (ODI).
Results Endoscopic spine surgery demonstrates significant advantages over conventional approaches, including reduced soft tissue trauma, minimal blood loss, shorter hospitalization, and faster postoperative recovery. Functional outcomes measured by VAS and ODI show superior improvements to open techniques, with a lower incidence of perioperative complications. Furthermore, technological advances have expanded indications, enabling safe and effective treatment of complex stenotic pathologies.
Conclusion Endoscopic spine surgery represents a paradigm shift in the treatment of LSCS, combining efficacy of decompression with the benefits of minimally invasive surgery. By aligning surgical practice with the global movement toward patient-centered, less invasive care, it effectively bridges the gap between traditional spine surgery and the modern world of spinal innovation.

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Beyond the Hunch: Navigating the Landscape of Post TB – Kyphosis

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Surgical Outcomes of Modified Hybrid MIS TLIF: Efficacy, Safety and Reliability
Introduction MIS-TLIF is a common surgical procedure to treat lumbar spondylolisthesis. However, we introduced and practice our own method of doing the surgery. We have invented our own Modified Hybrid MIS-TLIF and documented the long-term results of surgical strategy.
Methods 184 patients who had undergone instrumented Modified Hybrid MIS-TLIF between July 2021 and December 2025 were retrospectively reviewed. Here we used MIS Screw system with a midline mini open Incision to put the cage for fusion. The visual analog scale, Oswestry Disability Index and the patient's return-to-work status, effect on back muscle were used to assess outcomes.
Results The mean visual analog scale scores for back and leg pain decreased from 5.9 and 7.1 to 3.5 and 3.7, respectively, in the DS group (n=99) and from 6.7 and 6.8 to 1.8 and 2.0, respectively, in the IS group (n=85) (P<0.001). The mean Oswestry Disability Index scores improved from 60.7% to 23.5% in the DS group and from 63.9% to 19% in the IS group (P<0.001). Patient satisfaction rate was 80% and 81% in the DS and IS groups, respectively. Paraspinal Muscle Cross sectional area increased by 6.7% postoperatively. Evidence of fusion radiologically in 82 (96%) and 99 (100%) of the patients in the IS and the DS group, respectively, giving an overall fusion rate of 97.7% (179 out of 184). The final ASD rate, observed using radiography, was 68.4% (67 out of 99) in the DS and 40% (34 out of 85) in the IS group. However, 15.8% (15 out of 99) in the DS and 3% (2 in 85) in the IS group had symptoms associated with ASD.
Conclusions The long-term clinical and radiologic outcomes after instrumented Modified Hybrid MIS-TLIF in patients with unstable single-level spine are favorable.

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Efficacy, Safety and Reliability of Surgery by Single Anterior Approach in Neglected, Lately Presented Sub-Axial Cervical Spine Injury

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Introduction The optimal method for the management of neglected traumatic fracture dislocation of the subaxial cervical spine has not been well established. Our country is resource constrained and here cost effectiveness plays a big role in decision-making. So, we need a method which is cost-effective, can be done with fewer implants and is safe and effective. In this case series, we performed a single Anterior Approach to correct dislocation and decompression of spinal cord and outcome was measured scientifically.

Methods It is a prospective interventional study done in Our tertiary care centers. Study period: 10 years. Sample size 465. Cases operated at least 7 days after injury. Surgery was done by single anterior approach (ACDF). Using Stand-alone cage or Tricortical bone graft and anterior cervical plates and screws. Outcome analysis done by ASIA grading, VAS, and ODI scoring. Bridwell fusion grading was used to assess interbody fusion. Minimum follow-up period was 6 months.

Results Total sample size was 465. Age range was 21-55 (44.53 ± 12.5). 86.7% male (n = 404). The most common mechanism of injury fell from height 46.7% (n = 218); the most commonly injured level was C 5/6, 60% (n = 279). Average preoperative delay was 25 (±4) days. 66% (n = 306) patients had 1 grade ASIA impairment score (AIS) improvement, 20% (n = 93) had 2 AIS grade improvement, and 13% (n = 60) patients had no improvement of the postoperative ASIA score. Postoperative VAS and Macnab scores improved significantly. 80% (n = 372) patients achieved grade 1 fusion according to Bridwell fusion grading. 2 Patient had post operative dysphagia 1 patient had neck pain, No patient had any post-op neurological deterioration.

Conclusions Late and neglected cases of cervical spine injury can be managed by only anterior surgery with significantly good neurological and functional outcomes.

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Surgical Strategies for Osteoporotic Vertebral Fractures: Balancing Stability and Biology

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Background Osteoporotic vertebral fractures (OVFs) are a growing clinical challenge due to the aging population and increasing life expectancy. These fractures often result in severe pain, spinal deformity, and neurological deficits, significantly affecting quality of life. Surgical management is complex because of poor bone quality, comorbidities, and the risk of implant failure.

Objective To review and analyze current surgical strategies for osteoporotic vertebral fractures, focusing on stability restoration, pain relief, and prevention of postoperative complications.

Methods A literature-based synthesis of contemporary surgical techniques including vertebral augmentation (vertebroplasty and kyphoplasty), posterior instrumentation with cement-augmented pedicle screws, anterior reconstruction, and minimally invasive stabilization procedures. The selection criteria, biomechanical considerations, and outcome predictors were critically evaluated.

Results Minimally invasive cement augmentation techniques (e.g., balloon kyphoplasty) are effective for pain relief and partial restoration of vertebral height in stable fractures. In unstable or progressive collapse with neurological compromise, posterior fixation with cement-augmented screws provides superior stability. Hybrid constructs using short-segment fixation with intermediate screws or vertebral body reconstruction reduce the risk of implant loosening and adjacent-level fractures. Recent advances in expandable screws, calcium phosphate cement, and navigated MIS approaches have improved surgical safety and outcomes.

Conclusion Optimal surgical management of osteoporotic vertebral fractures requires an individualized approach balancing mechanical stabilization and biological integrity. Cement augmentation and minimally invasive techniques remain the mainstay, while emerging biomaterials and fixation strategies hold promise for enhancing long-term stability in osteoporotic spines.

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Radiation-Free AR-Guided Percutaneous Pedicle Screw Placement for Minimally Invasive Stabilization of Spinal Fractures in Diffuse Idiopathic Skeletal Hyperostosis

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INTRODUCTION / OBJECTIVES Spinal fractures in diffuse idiopathic skeletal hyperostosis (DISH) are unstable and technically demanding. Excessive ossification often obscures pedicle landmarks under fluoroscopy, making screw insertion difficult and increasing occupational radiation exposure. This study aimed to evaluate the feasibility and accuracy of radiation-free percutaneous pedicle screw (PPS) placement using an augmented reality (AR) navigation platform (NextAR).

MATERIALS AND METHODS Five consecutive patients with thoracolumbar fractures associated with DISH underwent minimally invasive posterior stabilization using AR-guided PPS placement. During intraoperative 3D imaging acquisition, all operating room staff exited the room to eliminate radiation exposure. The images were imported into the NextAR system for navigation. A total of 60 screws were inserted according to preoperative planning. Operative time and blood loss were recorded. Screw accuracy was assessed using postoperative CT based on the Gertzbein–Robbins classification.

RESULT / DISCUSSION Operative time ranged from 106 to 157 minutes, and blood loss ranged from 30 to 100 g. Among the 60 screws, 14 were penetrating endplate screws. According to the Gertzbein–Robbins classification, 58 screws were Grade A and 2 were Grade B. No major complications occurred. In DISH cases, pedicle identification is often difficult under conventional fluoroscopy. The AR navigation system, which directly tracks instruments using an integrated infrared camera, reduces reliance on fluoroscopy and may improve both efficiency and accuracy.

CONCLUSION Radiation-free AR-guided PPS placement using the NextAR system is feasible and accurate for minimally invasive stabilization in DISH-related spinal fractures. It may reduce occupational radiation exposure while enabling safe and precise screw insertion in technically challenging cases.

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Awake percutaneous fixation for unstable fractures of the spine in high-risk patients

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Objectives Unstable spinal fractures in elderly or medically compromised patients are increasing and present a significant surgical challenge. In ASA III–IV patients, the risks of general anesthesia may outweigh the benefits due to a higher likelihood of intraoperative complications. Awake surgery under local anesthesia with mild sedation may offer a safer alternative. This study evaluates the perioperative outcomes of awake percutaneous spinal fixation.

Methods This study included an observational analysis evaluating patients with ASA 3-4 who presented with unstable spinal fractures at a level one trauma center. These patients underwent awake spinal percutaneous fixation with mild sedation and local anesthesia. Data on demographics, radiology, and outcomes were collected.
Results Sixty-four patients underwent surgery between 2019- 2023. The average follow-up was 12 months (range: 8-24 months), with 33 females and 31 males. The average age was 77.7 years. All patients had an ASA score of 3-4. The injury types included 29 extension fractures, 24 unstable burst fractures, 9 chance fractures, and 2 teardrop fractures. All patients received unilateral fixation, with one patient undergoing bilateral fixation. Cement augmentation was performed in 50 patients. There were no neurological complications, and only one case of infection was reported, occurring 4 months post-surgery. All patients were discharged ambulatory. At the 2-week follow-up, the average VAS score decreased from a preoperative score of 9 (range: 8-10) to 2 (range: 0-4) ($P<0.01$). Postoperative X-rays taken at 6 and 12 weeks confirmed fracture healing. At the final follow-up, 4 cases of hardware loosening were identified, however those cases remained asymptomatic and did not require revision surgery.
Conclusions Our findings suggest that awake fixation is a safe and feasible alternative to general anesthesia in high-risk cases. However, it requires a dedicated multidisciplinary team including an anesthesiologist and a radiologist to ensure the procedure is performed safely and efficiently.

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Learning Curve for Uniportal Endoscopic Transforaminal Lumbar Interbody Fusion in Experienced Endoscopic Surgeon
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Introduction Full-endoscopic uniportal transforaminal lumbar interbody fusion (FE-TLIF) is a minimally invasive technique that offers advantages such as reduced tissue damage, blood loss, and postoperative pain. However, its adoption is challenged by a steep learning curve. This study aimed to evaluate the learning curve, perioperative outcomes, and complications of conventional FE-TLIF performed under fluoroscopic guidance with a non-expandable cage by an experienced uniportal endoscopic surgeon.
Methods and Methods An ambidirectional cohort study was conducted on 32 consecutive patients who underwent FE-TLIF at a single center between January 2023 and October 2025. Operative time was used as the primary metric for learning curve analysis, assessed using the cumulative sum (CUSUM) method and polynomial regression. Perioperative outcomes and complications were compared between the early and late phases, defined by the learning point derived from the CUSUM analysis.
Results The learning curve stabilized at approximately 15 cases, as identified by the peak of the fitted polynomial regression curve. The model showed a coefficient of determination (R^2) of 0.53, indicating moderate explanatory power. Operative time showed a non-significant reduction between the early (229.93 ± 34.61 min) and late phases (214.12 ± 29.78 min; $p = 0.180$). Length of stay, estimated blood loss, drain volume, Hb change, CRP change, opioid consumption, postoperative pain and Modified MacNab criteria were not non-significant between initial and late phase. Complications were more frequent in the early phase but not significant ($p = 0.3970$).
Conclusion Proficiency in conventional FE-TLIF using fluoroscopic guidance and a non-expandable cage can be achieved after approximately 15 cases. Although the regression model demonstrated moderate fit ($R^2 = 0.53$), the findings provide practical insights for surgeons adopting this technique, emphasizing the importance of procedural familiarization to reduce complications and improve outcomes during the initial learning phase.

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Pelvic Incidence as a Surgical Decision Modifier in Lumbar Stenosis: When Should We Add an Interlaminar Device?
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Introduction/Objectives Lumbar decompression is the standard surgical treatment for lumbar spinal stenosis (LSS), yet outcomes following adjunct interlaminar device (ILD) implantation remain inconsistent. Patient-specific spinopelvic parameters, particularly pelvic incidence (PI), may influence biomechanical loading and response to motion-preserving stabilization. This study aimed to determine whether PI modifies clinical outcomes following decompression alone versus decompression with ILD.
Materials and Methods A retrospective single-centre cohort of 108 patients undergoing lumbar decompression (n=49) or decompression with ILD (n=59) was analysed. Clinical outcomes including Oswestry Disability Index (ODI), Visual Analogue Scale (VAS), and EQ-5D were prospectively collected. Minimum clinically important difference (MCID) thresholds were predefined. Multivariable logistic regression models, adjusted for age, sex, and operative levels, evaluated MCID attainment and interaction effects between intervention and spinopelvic parameters. Firth penalized regression was performed to address small event counts.
Results/Discussion Both groups demonstrated significant postoperative improvement with comparable overall MCID rates (ODI 84–86%, VAS ~78%, EQ-5D 71–80%) . However, PI significantly modified treatment response. Increasing PI was associated with higher odds of MCID attainment with ILD across all outcomes (interaction OR 1.11–1.17, $p<0.05$) . Model-derived thresholds suggested greater ILD benefit above PI ~50–55°. Subgroup analysis confirmed superior ODI MCID in patients with PI ≥55° treated with ILD (96.0% vs 73.9%, $p=0.044$) . Other parameters, including lumbar lordosis and PI–LL mismatch, did not significantly modify outcomes. These findings suggest that sagittal morphology, particularly PI, plays a key role in determining response to motion-preserving stabilisation.
Conclusion Pelvic incidence is an important modifier of surgical outcomes in LSS. While decompression alone remains effective, patients with higher PI may derive greater benefit from adjunct ILD. Incorporating PI into preoperative planning may enable a more personalised, morphology-driven surgical strategy.

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Comparative effects of dual-position, single-lateral, and prone techniques in lumbar interbody fusion: a systematic review and network meta-analysis
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Introduction/Objectives Patient positioning in lateral and oblique lumbar interbody fusion (LLIF/OLIF) is a critical yet often underrecognized determinant of operative efficiency and alignment correction. Although both single-position and dual-position strategies are widely adopted, their comparative effectiveness remains unclear. This study aimed to compare perioperative efficiency, radiographic outcomes, clinical results, and safety among single-lateral, prone, and dual-position techniques using a network meta-analysis.

Materials and Methods A systematic review and network meta-analysis were conducted in accordance with PRISMA-NMA guidelines. Twenty-five studies comprising 2,391 patients were included. Random-effects models were used to estimate mean differences (MDs) and odds ratios (ORs) with 95% confidence intervals. Treatment ranking was assessed using the surface under the cumulative ranking curve (SUCRA).

Results/Discussion Single-position LLIF techniques demonstrated superior operative efficiency compared with dual-position strategies. LLIF single-lateral significantly reduced operative time (−62.06 minutes), estimated blood loss (−56.88 mL), and length of stay versus LLIF dual-position. LLIF single-prone showed comparable improvements. In contrast, OLIF dual-position was associated with longer operative time (+72.32 minutes) compared with OLIF single-lateral. Radiographically, LLIF single-prone achieved the greatest segmental lordosis correction and ranked highest in SUCRA analysis. No significant differences were observed in global lumbar lordosis, pain outcomes (VAS), or complication rates across techniques. These findings highlight that efficiency gains can be achieved without compromising safety or clinical effectiveness.

Conclusion Single-position LLIF—either lateral or prone—offers superior operative efficiency without compromising safety or clinical outcomes, challenging the routine use of dual-position strategies. Prone positioning provides additional advantages in segmental lordosis correction, supporting its role in alignment-focused surgery. Surgical positioning should therefore be selected based on procedural objectives rather than surgeon preference alone.

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Uniportal biportal endoscopy foramen magnum decompression with duraplasty for Chiari malformation type 1: a technical note

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Introduction/Objectives Chiari malformation type 1 (CM-1) is characterized by cerebellar tonsillar descent below the foramen magnum, resulting in cerebrospinal fluid outflow obstruction. Standard surgical treatment involves open foramen magnum decompression with duraplasty, which carries significant approach-related morbidity. We describe a novel application of uniportal biportal endoscopy (UBE) for foramen magnum decompression with duraplasty (FMDD) in a symptomatic CM-1 patient, aiming to minimize surgical trauma while achieving adequate neural decompression.

Materials and Methods A 53-year-old patient with radiologically confirmed CM-1. The technique begins with a working portal over the C2 spinous process, navigating to the C1 arch midline under endoscopic visualization. A drill mark is placed at the midline as a reference. Sequential drilling to eggshell thinning is performed; emissary veins encountered during occipital bone work are controlled with bone wax. Residual bone is removed and the craniocervical junction venous plexus is shrunk using low-power coagulation. The dura is opened in a Y-shaped fashion using a knife and blunt dissection. Arachnoid bands tethering the cerebellar tonsils are released. Duraplasty is performed with DuraGen as an inlay graft, sealed with DuraSeal.

Result/Discussion The procedure was completed successfully without intraoperative complications. Adequate decompression of the foramen magnum was confirmed endoscopically. The UBE approach allowed continuous panoramic visualization of the craniocervical junction with minimal muscle disruption. Key safety steps, measured lateral dissection, controlled venous plexus coagulation, and gravity irrigation prior to durotomy were reproducible and effective. The endoscopic magnification facilitated precise arachnoid band release and tonsil decompression.

Conclusion UBE foramen magnum decompression with duraplasty is a viable minimally invasive alternative for Chiari malformation type 1. The described technical steps provide a reproducible framework for safe endoscopic craniocervical decompression. Further case series are warranted to validate outcomes.

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Biportal endoscopy coccygectomy for unstable coccygeal fracture: a technical note

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Introduction/Objectives Coccygeal fractures with anterior displacement can cause debilitating chronic pain, particularly with sitting, squatting, and coccygeal mobility maneuvers. When conservative management fails, coccygectomy is the definitive surgical option. However, the proximity of the coccyx to the anal region confers a significant risk of surgical site contamination and infection with open approaches. We present a biportal endoscopy (BE) coccygectomy as a minimally invasive alternative that reduces this risk while enabling precise resection of the unstable fragment.

Materials and Methods A 20-year-old male presented with chronic coccygeal pain refractory to conservative treatment. Imaging confirmed an anteriorly displaced coccygeal fracture with pain reproducible on mobility maneuvers. BE coccygectomy was indicated given the high infection risk of open surgery in this anatomical region. The patient was positioned prone with the hips flexed in a jackknife position to expose the sacrococcygeal region. Two bilateral paramedian incisions were made parallel to the coccyx. Endoscopic portals were docked at the sacrococcygeal junction. Anterior wall integrity was carefully preserved to avoid rectal perforation, guided by tactile feedback throughout dissection. The unstable coccygeal fragment was resected. No drain was placed.

Result/Discussion The procedure was completed without intraoperative complications. Anterior rectal wall integrity was maintained throughout. The endoscopic field provided clear visualization for circumferential dissection while limiting soft tissue disruption and minimizing wound exposure near the anal region. Fibrin glue effectively obliterated the post-resection cavity. Biportal endoscopy offers a meaningful advantage over open coccygectomy by reducing contamination risk through smaller, more distant incisions, a critical consideration given the anatomical proximity to the anus.

Conclusion BE coccygectomy is a feasible and safe minimally invasive technique for unstable coccygeal fractures. It mitigates the infection risk inherent to the perianal surgical field while enabling complete resection. Further studies are needed to establish its role in routine coccygeal surgery.

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UTILITY OF PRONE NEUTRAL RADIOGRAPHS IN FUSION LEVEL DETERMINATION IN ADOLESCENT IDIOPATHIC SCOLIOSIS

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INTRODUCTION/OBJECTIVES Accurate selection of the lower instrumented vertebra (LIV) in adolescent idiopathic scoliosis (AIS) is essential to achieve optimal deformity correction while preserving distal motion segments. Radiographic landmarks such as the last touched vertebra (LTV) and last substantially touched vertebra (LSTV) are commonly used. This study evaluates the utility of prone neutral radiographs in guiding distal fusion level selection in AIS.

MATERIALS AND METHODS AIS patients who underwent posterior spinal fusion between January 2020 and August 2024 with preoperative prone neutral radiographs were retrospectively reviewed. Radiographic parameters, including Cobb angles, LTV, and LSTV, were measured independently by three blinded observers. Vertebral levels saved were calculated relative to the erect LSTV. Distal adding-on (AO) was assessed at a minimum follow-up of 12 months.

RESULT/DISCUSSION A total of 55 patients were included. Prone neutral radiographs demonstrated meaningful curve flexibility, with erect-to-prone correction ratios of 0.914 for the proximal thoracic curve, 0.783 for the main thoracic curve, and 0.749 for the lumbar curve. Fusion proximal to the erect LSTV was achieved in 40.0% of patients. At least one distal fusion level was preserved in 29.1% of cases. No cases of distal adding-on were observed at ≥12 months follow-up, suggesting that distal level preservation using prone neutral imaging is safe.

CONCLUSION Prone neutral radiographs are a useful modality for guiding distal fusion level selection in AIS. They demonstrate sufficient curve flexibility and allow preservation of distal motion segments in a substantial proportion of patients, without increasing the risk of distal adding-on.

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Metastatic Breast and Prostate Cancer: Truly Good Candidates for Palliative Spine Surgery?

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Objectives To evaluate 90-day and 1-year mortality following palliative spine surgery in metastatic breast and prostate cancer, compare outcomes between cancer types and hormone-defined subgroups, and identify clinical predictors of survival.

Background Palliative spine surgery aims to relieve pain and preserve neurological function, yet variable postoperative survival complicates patient selection. Conventional prognostic tools often overlook tumour biology and hormonal status. Improved risk stratification is needed to identify patients deriving durable benefit and avoid overtreatment.

Methods Retrospective review of 106 patients (66 breast, 40 prostate) undergoing palliative spine surgery (2003-2022). Endpoints were 90-day and 1-year mortality, stratified by primary cancer and hormone status. Clinical predictors were identified through univariate analysis.

Results Overall 90-day and 1-year mortality were 10.4% and 32.1%, respectively. Breast cancer patients had lower 1-year mortality than prostate cancer patients (22.7% vs. 47.5%, p=0.008). Hormone-dependent breast cancer carried the most favourable prognosis (1-year: 20.3%), while hormone-independent prostate cancer had the poorest (1-year: 75.0%, p=0.018). Across the overall cohort, thrombocytopenia and hypoalbuminaemia predicted 90-day mortality, while hypoalbuminaemia, anaemia, lymphopenia and visceral metastases predicted 1-year mortality. By cancer type, 1-year mortality was associated with hypoalbuminaemia and visceral metastases in breast cancer, and with anaemia in prostate cancer. In subgroup analysis, 1-year mortality was associated with hypoalbuminaemia and visceral metastases in hormone-dependent breast cancer, and with low BMI in hormone-dependent prostate cancer.

Conclusions Surgical candidacy should be guided by expected survival. Breast cancer patients, particularly with hormone-dependent disease, are favourable candidates. Conversely, the high mortality in hormone-independent prostate cancer suggests aggressive surgery may constitute overtreatment. Early mortality is associated with perioperative vulnerability, whereas longer-term survival correlates with systemic disease burden and physiological reserve. Clinicians should integrate hormonal status and objective biomarkers to optimise patient selection and reduce unnecessary surgical intervention.

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Full-Endoscopic Lumbar Interbody Fusion: From a Strategic Technical Roadmap to Optimized Clinical Outcomes

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Introduction/Objectives Full-Endoscopic TLIF (Endo-TLIF) offers superior tissue preservation and coaxial visualization but is often hindered by technical complexities and a restricted working corridor. This study aims to establish a rigorous framework for precision decision-making and strategic risk control. By synthesizing evidence-based protocols with early clinical trajectories, we delineate a systematic approach to mitigate procedural pitfalls and optimize surgical reliability.

Materials and Methods A comprehensive review of high-impact literature was integrated with a retrospective analysis of 27 consecutive patients (mean age: 69.8 years) treated between January 2025 and March 2026. The investigation focused on critical technical checkpoints across three phases: (1) Pre-operative (patient selection and mandatory instrumentation); (2) Intra-operative (efficient docking, neural protection, and specialized endplate maneuvers); and (3) Stability phase (cage optimization).

Result/Discussion The successful implementation of Endo-TLIF necessitates a proactive risk-mitigation strategy. Pre-operatively, risk control commences with stringent patient selection and mandatory instrumentation readiness; the absence of dedicated tools significantly correlates with increased operative time. Intra-operatively, precision docking and direct visual-guided endplate preparation—extending to the contralateral annulus while strictly preserving subchondral bone—are paramount, especially in cases with diminished disc height. Applying this structured protocol, the cohort exhibited substantial clinical improvements. The mean preoperative ODI of 63 significantly improved to 27, and the mean VAS score decreased from 7.1 to 3.1 at the 6–12 month follow-up. Biomechanical optimization via cage placement and continuous neural shielding using protected cannulas effectively prevented subsidence and dural irritation, reducing the surgeon's cognitive load and enhancing overall satisfaction.

Conclusion Uniportal Endo-TLIF is a sophisticated fusion procedure requiring a dedicated shift in surgical philosophy. By prioritizing instrumentation readiness and meticulous endplate preparation, surgeons can effectively overcome inherent technical limitations. This systematic framework transforms a demanding procedure into a safe, reproducible, and clinically superior modality with proven functional recovery.

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Far-Lateral Transforaminal Unilateral Biportal Endoscopic Lumbar Discectomy for Upper Lumbar Disc Herniations

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Objective The upper lumbar region has distinctive anatomical characteristics that contribute to the challenges of performing discectomy. We introduce far-lateral transforaminal unilateral biportal endoscopic (UBE) lumbar discectomy for central or paracentral disc herniations in the upper lumbar region.

Methods We conducted retrospective review of the patients who underwent a far-lateral transforaminal UBE lumbar discectomy at our institution from January 2018 to September 2024. The electronic medical records, operative records, and radiologic images of the patients were reviewed.
Results A total of 27 patients underwent far-lateral transforaminal UBE lumbar discectomy for central or paracentral disc herniations in the upper lumbar region. The patient had a mean age of 54.0 ± 13.7 years. Operation was performed at the L1–2 level in 3 patients (11.1%), L2–3 in 9 patients (33.3%), and L3–4 in 15 patients (55.6%). The patients were followed-up for a mean of 27.7 ± 19.3 months. The Oswestry Disability Index was significantly decreased from 36.3 ± 6.8 preoperatively to 3.7 ± 3.3 at last follow-up ($p < 0.001$). The visual analogue scale (VAS) back was significantly decreased from 7.8 ± 0.9 preoperatively to 3.1 ± 0.6 postoperative day 2 ($p < 0.001$). The VAS leg was significantly decreased from 8.1 ± 0.8 preoperatively to 2.3 ± 0.7 postoperative day 2 ($p < 0.001$).
Conclusion The far-lateral transforaminal UBE lumbar discectomy would be a viable surgical option for upper lumbar disc herniations.

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Percutaneous Endoscopic Decompression for Lumbar Radiculopathy with Radiographic Instability: A Non-Fusion Strategy Balancing Clinical Efficacy and Spinal Stability

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Introduction For patients with lumbar radiculopathy (LR) with or without radiographic lumbar instability (RLI), it is controversial whether to choose percutaneous endoscopic lumbar discectomy (PELD) treatment. We have previously admitted a large number of patients who recovered from LR treated with PELD, some of whom had RLI and achieved satisfactory outcomes after treatment. The purpose of this study was to investigate the surgical outcomes of patients with LR combined with RLI treated with PELD for decompression only.
Methods A retrospective analysis included 579 LR patients undergoing PELD. We compared surgical outcomes with imaging changes in LR patients with and without RLI who were matched for age, sex, surgical segmentation, and surgical approach. Outcomes included Oswestry Disability Index (ODI), Japanese Orthopaedic Association (JOA), and visual analog scale (VAS) scores.
Result A total of 486 patients (83.9%) with complete data were considered eligible for this study. PTED and PEID were performed on 252 and 234 patients, respectively. A total of 73 patients (15.0%) with a combined RLI in lesion segment were treated with percutaneous transforaminal endoscopic discectomy (PTED) in 50 cases and percutaneous endoscopic interlaminar discectomy (PEID) in 23 cases. Comparing the outcomes of the 73 with RLI to the 73 matched patients without RLI, there were no significant differences in preoperative or postoperative outcomes between the two groups, and patients showed improvement in ODI, JOA, and VAS postoperatively during a mean follow-up period of 48.5-month. Radiographic instability persisted in most patients (>78%) postoperatively, with higher rates in older patients with lumbar segmental translational instability (LSTI) and in those with combined LSTI and lumbar segmental rotational instability (LSRI).
Conclusion PELD showed acceptable surgical outcomes regardless of the presence of RLI. In patients of LR with RLI, fusion surgery may not always be necessary.

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Deep-Learning-Based Automated Kinematic Analysis of the Lumbar Spine: A Multicenter Study on Precision Measurement and Clinical Alignment

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Objective This study aimed to develop and validate a fully automated, deep-learning framework for the precise and standardized measurement of lumbar intervertebral range of motion (IROM) and sagittal translation (ΔST) from dynamic radiographs, to overcome the labor-intensity and high inter-observer variability of manual methods.
Methods We conducted a multicenter retrospective study using a dataset of 905 patients (1810 images) from three institutions. A Multi-task High-Resolution Network (HRNet) was developed, utilizing an encoder for multi-scale feature extraction and two decoders for the automated identification of vertebral body centroids (L1-S1) and localization of vertebral corners. IROM and ΔST were then automatically calculated from these landmarks. Model performance was trained and validated on an internal set of 748 patients and tested on an external set of 157 patients. Results were compared against a gold standard established by expert consensus, with evaluation metrics including identification rate (IR), mean absolute error (MAE) for landmark detection, and MAE for the kinematic parameters.
Results The model demonstrated outstanding performance. On the internal (external) test sets, the centroid identification rate was 98% (98%), and the MAE for corner localization was 2.13 mm (2.37 mm). Clinical parameter measurement showed excellent alignment with radiologists, with MAEs of 2.98° (3.14°) for IROM and 1.67 mm (1.64 mm) for ΔST on the internal (external) datasets, revealing no significant systematic bias. The automated system drastically improved efficiency, reducing average processing time per patient from 180 seconds to 0.1 seconds.
Conclusion The proposed Multi-task HRNet provides a highly precise, efficient, and objective solution for automated lumbar kinematic analysis. Its robust performance across multicenter data and strong clinical alignment support its potential as a viable tool for standardizing the assessment of spinal mobility and instability in clinical practice.

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HASAN SADIKIN LAMINOPLASTY : A TECHNICAL NOTE OF AN ALTERNATIVE BURRLESS CERVICAL LAMINOPLASTY TECHNIQUE FOR RESOURCE-LIMITED SETTINGS

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Introduction In Indonesia, healthcare delivery faces significant structural and socioeconomic challenges, particularly in regional and peripheral hospitals where access to advanced surgical equipment is limited. The high cost and limited availability of high-speed burr systems may restrict the feasibility of standard cervical laminoplasty techniques. This technical note describes a step-by-step burrless cervical laminoplasty technique using Kerrison rongeurs as a safe alternative method to conventional burr-assisted methods.
Methods A burrless open-door cervical laminoplasty was performed exclusively using Kerrison rongeurs. A 2.0-mm Kerrison rongeur was used for hinge preparation by creating selective bicortical cuts at the cranial and caudal ends of the hinge, followed by unicortical outer cortex resection along the hinge body while preserving the inner cortex. A 1.0-mm Kerrison rongeur was used to create the open side and complete bicortical decompression. We proposed this procedure, as one option of technical burrless laminoplasty and called Hasan Sadikin Technique.

Discussion The fundamental principle of hinge creation in cervical laminoplasty is the preservation of the inner cortex to function as a greenstick hinge, combined with controlled weakening of the outer cortex. The described burrless technique adheres to this biomechanical concept through selective end-point stress relief and preparing the unicortical hinge body. Use of a 2.0-mm Kerrison rongeur allows effective outer cortical weakening with reliable tactile feedback while minimizing the risk of inner cortex violation. This approach reproduces the essential mechanics of burr-assisted hinge thinning while reducing dependence on specialized instrumentation.

Conclusion Burrless hinge creation using Kerrison rongeurs is a feasible and reproducible alternative for cervical laminoplasty that preserves hinge biomechanics and reduces reliance on high-speed burr systems. With appropriate technique and patient selection, this method may expand the accessibility of cervical laminoplasty in resource-limited settings.

Keywords : Cervical laminoplasty; burrless technique; hinge creation

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Postoperative dysesthesia secondary to thermal injury following biportal endoscopy for lumbar canal stenosis: a report of three cases and technical details

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Introduction/Objectives Radiofrequency (RF) is widely used in unilateral biportal endoscopic surgery (UBE) for soft tissue dissection and hemostasis. However, thermal damage to neural structures remains an underreported complication. We describe three cases of nondermatomal dysesthesia following UBE for lumbar spinal stenosis, attributed to RF-related thermal injury, and outline technical recommendations to minimize this risk.

Materials and Methods Three patients (ages 68–77) who underwent UBE decompression at L4–5 for lumbar canal and lateral recess stenosis at outside institutions were evaluated at our center for persistent postoperative dysesthesia. All patients underwent clinical examination, magnetic resonance imaging, computed tomography, and electromyography. No compressive pathology or structural lesion was identified to explain the symptoms. The dysesthesia was therefore attributed to RF-induced thermal injury to neural structures.

Result/Discussion All three patients presented with nondermatomal dysesthesia including numbness, tingling, coldness, and pain in the lower extremities. Imaging showed no neural compromise at the operated levels. Thermal injury in UBE occurs via two mechanisms: direct contact of the RF tip with neural structures and indirect heating of the epidural space. Symptoms improved over three to four months with conservative management including anticonvulsants and selective nerve root blocks. Key preventive strategies include continuous saline irrigation, intermittent low-power bursts, upright probe positioning to minimize contact area, and switching to coagulation mode after dural exposure.

Conclusion RF-related thermal injury is an underrecognized cause of postoperative dysesthesia in UBE. Awareness of proper RF technique, including low-power settings, short-duration activation, and adequate saline irrigation, is essential to prevent neural damage.

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Novel anatomic cage design reduces cage subsidence in Oblique Lumbar Interbody Fusion (OLIF)

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Introduction Cage subsidence is a recognized complication following Oblique Lumbar Interbody Fusion (OLIF), ranging from 8% to 46%, and may lead to loss of segmental alignment, reduced indirect decompression, non-union, and construct failure. While age and bone quality have been found to predict cage subsidence, other studies suggest cage geometry and endplate fit may also influence subsidence rate. We hypothesized that an anatomic cage design that more closely matches endplate morphology would reduce cage subsidence compared with a wedge-shaped cage.

Methods We retrospectively reviewed a prospectively maintained database of consecutive single- and multilevel OLIF procedures performed by a single senior surgeon over a 2-year period. Cage subsidence was assessed on routine postoperative computed tomography (CT) at 3 months. Two cage designs were used: a standard wedge-shaped Pivox cage (Medtronic) and an anatomic Aerofoil cage (Signature Orthopaedics), designed to better match endplate morphology. Subsidence rates were compared using Fisher's exact test. Preoperative bone quality was assessed using CT-derived Hounsfield Unit (HU) measurements adjacent to the vertebral endplates of the operated level. Age and HU measurements were analysed as possible independent variables using multiple regression.

Results A total of 26 patients (8 male, 18 female; mean age 67.5 years) underwent OLIF across 42 levels. Twenty-three levels (54.8%) received a Pivox cage and nineteen (45.2%) an Aerofoil cage. Subsidence occurred in 9/23 Pivox levels (39.1%) compared with 1/19 Aerofoil levels (5.3%) (odds ratio 11.57; Fisher's exact $p = 0.0128$). Overall subsidence was 23.8%. Multivariate regression analysis for age and HU measures were found not to be independent explanatory variables for cage subsidence.

Conclusion In this small retrospective observational cohort, a substantial difference in subsidence rates was observed between cage designs, with the anatomic shape (Aerofoil) cage 11.57 times less likely to result in subsidence compared with a standard wedge-shaped cage (Pivox).

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Lumbar Lordosis In Asian Patients – Implications To Adult Deformity Correction

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Introduction Sagittal and spinopelvic alignment are critical determinants of clinical outcomes in degenerative and deformity spine surgery. Existing alignment targets are largely derived from Western populations and may not be directly applicable to Asian patients, who have been reported to demonstrate smaller spinopelvic parameters.

Materials and Methods A prospectively collected dataset of 210 Asian adults with standing lateral lumbosacral radiographs was analysed. Patients with prior spinal, pelvic, or hip pathology were excluded. Spinopelvic parameters measured included pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS), lumbar lordosis (LL), and segmental lordosis from L1-2 to L5-S1. Sagittal spinal morphology was classified using the Roussouly classification. Comparisons by sex were performed, and results were compared with published normative data from Caucasian and African American populations.

Results The cohort comprised of 128 males (61%) and 82 females (39%), with a mean age of 52.7 ± 17.4 years. Mean LL was 44.2 ± 11.8°, with females demonstrating higher LL than males (46.6 ± 11.9° vs 42.7 ± 11.5°, $p = 0.024$). Segmental analysis showed the greatest contribution to lordosis from L5–S1 (14.4 ± 6.25°, 32.6%) and

L4–5 (10.5 ± 4.49°, 23.9%). Most patients exhibited Roussouly type 1 or 2 alignment (53.8%), followed by type 3 (36.7%) and type 4 (9.5%). Compared with other ethnicities, Asian patients exhibited significantly lower LL, PI, and SS (all $p < 0.01$), with a more distal apex of lordosis.

Conclusions Asian patients demonstrate a similar pattern of segmental lordosis distribution to Western populations but exhibit consistently smaller absolute lordosis at each vertebral level and a predominance of Roussouly type 1–2 morphology. Aggressive distal correction based on Western targets may thus be unnecessary in Asian patients, increasing the risk of mechanical complications.

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Evaluation of cement leakage after percutaneous vertebroplasty.

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Introduction In Japan, with the progression of a super-aging society, the number of elderly patients with osteoporotic vertebral fractures has been increasing. Percutaneous vertebroplasty is a useful treatment option for osteoporotic vertebral fractures because it allows minimally invasive treatment. However, if cement leakage occurs during percutaneous vertebroplasty, serious complications may arise. The purpose of this study was to evaluate cement leakage after percutaneous vertebroplasty.

Patients and Methods The study included 95 patients (38 male, 57 female, age, 78 years) who underwent percutaneous vertebroplasty for vertebral fractures at our hospital between January 2021 and September 2025. The evaluated variables were operative time, blood loss, surgical procedure, level of injury, cement volume used, type of cement leakage, and complications. Cement leakage was classified according to Yeom et al. as follows: leakage from the segmental vein was defined as Type S, leakage from the basivertebral vein as Type B, and leakage from the fracture site as Type C.

Results The mean operative time was 33.9 minutes, and mean blood loss was 5 g. The procedure was balloon kyphoplasty (BKP) in 69 cases and vertebral body stenting (VBS) in 26 cases. The cement volume used was 2.4 mL on the right and 2.7 mL on the left. Cement leakage was observed in 4 cases of Type S and 14 cases of Type C, while no Type B leakage occurred. Complications included adjacent vertebral fractures in 7 cases and loss of correction requiring additional posterior fixation surgery in 5 cases. No cases developed neurological abnormalities of the lower extremities due to cement leakage.

Conclusion We evaluated cement leakage associated with percutaneous vertebroplasty at our hospital. Most cases of cement leakage were Type C leakage from the fracture site.

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Persistent Radiculopathy after Full Endoscopic Spine Surgery: Etiology, Risk Factors, and Preventive Strategies

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Purpose To identify the causes and risk factors of persistent radiculopathy following full endoscopic spine surgery (FESS) and to propose a structured diagnostic and evaluation algorithm.

Overview of Literature While FESS provides excellent clinical outcomes, persistent radicular pain remains a concern. Existing literature focuses predominantly on spinal causes, often overlooking extraspinal pain generators and the role of systematic clinical evaluation.

Methods A prospective cohort of 150 patients undergoing FESS for lumbar disc herniation and stenosis was analyzed. Persistent radiculopathy was defined as symptoms persisting beyond 2–4 weeks postoperatively or early recurrence within 3 months. Patients were evaluated using a structured diagnostic algorithm incorporating detailed history, targeted clinical examination, and imaging (MRI/CT). Outcomes were assessed using Visual Analog Scale (VAS) and Oswestry Disability Index (ODI). Multivariate analysis was performed to identify predictive factors.

Results Persistent radiculopathy is often multifactorial: Amongst the common causes were residual or incomplete decompression, recurrent disc herniation and neural irritation. Importantly, extraspinal causes, including sacroiliac joint dysfunction and piriformis syndrome, were identified in a significant proportion mimicking radiculopathy. Risk factors included concurrent osteoarthritis , seropositive and seronegetive arthropathies , underlying sacroiitis , migrated disc fragments, foraminal stenosis, and early learning curve cases. The proposed algorithm enabled systematic identification of etiologies and guided targeted management.

Conclusions Persistent radiculopathy after FESS is multifactorial, involving both spinal and extraspinal causes. A structured algorithm emphasizing meticulous history taking and examination improves diagnostic accuracy and prevents unnecessary re-intervention. This approach may serve as a practical framework for postoperative evaluation in endoscopic spine surgery.

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Redefining the Management of Chronic Discogenic Low Back Pain: A Stepwise Algorithm Integrating Discography, Lateral Recess Block, and Transforaminal Endoscopic Interventions

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Background Chronic discogenic low back pain remains challenging, especially in patients with persistent symptoms despite conservative management and inconclusive MRI findings. In such cases, patients are often subjected to lumbar fusion without precise identification of the pain generator, potentially leading to overtreatment.

Methods This retrospective observational study at CARE CHL Hospital, Indore, included 200 patients with low back pain >6 weeks unresponsive to conservative therapy. MRI showed annular fissure, disc bulge, or degenerative changes without clear clinical correlation. All patients underwent provocative discography combined with therapeutic lateral recess block (LRB) under fluoroscopic guidance. Concordant pain reproduction was considered positive. LRB was performed using 1 ml xylocaine and 1 ml triamcinolone. Patients with immediate relief were managed conservatively, while others underwent transforaminal endoscopic radiofrequency ablation. Outcomes were assessed using VAS and ODI scores.

Results Concordant pain reproduction was observed in all patients. Immediate relief following LRB occurred in 80 patients (40%). Among the remaining 120, 60 underwent radiofrequency ablation, 50 TELD, and 10 required limited fusion. Significant improvement in VAS and ODI was noted post-intervention and at 6 weeks. Most patients achieved meaningful relief without requiring fusion.

Conclusions Discogenic pain unresponsive to conservative therapy is frequently overtreated with fusion in the absence of accurate pain generator identification. This study proposes a structured, algorithm-based approach combining provocative discography and LRB to confirm the symptomatic disc, followed by stepwise minimally invasive interventions, including transforaminal endoscopic techniques. This strategy enables targeted treatment, reduces unnecessary fusion, and promotes optimal clinical outcomes with preservation of spinal integrity.

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Radiographic artifacts in additive manufactured titanium rods

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Introduction/Objectives Additive manufacturing (AM) of titanium is emerging as a valuable alternative to conventional machining for spinal fixation implants. For patients with spinal metastases, AM allows for patient-specific rod designs that can better accommodate compromised anatomy. However, the radiological performance of rods possessing AM-specific features and characteristics has not been established. This study investigates how various AM design and processing parameters affect the imaging quality of titanium spinal rods.

Materials and Methods We utilized selective laser melting (SLM) to produce 5.5 mm titanium rods featuring internal holes ranging from 1.1 to 3.3 mm, oriented both parallel and 2º off-axis. Rods were fabricated in two distinct build directions—perpendicular and parallel to the rod's primary axis. A subset of these rods underwent heat treatment to evaluate the influence of microstructure on imaging. All rods were subsequently imaged in an agar phantom using CT (120 kVp) and 3T MRI to assess artifact severity and the visibility of internal features.

Result/Discussion The titanium rods exhibited typical beam hardening artifacts, where artifact intensity showed a strong inverse relationship with the size of the internal hole. Angling the internal hole produced only a minor shift in the artifacts located at the rod ends. Significant differences in artifact morphology were observed between the top and side surfaces on both CT and MRI scans, which were attributed to microstructural variations resulting from the build direction. The impact of microstructure on imaging was further demonstrated by the unique artifacts generated by the heat-treated rods.

Conclusion The transition to AM for spinal implants offers great versatility in geometric design. However, these design considerations must extend beyond mechanical functionality to include the optimization of radiographic imaging performance. This is essential to align with the growing clinical demands in the management and treatment of metastatic spinal care.

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Effectiveness of Intrawound Vancomycin Powder in Preventing Postoperative Infection After Anterior Cervical Discectomy and Fusion: A Retrospective Cohort Study

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Objective To evaluate whether intrawound vancomycin powder reduces postoperative infection after anterior cervical discectomy and fusion (ACDF) without increasing adverse events.

Methods A retrospective cohort study was conducted of patients who underwent ACDF at Chiang Mai University Hospital between January 2015 and December 2025. A total of 527 patients were included: 360 in the control group and 167 in the vancomycin group. All patients received standard systemic perioperative antibiotic prophylaxis; patients in the vancomycin group additionally received locally applied 1 g vancomycin powder at the operative site. Patients were followed for at least 90 days postoperatively. The primary outcome was postoperative infection-related events. Secondary outcomes included superficial and deep infection, postoperative complications, and potential risk factors for infection.

Results Postoperative infection-related events occurred in 5 of 360 patients (1.4%) in the control group and 2 of 167 patients (1.2%) in the vancomycin group. This corresponded to no statistically meaningful difference in infection-related event rates between groups. In the control group, infection events consisted of 2 deep and 3 superficial surgical site infections. In the vancomycin group, 1 deep cervical surgical site infection and 1 iliac crest donor-site infection were identified. Smoking was associated with a higher infection rate, with infections occurring in 3 of 102 smokers (2.9%) compared with 4 of 400 non-smokers (1.0%); however, this association did not reach statistical significance. Immunocompromised status, operative time, and intraoperative blood loss were not significantly associated with postoperative infection. Overall complication rates were low in both groups, and the most reported complications were transient hoarseness and dysphagia.

Conclusion Intrawound vancomycin powder was not associated with a reduction in postoperative infection-related events after ACDF in this cohort. Given the low baseline infection rate, the study was likely underpowered to detect a small between-group difference. Larger studies are warranted to better define the role of locally applied vancomycin powder in infection prevention after ACDF.

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Oblique Lumbar Interbody Fusion with Release of Anterior Longitudinal Ligament and Hyperlordotic Cages In Proximal Level Degeneration: 1-2 Year Clinical And Radiological Results

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Introduction Restoring sagittal alignment in proximal level degeneration following flat back lumbar fusion is essential to improve clinical outcomes. The use of hyperlordotic cages via a minimaly invasive OLIF technique with ALL release, can avoid the need for an osteotomy. The aim of this study was to evaluate the clinical and radiological outcomes in patients who underwent OLIF with ALL release and insertion of either 22 or 28 degree 3D porous lamellar titanium cages (Cascadia Lateral Cages with Cayman United Plate).

Material and Methods 18 patients from a single surgeon series were identified who had at least a 6-month follow-up. Complications were recorded together with radiographic and clinical outcome parameters. CT scans at 1 year were evaluated.

Results 18 patients were included (15 had follow-up > 1 year). All patients (except one) had a lumbar flat back fusion with adjacent level disc degeneration. 22 degree cages were used in 9 cases and 28 degree cages were used in the other cases. Cages were inserted at L2/3 in 7 cases and L3/4 in 11 cases and secured laterally with

plate and screws. Average BMI was 29.3. There were no vascular injuries. There was an average improvement of SVA from 95 to 35mm and PI-LL from 20 to 5 degrees with good restoral of global alignment. Average 6-month outcome scores: VAS back 8.7 to 3.8, VAS leg 8.7 to 3.0, EQ-5D 0.153 to 0.598, EQ-5D VAS 30 to 73 and ODI 62 to 32. Scores continued to improve in patients reaching 1 year and 2 year follow-up mark. CT scans showed evidence of fusion with no loosening at the 1 year mark.

Conclusions The use of hyperlordotic cages inserted via an OLIF technique with ALL release is an effective surgical strategy in cases of lower lumbar flat back fusion with good associated outcomes.

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FULL-ENDOSCOPIC ANTERIOR DOUBLE ODONTOID SCREW FIXATION IN TYPE II ODONTOID FRACTURES: A COMPREHENSIVE SURGICAL TECHNIQUE AND CASE SERIES

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Objectives To describe the full-endoscopic anterior double odontoid screw fixation (ADOSF) as an innovative surgical method specifically designed to enhance intraoperative visualization and reduce approach-related complications associated with the traditional open anterior approach, and to report the early outcomes of patients treated with this technique at our institutions.

Materials and Methods Patients with acute displaced type II odontoid fractures (Anderson–D'Alonzo type II and Grauer subtype IIA or IIB) who underwent full-endoscopic ADOSF at Maharaj Nakorn Chiang Mai Hospital and Sriphat Medical Center, Chiang Mai, Thailand, between July 2023 and June 2025 were retrospectively reviewed. A detailed surgical technique is described. Clinical demographics, intraoperative data, postoperative imaging, and procedure-related complications were collected and analyzed.

Results Three patients met the inclusion criteria. The mean age was 66.3 years. One patient had a Grauer type IIA fracture, and two had type IIB fractures. All procedures were completed successfully without intraoperative complications or conversion to an open approach. The mean operative time was 99 minutes, and the mean estimated blood loss was 15 mL. Postoperative imaging demonstrated excellent fracture reduction and accurate screw placement in all cases. Bony union was confirmed in one patient via CT scan. The other two patients were lost to in-person follow-up before CT evaluation could be performed; however, long-term clinical assessment via telemedicine revealed complete resolution of neck pain and no functional limitations in all three patients.

Conclusion This study provides the first baseline surgical metrics for full-endoscopic ADOSF, demonstrating it is a feasible and safe minimally invasive surgical option for selected patients with acute, reducible type II odontoid fractures. The detailed surgical technique presented in this study may facilitate wider adoption and support further clinical evaluation of this approach.

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Annular Repair in Endoscopic Lumbar Discectomy: A Narrative Review of Recurrence Prevention and Technical Demonstration Using Unilateral Biportal Endoscopy

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Background Recurrent lumbar disc herniation (RLDH) remains a significant clinical challenge after discectomy, with reported recurrence rates ranging from 5% to 20%. Residual annular defects following nucleus pulposus removal are widely considered a major contributor to re-herniation and subsequent reoperation. Large annular defects (≥6 mm) have been particularly associated with a higher risk of recurrence. However, evidence regarding the effectiveness of annular repair in endoscopic spine surgery remains limited.

Methods A narrative review of the literature was conducted focusing on annular repair following lumbar discectomy and endoscopic techniques. Particular emphasis was placed on studies evaluating recurrence and reoperation rates. Additionally, a surgical video demonstrates the UBE technique for annular repair.

Results Previous systematic reviews and meta-analyses suggest that annular repair may significantly reduce re-herniation and reoperation rates compared with discectomy alone. In a meta-analysis including 1907 patients, annular repair was associated with a significantly lower rate of recurrent disc herniation (4.9% vs 14.6%) and reoperation (4.7% vs 14.3%) compared with controls, although functional outcomes such as VAS and ODI scores were similar between groups.

Technical Note The accompanying surgical video demonstrates UBE annular repair following lumbar discectomy. Key steps include identification of the annular defect, measurement using a calibrated probe under endoscopic visualization, preparation of the annular edges, and closure using an endoscopic suturing device. Indications for repair include large annular defects (≥6 mm), high-risk patients for recurrence, and preserved disc height.

Conclusion Annular repair is a promising adjunct to lumbar discectomy that may reduce recurrence and reoperation, especially in large annular defects. While short-term clinical outcomes are similar to standard discectomy, UBE endoscopic repair is a feasible, minimally invasive option.

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Navigation-Assisted Unilateral Biportal Endoscopic Decompression of Far-Out Compression in Bertolotti's Syndrome: Technical Note

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Far-Out Compression in Bertolotti's Syndrome is a recognized cause of chronic low back pain associated with lumbosacral transitional vertebrae and may present with far-out nerve root compression. We present a technical note demonstrating navigation-assisted unilateral biportal endoscopic (UBE) decompression in a patient with bilateral far-out stenosis and right-sided pseudarthrosis. Real-time navigation facilitated accurate docking, foraminoplasty, nerve root identification, and complete pseudarthrosis resection while preserving the facet joint. Postoperatively, the patient experienced significant pain relief and functional recovery. This video highlights the technical workflow and advantages of navigation-assisted UBE in managing complex transitional anatomy with combined foraminal compression and pseudarthrosis.

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A Motion-to-Load-to-Response Digital Twin Strategy for Rapid Biomechanical Assessment of Instrumented Lumbar Segments

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Introduction/Objectives Rapid biomechanical assessment of instrumented lumbar segments may support surgical decision-making by providing quantitative information on load transfer and tissue-level mechanical response. This study aimed to evaluate a digital twin strategy that decomposes lumbar biomechanical prediction into sequential motion-to-load and load-to-response steps for efficient assessment of normal and instrumented lumbar conditions.
Materials and Methods A hybrid computational framework combining multibody dynamics, finite element analysis, and Kriging surrogate modeling was developed. High-fidelity simulations were generated for physiologic lumbar motions including flexion, extension, lateral bending, and axial rotation. Two sequential surrogate models were trained: the first estimated spinal loading conditions from three-dimensional lumbar kinematics, and the second predicted von Mises stress and displacement under those loads. The framework was applied to both a native lumbar model and a postoperative model with transforaminal lumbar interbody fusion and pedicle screw fixation. Predictive performance was assessed against full-order simulations, and estimated intradiscal pressure was compared with physiologic values reported in the literature.
Result/Discussion The sequential surrogate strategy reproduced full-order biomechanical responses with high accuracy across all motion modes. Mean absolute errors remained below 0.5% in the native model and below 0.2% in the postoperative model. Predicted intradiscal pressure values were within or close to physiologic ranges, supporting biomechanical plausibility. These findings suggest that separating kinematic-to-load estimation from load-to-response prediction can preserve physical interpretability while substantially improving computational efficiency.
Conclusion The proposed motion-to-load-to-response digital twin strategy enabled rapid biomechanical assessment of instrumented lumbar segments with high predictive accuracy. This framework may serve as a practical foundation for quantitative support in preoperative planning, intraoperative assessment, and postoperative monitoring of lumbar fusion procedures.

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Clinical study on spinal tuberculosis with special interest in Rifampicin/drug resistant tuberculosis

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Introduction Drug resistant spinal tuberculosis is an emerging health problem in both developing and developed countries..As literature regarding MDR cases of spinal TB is limited, & this study is focused only on spinal tuberculosis including MDR cases, hence study proves its importance secondly Incidence of MDR TB around 13 to 30% as per literature, However, no separate data is available for spinal TB in India report 2024.
Material and Method This was a prospective study conducted at a tertiary care hospital in central India. All the cases were recruited based on their clinicoradiological and pathological features. All participants had been given antitubercular therapy as per national guidelines at state TB Hospital. The study was done from Jan 2022 to Aug 2024 and included 46 patients.
Results and Discussion Of 46 cases, 06 were diagnosed to have bacteriologically proven MDR-TB of the spine in which 04 were Rifampicin resistant and 02 were resistant to both Isoniazid and Rifampicin. Total 38 patients were operated (MIS screw and rod fixation)) and satisfying the inclusion/exclusion criteria and available for follow-up were included in study. Most of the patients improved with meaningful outcomes as shown per Frankel's Scale.
Conclusion Our data highlights an alarming presence of MDR isolates in tuberculosis of the spine. Hence, it is recommended that drug sensitivity testing should be mandatory in all patients of Pott's spine. Early surgery in case of worsening symptoms in spite of medical management/ deformity/new or recurrent complication to prevent devastating paraplegia or quadriparesis and there is need to standardize the treatment in MDR cases of Pott's spine.

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CAUDA EQUINA SYNDROME: A RARE PRESENTATION OF CAGE MIGRATION FOLLOWING LUMBAR FUSION SURGERY- A CASE REPORT

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Introduction Transforaminal lumbar interbody fusion (TLIF) is a widely accepted surgical technique for the management of degenerative lumbar spondylolisthesis. The procedure allows circumferential decompression, restoration of disc height, and segmental stabilization. Despite favourable outcomes, complications such as interbody cage migration or back-out can occur and may compromise surgical success, necessitating revision surgery.
Case Report We present the case of a 45-year-old male with symptomatic degenerative L4–L5 spondylolisthesis who underwent Minimally Invasive Transforaminal lumbar interbody fusion (MIS-TLIF) after failure of conservative treatment. Postoperatively, the patient developed posterior migration of the interbody cage with neural compression leading to Cauda Equina syndrome. Revision surgery MIS-LTLIF (MIS-TLIF with large footprint cage) was performed with removal of the migrated cage of size 9*22 mm and insertion of a larger footprint interbody cage of size 10*40 mm following meticulous disc space and endplate preparation bilaterally. Post-revision surgery imaging demonstrated stable implant positioning, and the patient showed significant clinical improvement without further complications.
Conclusion Interbody cage back-out following TLIF is a preventable complication. Inadequate disc space preparation and suboptimal cage footprint selection play a significant role in cage migration. Proper surgical technique and appropriate implant choice are essential to ensure construct stability and favourable clinical outcomes.

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Beyond the Buzz: What Healthcare Providers Really Think About Robotic Spine Surgery

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Robotic spine surgery is an emerging technology that offers clinical advantages over conventional techniques, including improved accuracy, enhanced navigation, and reduced radiation exposure. However, adoption remains inconsistent due to cost, training demands, and perceived limitations. This study aims to examine and provide insight into the perceptions of robotic spine surgery among healthcare providers and its implications for clinical practice and technology adoption.

A cross-sectional survey was conducted among 68 healthcare providers, including junior doctors, residents, consultants, and operating room nurses in the orthopaedics surgery and neurosurgery departments at a single tertiary institution. An anonymous 20-item questionnaire assessed perceptions, experience, advantages, and challenges using Likert scales. Spearman's rank correlation was used to evaluate associations between experience and perceived benefits.

Perceptions of robotic spine surgery were generally favourable, particularly for enhanced precision (78%), reduced human error (79%), and improved outcomes (66%), with more modest confidence in reduced complications (51%). 66% of respondents had prior experience with the technology, and experience levels increased with seniority. Junior clinicians showed lower exposure and more neutral views. Experience demonstrated weak but statistically significant associations with perceived benefits, and a moderate association with the likelihood of recommending this technology to others. Key advantages reported included precision (86.8%) and efficiency (56%). Major barriers were high cost (86.8%) and training requirements (70.6%). Most respondents (79%) anticipated robotic surgery becoming standard practice, as an adjunct rather than a replacement for surgical expertise.

Perceptions of robotic spine surgery are positive, with recognised benefits in precision, workflow, and reduced human error. However, variability exists across experience levels, which likely reflects differences in exposure rather than resistance. Barriers such as cost and training represent implementation challenges, not limitations of the technology. Overall, robotic spine surgery is an important adjunct in modern spinal care, with adoption expected to increase with improved training and accessibility.

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Single-Incision Full Endoscopic Decompression for Two-Level Lumbar Stenosis Achieves Similar Outcomes with Reduced Operative Time

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Introduction Full endoscopic spine surgery (FESS) is an evolving minimally invasive spine surgery offering reduced soft tissue disruption and faster recovery. Multi-level decompression traditionally requires multiple incisions; however, a single-incision technique has recently been described. Direct comparison between single- and multiple-incision approaches for multi-level FESS decompression has yet to be described. This study aims to compare the clinical and perioperative outcomes between single- and multiple-incision techniques.

Materials and Methods A single-center retrospective review was conducted of patients undergoing primary contiguous two-level FESS decompression laminectomy from Jan 2024 to Dec 2025. Patients with prior lumbar spine surgery, trauma, infection or tumor were excluded. Patients were grouped by technique: single incision (S) or multiple incision (M). Outcomes included operative time, fluoroscopy time, complications and functional outcomes measured at preoperatively and at 6 months post-operatively. These include visual analogue scale (VAS) for back pain, leg pain and leg numbness and North America Spine Society (NASS) lumbar spine outcome assessment instruments (Oswestry Disability Index (ODI) and Neurogenic Symptoms score).

Results 42 patients met the inclusion criteria (26 S, 16 M). Baseline demographics and preoperative functional scores were comparable between groups. Both groups demonstrated significant improvements in VAS back pain, leg pain, leg numbness and NASS ODI and Neurogenic Symptoms scores at 6 months, with no significant differences in magnitude of improvement and absolute scores. The S group had significantly shorter operative time compared to the M group (S 97.7min vs M 126.3min p = 0.001). There was no significant difference in fluoroscopy time. No complications such as dura tears or wound infections were encountered for both groups.

Conclusion Single-incision FESS for contiguous two-level lumbar stenosis achieves comparable clinical outcomes to conventional multiple-incision approach with added benefits of fewer skin incisions and reduced operative times. This technique represents an efficient alternative for multi-level endoscopic decompression.

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Allograft vs Bioactive Glass-Ceramic Cages in Anterior Cervical Discectomy and Fusion: Long-Term Randomized Trial Follow-up

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Study design Observational extended follow-up of a randomized controlled trial.

Objective To compare mid- to long-term clinical and radiographic outcomes of allograft versus bioactive glass-ceramic (BG) cages for anterior cervical discectomy and fusion (ACDF) while preserving the original random allocation.

Methods All patients randomized in the parent RCT underwent 1-2 level ACDF between August 2017–August 2022 (allograft n=18; BG n=22) were followed through August 2025. We compared patient-reported outcomes—neck disability index (NDI) and visual analogue scale (VAS)—cervical sagittal alignment, including C2–7 lordosis (CL), T1 slope, and T1 slope minus cervical lordosis (T1sCA), and CT–based subsidence using adjusted linear mixed-effects models (LMMs); fusion (Bridwell I–II) was compared between groups.

Results Among 40 patients, 90% had follow-up longer than 24 months with mean follow-up 53.5±25.2 months. Both groups showed significant within-group improvements in all patient reported outcomes. However, at the last visit, between-group differences were non-significant for the primary endpoints: NDI (BG–allograft −0.98, 95% CI −9.17 to 7.21; p = 0.814) and C2–7 lordosis (BG–allograft −0.19°; p = 0.917). Other endpoints (VAS, T1sCA, subsidence, fusion) were likewise similar. No cage breakage or migration occurred; adverse events were minor.

Conclusion Over multi-year follow-up, bioactive glass-ceramic cages provided equivalent clinical improvement and radiographic stability to allograft cages after ACDF.

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Synergistic Correction with Combined MIS-Pedicle Subtraction Osteotomy and Anterior Column Realignment Enabling 40° Sagittal Realignment in Short Fusion: A Technical Case Report

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Background Minimally invasive surgery (MIS) techniques for adult spinal deformity (ASD) are generally associated with limited correction per level. While anterior column realignment (ACR) can restore segmental lordosis through anterior longitudinal ligament (ALL) release, and MIS-pedicle subtraction osteotomy (MIS-PSO) provides powerful three-column correction, the combined application of these techniques has not been previously reported. We describe a novel strategy combining MIS-PSO and ACR to achieve substantial sagittal correction with short-segment fusion.

Case Description A 69-year-old female presented with severe low back pain and bilateral leg pain. Radiographs demonstrated spontaneous fusion at L4–5 with 24° local kyphosis. Global alignment parameters revealed lumbar lordosis (LL) of 17°, lower lumbar lordosis of 0°, PI–LL mismatch of 46°, and sagittal vertical axis (SVA) of 152 mm. The proximal lumbar spine above L3 showed preserved disc height and alignment without significant degeneration. The patient underwent lateral L3–4 ACR in the lateral decubitus position, followed by percutaneous pedicle screw (PPS) guidewire insertion from L3 to SAI in the prone position. Through a separate midline incision, L5 MIS-PSO was performed using an egg-shell technique to achieve three-column osteotomy through a limited exposure.
Results ACR provided 11° of segmental lordosis, and MIS-PSO contributed an additional 29°, achieving a total sagittal correction of 40°. Postoperative parameters improved to LL 57°, PI–LL mismatch 4°, and SVA 34 mm. At 2-year follow-up, alignment was well maintained without mechanical complications.
Conclusion ACR enables anterior column lengthening and restoration of segmental lordosis, whereas MIS-PSO provides powerful posterior three-column correction through a minimally invasive approach. The synergistic combination of these techniques allowed approximately 40° sagittal correction with short-segment fusion while preserving proximal motion segments. This strategy may represent a novel minimally invasive option for selected ASD patients requiring substantial correction without long-segment fusion.

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Evaluation of Neuromuscular Function via Surface Electromyography in Lumbar Disc Herniation: A Clinical Study

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Background Lumbar disc herniation (LDH) often leads to lower limb pain and muscle strength decline. Even after decompression, restoring muscle strength remains clinically challenging. While surface electromyography (sEMG) is routinely used to monitor neurological function, its application in assessing specific muscle function is less common. This study aimed to investigate muscle functional states preceding muscle strength decline following nerve injury.
Methods Twenty patients with L4/5 LDH (unilateral pain >3 months, no comorbidities, M.R.C. Manual Muscle Testing grade 5 muscle strength) were recruited as the observation group, alongside 20 healthy controls. Bilateral tibialis anterior muscle activity was recorded during contraction using an SG-1600B sEMG system (Zhejiang DNO Medical Technology Co. Ltd.). Key parameters included root mean square (RMS), average electromyography (AEMG), mean power frequency (MPF), and median frequency (MF).
Results In the healthy group, no significant bilateral differences were observed across all sEMG parameters. In the LDH group, while RMS, MPF, and MF showed no significant differences between symptomatic and asymptomatic limbs, the AEMG of the symptomatic limb was significantly lower than that of the asymptomatic side ( ).
Conclusion Patients with L4/5 LDH exhibit a significant decrease in AEMG values in the affected lower limb even in the absence of overt muscle strength decline. This suggests that AEMG can detect subclinical impairment of muscle function before the occurrence of limb strength reduction.

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Morphometric Feasibility of Anterior Double 3.0-mm Herbert Screw Fixation for Odontoid Fractures in an Asian Population: A Three-Dimensional CT-Based Study

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Objectives To evaluate the morphometric feasibility of anterior double 3.0-mm Herbert screw fixation of the odontoid process in a Southeast Asian population using three-dimensional computed tomography and to determine the optimal screw length and insertion trajectory.
Methods This retrospective observational study reviewed cervical spine CT data from patients presenting to the emergency room of Chiang Mai University Hospital between January 2015 and December 2023. After exclusions, 315 adult Thai patients were included. Three-dimensional models of C2 were reconstructed from DICOM CT data using MIMICS software, and virtual 3.0-mm Herbert screws were inserted using dedicated modeling software. Odontoid anteroposterior, transverse, and sagittal diameters were measured. Screw feasibility, screw length, sagittal and coronal insertion angles, and inter-screw distance at the insertion point were analyzed. Measurements were independently performed by three experienced spine surgeons
Result Among 315 patients, 225 were male and 90 were female, with mean age of 40.4 ± 18.6 years. Mean odontoid dimensions were 11.07 ± 0.89 mm for anteroposterior diameter, 9.25 ± 0.86 mm for transverse diameter and 37.69 ± 3.08 mm for sagittal diameter. Male had significantly greater anteroposterior and sagittal diameters than females (both $P < 0.001$), whereas transverse diameter was not significantly different ($P = 0.058$). The feasibility of anterior double 3.0-mm Herbert screw fixation was 100%. Mean coronal screw angle was 4.66 ± 0.69°, mean sagittal screw angle was 14.84 ± 2.07°, mean screw length was 34.41 ± 2.39 mm, and mean inter-screw distance at the insertion point was 5.71 ± 0.76 mm. Screw length was significantly greater in males than females ($P < 0.001$), while insertion angles and inter-screw distance did not differ significantly between sexes.
Conclusions Anterior double 3.0-mm Herbert screw fixation of the odontoid process is morphometrically feasible in Asian population based on 3D-CT analysis. Although males required longer screws than females, screw trajectory and insertion point parameters were comparable between sexes.

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The role of Enhanced Recovery After Surgery (ERAS) pathway in Lumbar Endoscopic Procedures: Predictors of Early Discharge

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Introduction/Objectives Enhanced Recovery After Surgery (ERAS) has revolutionised spine surgery by integrating peri-operative strategies through evidence-based medicine to improve recovery and reduce the length of hospital stay. We aim to identify factors associated with early discharge following elective lumbar spine surgery conducted under an institutional ERAS protocol.
Materials and Methods A total of 108 consecutive patients were included in this study between January 2024 and October 2025. Procedures performed under the ERAS protocol consisted of endoscopic lumbar discectomy, endoscopic lumbar decompression, minimally invasive lumbar discectomy and minimally invasive lumbar decompression. Demographic, surgical and peri-operative variables were collected. The primary outcome was length of stay post-operatively. Univariate and multivariate linear regression analyses were conducted to identify factors independently associated with the length of stay.

Result/Discussion The mean length of inpatient stay was 1.5 ± 1.0 days. On univariate analysis, age ($p < 0.001$), gender ($p = 0.041$), American Society of Anaesthesiologists (ASA) score ($p = 0.004$), type of surgery ($p = 0.014$), duration of surgery ($p = 0.017$) and immediate complications ($p = 0.007$) were all significantly associated with length of stay. However, after multivariate adjustment, only age (B = 0.018, 95% CI 0.004–0.033, $p = 0.011$) remained as a significant independent predictor.

Conclusion The implementation of an ERAS protocol for lumbar spine surgery is safe and reduces the overall length of inpatient hospital stay. Younger age was the only independent predictor of facilitating early discharge. These findings support the successful application of ERAS, particularly in younger patients undergoing lumbar endoscopic procedures.

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Stand-Alone Transforaminal Endoscopic Lumbar Discectomy for Disc Herniation Coexisting with Spondylolysis: Clinical and Radiographic Outcomes over 5-Year Follow-Up

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Introduction/Objectives Symptomatic disc herniation coexisting with spondylolysis is a rare clinical entity with limited evidence guiding surgical decision-making. This study aimed to assess the clinical and radiographic outcomes of stand-alone transforaminal endoscopic lumbar discectomy (TELD) for this indication over medium-term follow-up.

Materials and Methods Twelve patients with symptomatic disc herniation at the level of asymptomatic spondylolysis or an adjacent level who underwent stand-alone TELD under local anesthesia, identified from 443 consecutive lumbar discectomies (2.7%), were retrospectively analyzed. Outcomes included VAS (back/leg), ODI, MacNab criteria, and radiographic parameters including spondylolisthesis grade, disc height, lumbar lordosis, spinopelvic alignment, Pfirrmann and Pathria grades.

Result/Discussion Mean age was 50.50 ± 17.15 years; mean follow-up, 59.58 ± 41.12 months. VAS/back improved from 6.08 ± 2.39 to 2.17 ± 2.29 ($p = 0.001$), VAS/leg from 6.83 ± 1.53 to 1.25 ± 2.56 ($p = 0.001$), and ODI from 51.57 ± 16.82 to 14.97 ± 17.06 ($p < 0.001$). MacNab outcomes were good/excellent in 91.7%. No surgical complications occurred. Radiographic parameters remained stable throughout follow-up, except in one patient with bi-level spondylolysis, who required fusion at 69 months due to progression of spondylolisthesis. The results of this cohort demonstrated significant, durable improvements in both back and leg pain, with consistently high satisfaction levels and no evident deterioration in clinical outcomes during a mean follow-up of approximately 5 years.

Conclusion Stand-alone TELD is a viable, tissue-sparing alternative for disc herniation coexisting with spondylolysis in carefully selected patients, demonstrating durable symptom relief over 5-year follow-up without accelerated degeneration. Multi-level spondylolysis and pre-existing instability may represent a contraindication for this approach. Future multi-center studies are needed to further define optimal patient selection criteria.

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Comparing the perioperative and postoperative outcomes of interlaminar and transforaminal endoscopic lumbar facet cyst removal: A systematic review and meta-analysis

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Introduction Endoscopic lumbar facet cyst (LFC) resection is an effective alternative to open techniques, with improved perioperative outcomes, but literature comparing different endoscopic approaches for this pathology is lacking. This systematic review and meta-analysis aims to compare the outcomes of interlaminar and transforaminal endoscopic LFC resection.

Materials and Methods The study was conducted following PRISMA 2020 guidelines and registered on PROSPERO (CRD42025641852). A systematic search was performed across PubMed, Cochrane Library, CINAHL, Embase and Web of Science. Primary studies that reported on endoscopic facet cyst resection via an interlaminar or transforaminal approach were included. Extracted data was analyzed using R. Single-arm meta-analysis of proportions and pairwise meta-analysis of odds ratios were performed for dichotomous outcomes, while single-arm and pairwise meta-analysis of means were performed for continuous outcomes.

Results Six studies involving 172 patients were included. No significant difference was found between the two approaches for operative time, dural tear, nerve injury, residual cyst, recurrence, length of stay, instability, MacNab and Oswestry Disability Index scores. The interlaminar group had a smaller incidence of transient postoperative dysesthesia (OR = 0.04; 95% CI 0.01–0.23; $p = 0.0003$; $I^2 = 0\%$) and a greater decrease in Visual Analog Scale scores (OR = -1.25; 95% CI -1.73 to -0.77; $p < 0.0001$; $I^2 = 0\%$).

Conclusion Both interlaminar and transforaminal approaches are safe and effective. The choice of approach should depend on cyst location, cyst level, surgeon familiarity, and consider the greater risk of transient postoperative dysesthesia with the transforaminal approach.

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Clinical Outcomes of a Surgical Strategy Following Infection Control for Pyogenic Spondylitis

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Introduction / Objectives Treatment strategies for pyogenic spondylitis vary among institutions, and recent studies have suggested the potential benefits of early surgical intervention. However, surgery during the active phase of infection may increase the risk of complications. At our institution, conservative treatment with antibiotics is the first-line approach, and surgery is performed after infection control in patients with spinal instability or neurological deficits. This study aimed to compare clinical outcomes between surgical and conservative cases and to evaluate the usefulness of a delayed surgical strategy.

Materials and Methods We retrospectively reviewed 108 patients with pyogenic spondylitis treated at our institution, including 34 surgical and 74 conservative cases. The following variables were analyzed: age, sex, length of hospital stay, duration of antibiotic therapy, presence of diabetes mellitus, history of dialysis, neurological deficits, rate of pathogen identification, and presence of epidural abscess.

Results / Discussion The median age was 66 years (range, 17–87) in the surgical group and 74 years (range, 9–94) in the conservative group. The median length of hospital stay was 45 days (range, 12–156) in the surgical group and 46 days (range, 4–227) in the conservative group. The median duration of antibiotic therapy was 15

days (range, 3–73) and 20 days (range, 0–87), respectively. In the surgical group, 4 patients had neurological deficits and 5 had epidural abscesses. The rate of pathogen identification was 35% in the surgical group and 73% in the conservative group. Two in-hospital deaths occurred in the conservative group, while none occurred in the surgical group. Delayed surgery after infection control was performed safely without severe postoperative complications.
Conclusion A surgical strategy following infection control may be a safe and effective treatment option for pyogenic spondylitis, with its clinical benefits outweighing the potential for a longer hospital stay.

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Who Stays and Who Goes? A Preoperative and Intraoperative Risk Stratification Model to Predict Admission After Lumbar Spinal Fusion
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Introduction Increasing demands on inpatient beds at acute hospitals highlight the need for timely discharge planning, particularly after elective surgeries such as lumbar spinal fusion. A significant proportion of these patients require step-down rehabilitation at community hospitals (CHs), yet discharge planning remains largely reactive with a lack of predictive criteria to guide discharge disposition.
Objective To develop and validate a novel scoring system for predicting community hospital admission following single or double-level lumbar spinal surgery.
Methods A retrospective analysis was conducted on a prospectively collected cohort of 189 patients who underwent single or double-level lumbar spinal fusion between 2019 and 2023 at a tertiary hospital. Preoperative, intraoperative, and postoperative variables were analysed using univariate analysis to identify predictors of CH discharge. A scoring system was developed by assigning point values (1 or 2 points) to significant variables. Receiver operating characteristic (ROC) analysis and Youden's index were used to optimize the model and establish a cut-off score to stratify patients into low, moderate, and high-risk groups.
Results Of the 189 patients, 75 (32.6%) required CH admission postoperatively. Significant predictors included female sex (OR = 3.462), osteoporosis (OR = 7.780), preoperative use of walking aids (OR = 4.444), ASA >2 (OR = 3.643), and intraoperative transfusion (OR = 6.400). The final scoring model achieved an AUC of 0.806, with female sex and ASA >2 as minor criteria (1 point), while osteoporosis, preoperative walking aid use, and transfusion were major criteria (2 points). Age was not a risk factor for CH admission. A total score ≥4 was identified as the optimal cut-off for predicting CH admission.
Conclusions This scoring system facilitates early identification of patients requiring CH admission after lumbar spinal fusion, supporting anticipatory care planning. Its integration into preoperative workflows can assist in improving hospital bed utilization and streamlining transitions of care.

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Risk Factors of Cage Subsidence in OLIF51: Influence of Endplate Sclerosis and Cage Placement
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Introduction Oblique lateral interbody fusion at L5/S1 (OLIF51) enables anterior longitudinal ligament release and restoration of lordosis via an anterior approach. However, cage subsidence (CS) may occur, limiting correction. This study investigated risk factors for CS after OLIF51.
Methods We retrospectively analyzed 122 patients with lumbar degenerative disease who underwent OLIF51 by a single surgeon (December 2022 onward). Patients were divided into a non-CS group (NCS, n=106) and a CS group (n=16). We evaluated spinopelvic parameters, segmental lordosis, disc height, endplate sclerosis, cage parameters, L5 vertebral Hounsfield units (HU), and cage position (anterior vs posterior relative to the midpoint of the endplates). CS was defined as ≥2 mm endplate discontinuity on CT.
Results No significant differences were observed in demographics or spinopelvic parameters. The NCS group had significantly higher L5 HU (167 vs 120) and a higher rate of endplate sclerosis (72% vs 21%). Final segmental lordosis (18° vs 12°) and anterior disc height (16 mm vs 11 mm) were significantly greater in the NCS group. Cage position differed significantly: anterior placement was more common in the NCS group (79%), whereas posterior placement was predominant in the CS group (75%). Multivariate analysis identified posterior cage placement and absence of endplate sclerosis as independent risk factors. CS incidence was 85% when both were present and 41% when either was present.
Conclusion Posterior cage placement, especially in patients with low HU, increases the risk of CS. Cage positioning should consider endplate strength to minimize subsidence.

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Fully Endoscopic Decompression of Flaval Cyst causing myelopathy: A case report and review of literature
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Introduction Flaval cysts are benign lesions arising from the ligamentum flavum. Although rare in the thoracic spine, they can cause significant spinal cord compression and myelopathy. While open surgical decompression is well described, the role of full endoscopic spine surgery (FESS) in the thoracic spine remains limited due to technical and anatomical challenges. We present a rare case of thoracic myelopathy secondary to a facet joint cyst treated with FESS, together with a focused literature review.
Methods A 57-year-old male presented with progressive gait instability, recurrent falls, bilateral lower-limb weakness, and mild urinary incontinence. Magnetic resonance imaging of the thoracic spine demonstrated a 1.0 × 1.0 cm posterior epidural cyst at T11–12 causing severe canal stenosis and spinal cord compression with signal changes suggestive of myelomalacia. He underwent successful right-sided T11–12 uni-portal endoscopic decompression and cyst marsupialization, with resolution of his symptoms postoperatively.
Discussion Full endoscopic spine surgery (FESS) is an emerging minimally invasive technique for neural decompression. Despite technical challenges in the thoracic spine, owing to the challenging anatomy and a steep learning curve, in the hands of an experienced operator, it offers advantages including improved visualization, reduced blood loss, and shorter hospital stay.
Conclusion FESS represents a promising treatment option for selected thoracic facet cysts and other compressive pathologies, although further studies are required to better define its role.

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Does Lung Primary Necessarily Mean Poor Prognosis in Spinal Metastases

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Objectives To identify predictors of mortality in lung cancer patients undergoing surgery for spinal metastases and develop a simple biomarker-based prognostic score.
Background Lung cancer is the most common primary tumour in patients undergoing surgery for spinal metastases, yet outcomes are increasingly heterogeneous. Although female patients with lung cancer often demonstrate superior survival, whether this advantage persists in surgically treated spinal metastases remains unclear. Serum albumin and neutrophil-to-lymphocyte ratio (NLR), though readily available and prognostically valuable, remain underutilised.
Methods We retrospectively analysed 64 lung cancer patients undergoing surgery for spinal metastases (2003-2022). Primary outcomes were 90-day and 1-year mortality. Candidate predictors included sex, preoperative albumin and NLR. A 2-point risk score (albumin <35 g/L and NLR ≥6) was evaluated using logistic regression and ROC analysis.
Results Overall 90-day and 1-year mortality were 21.9% and 51.6%. Female sex was strongly protective, with 90-day mortality of 8.1% versus 40.7% in males (p=0.002) and 1-year mortality of 40.5% versus 66.7% (p=0.039). Hypoalbuminaemia and elevated NLR independently predicted mortality at both timepoints. The biomarker score effectively stratified risk, with 90-day mortality of 4.3%, 20.7% and 58.3% for scores 0, 1 and 2 (p=0.001) and 1-year mortality of 26.1%, 58.6% and 83.3% (p=0.003). The score demonstrated good discrimination (AUC 0.778 for 90-day and 0.725 for 1-year mortality).
Conclusions Female sex and a simple albumin-NLR score effectively stratified survival after surgery for spinal metastases from lung cancer. Patients with score 0 had favorable outcomes supporting surgical candidacy, whereas those with score 2 had poor prognosis warranting non-operative or more selective management. These findings challenge the notion that lung primary uniformly confers poor surgical outcomes and provide practical tools for preoperative risk stratification.

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THE TRANSORAL ENDOSCOPIC APPROACH(TEA) TO THE UPPER CERVICAL SPINE : A COMPREHENSIVE SURGICAL TECHNIQUE, FEASIBILITY, AND OUTCOMES IN A CASE REPORT

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Introduction/Objectives The craniovertebral junction (CVJ) is a complex anatomical region where ventral compression can lead to significant neurological compromise. The traditional transoral microscopic approach provides direct access but is associated with considerable morbidity. The Transoral Endoscopic Approach (TEA) is a minimally invasive technique that improves visualization and reduces tissue disruption. This study aims to describe a standardized TEA technique and evaluate its clinical feasibility and outcomes, with a representative case presented.
Materials and Methods A stepwise TEA technique was applied, including positioning, corridor creation, full-endoscopic odontoidectomy, and posterior stabilization. A retrospective review of patients undergoing TEA at a single institution was performed, assessing clinical and radiographic outcomes.
Results/Discussion The TEA technique achieved effective ventral decompression with early neurological improvement and low complication rates. Patients resumed oral intake early without major complications such as infection or cerebrospinal fluid leakage. Radiographic analysis demonstrated adequate decompression, stable alignment, and successful fusion. The endoscopic approach provides enhanced visualization and minimizes soft tissue injury compared with conventional techniques.
Conclusion The Transoral Endoscopic Approach is a safe and effective minimally invasive technique for anterior CVJ pathology. When combined with posterior stabilization, it offers a comprehensive treatment strategy and may represent an important advancement in modern spine surgery.

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A Comprehensive Framework for the Radiographic Assessment of Lumbar Pedicle Screw Instrumentation: Review of literature and a new proposed criteria assessment

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Background Accurate pedicle screw placement is essential for spinal stability and neural safety. Existing assessment systems, including the Gertzbein–Robbins and related modifications, largely focus on cortical breach magnitude, typically using 2-mm incremental or in–out classifications. While these radiographic systems standardize reporting, they overlook biomechanical and trajectory-related parameters that critically influence construct performance and long-term outcomes.
Objective To review current pedicle screw accuracy assessment systems, identify their limitations, and propose a new evidence-based, multidimensional classification that integrates mechanical and trajectory considerations relevant to modern image-guided and robotic spine surgery.
Methods A narrative review of the literature was conducted to critically appraise existing pedicle screw accuracy grading systems and relevant biomechanical evidence regarding cortical breach, screw sizing, trajectory alignment, and facet joint violation. Findings were synthesized to develop a novel multidimensional classification framework for CT-based assessment of lumbar pedicle screw placement.
Results Current classifications primarily quantify breach extent without accounting for pedicle fill ratio, screw length optimization, sagittal alignment, or facet joint preservation. Recent biomechanical studies demonstrate that screw trajectory parallel to the superior endplate reduces cyclic stress and loosening, while adequate screw-to-pedicle occupancy improves pull-out strength. Based on these findings, the proposed model incorporates three key domains: (1) cortical breach integrity, (2) dimensional optimization, and (3) trajectory alignment, including axial convergence, sagittal orientation, and facet joint integrity. This multidomain framework links radiographic precision with mechanical stability and clinical safety.
Conclusions Current pedicle screw accuracy assessments are limited by their narrow radiographic scope. The proposed multidimensional classification provides a comprehensive, clinically relevant framework that unifies breach, mechanical, and trajectory parameters. This approach reflects the demands of modern minimally invasive and robotic-assisted spine surgery and may improve prediction of neurologic, vascular, and mechanical complications.

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Comparative Analysis of Uniportal and Biportal (Contralateral and Ipsilateral) Endoscopic Spine Surgery for Cervical Foraminal Stenosis: Clinical and Radiographic Outcomes

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Purpose To compare the clinical and radiographic outcomes of uniportal, contralateral biportal, and ipsilateral biportal endoscopic spine surgeries for cervical foraminal stenosis.

Material & methods This retrospective cohort study included 147 patients with cervical foraminal stenosis who underwent endoscopic spine surgery from single specialized hospital. The patients were divided into three groups: uniportal (n=54), contralateral biportal (n=44), and ipsilateral biportal (n=49). Clinical outcomes were assessed using operative time, complications, Macnab grading, and VAS scores for neck and arm pain. Radiographic outcomes included midforaminal diameter (MFD), distal foraminal diameter (DFD), midforaminal height (MFH), facet joint resection rate, and sagittal alignment change. Statistical analysis was performed to compare the outcomes between the groups using appropriate tests.

Results All surgical procedures resulted in similar clinical outcomes in terms of arm and neck pain reduction, operative time, and postoperative Macnab grading. Complication rates were low and comparable across all groups (p=0.553). The mean reduction in VAS scores for neck pain was 4.04 ± 1.46 in the uniportal group, 3.30 ± 1.69 in the contralateral biportal group, and 3.84 ± 1.52 in the ipsilateral biportal group (p=0.107). Most radiographic parameters, including foraminal expansion ratios for MFD, DFD, and MFH, were similar among the groups. However, the contralateral biportal group had a significantly narrower facet joint width postoperatively (p=0.014) and a higher, though not statistically significant, facet joint resection rate (p=0.054).

Conclusion All three endoscopic surgical approaches provided similar clinical outcomes and radiographic improvements for cervical foraminal stenosis. The contralateral biportal approach resulted in a significantly narrower facet joint width postoperatively and a higher facet joint resection rate compared to the uniportal and ipsilateral biportal approaches. Long-term outcomes should be followed to further assess the benefits and potential risks of these surgical techniques.

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Development of a Predictive Model for Clinically Meaningful Functional Improvement Following Anterior Cervical Procedures

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Introduction: Both anterior cervical discectomy and fusion (ACDF) and artificial disc replacement (ADR) are effective treatments for cervical degenerative conditions, yet optimal patient selection criteria remain undefined. This study aims to develop a predictive model to identify baseline characteristics associated with achieving clinically meaningful functional improvement at 2-year follow-up.

Materials and Methods A retrospective study of patients who underwent ACDF (n=201) or ADR (n=96) for cervical degenerative conditions at a tertiary institution was conducted. The primary outcome was achievement of ≥30% improvement in Neck Disability Index (NDI), representing the established minimal clinically important difference. Baseline variables examined were age, gender, pre-operative NDI, Japanese Orthopaedic Association (JOA) score, Visual Analog Scale (VAS) for neck and arm pain, neurogenic symptom score (NSS), and total cervical range of motion (ROM). Multivariable logistic regression was used to develop the predictive model. Model discrimination was assessed using area under the receiver operating characteristic curve (AUC); calibration was evaluated with the Brier score.

Results/Discussion At 2-year follow-up, 76.1% of patients achieved ≥30% NDI improvement (78.1% ADR vs 75.1% ACDF, p=0.571). Independent predictors of NDI success were pre-operative NDI (OR=1.08, p<0.001), VAS neck pain (OR=0.81, p=0.004), and JOA score (OR=1.19, p=0.02). Surgical technique, age, ROM, VAS arm pain, and NSS were not significant predictors (p>0.05). The final predictive model demonstrated good discrimination (AUC=0.747) and calibration (Brier score=0.164). Among patients with predicted probability ≥0.70, 82.6% (180/218) achieved successful outcomes, demonstrating that this model has high positive predictive value.

Conclusion Patients with higher baseline disability, lower neck pain severity, and better neurological function were more likely to achieve successful outcomes regardless of surgical technique. This predictive model, which uses preoperative patient-reported parameters, demonstrates good discriminative ability to predict clinically meaningful functional improvement following anterior cervical spine surgery. These findings may assist in preoperative counselling and expectation setting.

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Separation Surgery versus Gross Total Resection for Spinal Metastases: Perioperative Outcomes and Overall Survival in a Single Center Retrospective Cohort

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Introduction Surgical management of spinal metastases aims to relieve neural compression and restore stability. While GTR offers maximal cytoreduction, SS facilitates effective postoperative SBRT with potentially lower morbidity. The relative benefits of each approach remain under debate.

Methods Patients who underwent surgery for spinal metastases between 2015 and 2022 were retrospectively reviewed and categorized as GTR or SS. Baseline characteristics included Eastern Cooperative Oncology Group (ECOG) performance status, Spinal Instability Neoplastic Score (SINS), and Bilsky Epidural Spinal Cord Compression (ESCC) grade. Tumor histologies were balanced according to radioresistance classification. Perioperative outcomes included estimated blood loss, operative time, complication rate, and length of stay. Progression-free survival (PFS) and overall survival (OS) were analyzed using Kaplan–Meier methods and compared with the log-rank test. Cox regression identified independent predictors of survival.

Results Thirty-nine patients were included (15 GTR, 24 SS). Baseline demographics, ECOG, SINS, ESCC, and radiotherapy status were comparable between groups. SS resulted in significantly lower intraoperative blood loss and fewer complications than GTR (p = 0.003, p = 0.037), while operative time and hospital stay did not differ (p = 0.598, p = 0.831). PFS, OS, and mortality rates were also similar between groups (p = 0.851, p = 0.765, p = 0.908). On multivariate analysis, female sex and preoperative ECOG independently predicted OS but not PFS.

Conclusion Separation surgery achieved equivalent oncologic control to gross total resection with lower blood loss and complication rates. When postoperative SBRT is planned, SS represents a lower-morbidity alternative that achieves adequate decompression and facilitates high-dose radiotherapy without compromising survival outcomes.

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A Tailored Approach to Midline Disc Herniation: Microdiscectomy and Dynamic Stabilization in Focus

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Introduction Midline disc herniation (MDH) is a rare and challenging condition with no consensus on the optimal surgical approach. While microdiscectomy alone remains a common treatment, the role of dynamic stabilization in preventing recurrence and postoperative instability remains unclear.
Methods A retrospective analysis was conducted on 54 patients who underwent surgery for MDH between 2018 and 2021. Patients were divided into two groups: 33 underwent microdiscectomy alone, while 21 received additional dynamic stabilization. The primary inclusion criteria included neurogenic or radicular pain, chronic low back pain unresponsive to conservative treatment, and radiological evidence of disc herniation at L4-5 or L5-S1. Clinical outcomes were assessed using the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) preoperatively and at regular postoperative intervals. Radiological factors such as Pfirrmann grade, annular tear size, sacralization, and Modic changes were analyzed.
Results Both groups demonstrated significant improvement in pain and disability scores over time. Although patients with annular tears >15 mm reported higher postoperative pain ($p = 0.048$), other radiological parameters, including sacralization, Pfirrmann grade, and Modic changes, did not significantly affect outcomes. While early postoperative pain was slightly lower in the dynamic stabilization group, long-term results were comparable between the two groups. The study underscores the importance of patient selection, as stabilization was reserved for those with sacralization, Pfirrmann grade ≥3, Modic degeneration, or recurrent herniation, mitigating the need for revision surgery.
Conclusion Dynamic stabilization is a valuable adjunct to microdiscectomy in select MDH cases, particularly in patients at higher risk of postoperative instability. Proper patient selection based on radiological and clinical parameters enhances surgical outcomes, reducing recurrence rates and improving overall patient satisfaction. Future prospective studies with larger cohorts are needed to further refine surgical decision-making in MDH management.

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Comparative Risk of Instrumentation Failure in Dynamic and Rigid Spinal Stabilization: A Propensity-Matched Cohort Study

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Introduction Dynamic systems, while conceptually appealing, are not free from implant-related complications and require careful patient selection and long-term monitoring. Thus, the optimal strategy for stabilization remains debated.
Methods Retrospective analysis was conducted on 952 patients who underwent thoracic, thoracolumbar, thoracolumbosacral, lumbar, or lumbosacral instrumentation between 2018 and 2024. Instrumentation failure was identified in a subgroup of 106 patients. Propensity score matching (1:1 nearest-neighbor, caliper 0.1) was applied using age, sex, osteoporosis, fusion length, and involvement of S1 as the lowest instrumented vertebrae, yielding two balanced cohorts of 196 dynamic and 196 rigid stabilized cases. Survival differences were assessed by Kaplan–Meier and log-rank ests, and multivariable Cox regression was performed in both the full cohort and matched groups to identify potential risk factors.
Results The overall failure rate was 11.1%, significantly higher in rigid constructs (22%) compared to dynamic systems (6.7%, $p<0.001$). In the matched cohort, failure remained more frequent in the rigid group (24.5% vs. 10.7%, $p<0.001$). Survival analysis demonstrated earlier and more frequent failure in rigid systems (log-rank $p<0.01$). On Cox regression, rigid stabilization (HR=2.83, 95% CI 1.41–5.68), osteoporosis (HR=4.40, 95% CI 2.08–9.27), PI–LL mismatch (HR=1.03 per degree, 95% CI 1.01–1.06), and older age (HR=1.27, 95% CI 1.04–1.54) independently predicted failure, consistently in both the overall cohort and the propensity score matched analysis.
Conclusion Restoration of sagittal alignment and consideration of patient-specific factors such as bone quality and spinopelvic morphology appear crucial in preventing hardware-related complications. These findings support the selective use of dynamic systems in appropriately chosen patients to enhance implant longevity and reduce mechanical failure.

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Triple level cervical disc arthroplasty: an effective alternative to ACDF or hybrid procedures in multilevel cervical degenerative disc disease.

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Introduction Anterior cervical discectomy and fusion (ACDF) has traditionally been the gold standard of treatment for cervical degenerative disc disease. However, segmental immobilisation after fusion may lead to adjacent segment disease. Single to double level cervical disc arthroplasty (CDA) is safe an effective compared with ACDF, whilst mitigating the risk of adjacent segment disease. We hypothesize that this benefit may also be sustained in triple level CDA, however current evidence is limited.
Methods We conducted a retrospective cohort study of patients who underwent triple level CDA, ACDF, and hybrid surgery (HS) at a tertiary institution performed by four fellowship trained spine surgeons. Patients were assessed pre-operatively, then post-operatively at 1, 3, 6, and 12 months. Outcome measures included baseline characteristics, length of stay, operative time, cervical lordosis (CL), range-of-motion, Neck Disability Index (NDI), Short-form-12 for Physical Component Summary (SF12-PCS) and Mental Component Summary (SF-12-MCS), Visual Analogue Score (VAS) for neck and arm pain, post-operative neurological success and adverse events.
Results A total of 27 patients were included, of which 14 underwent CDA, 4 underwent ACDF, and 9 underwent hybrid procedures. Mean cervical lordosis improved postoperatively in the entire population (6.8 vs 14.4, $P = 0.007$). At 1m postoperatively, the CDA group saw the largest increase in mean CL compared with preoperative CL. Further, C2-C7 ROM was restored to preoperative range at 12m, with significantly better ROM when compared to the HS group (43.8 vs 27.9, $P = 0.034$). The mean length of stay (3.86 ± 1.66, $P = 0.044$) and operative time (216 ± 48, $P = 0.632$) was shortest in the CDA group. All groups had improvement in clinical outcomes with neurological success.
Conclusion Whilst ACDF, CDA, and HS are all effective in treating multilevel CDDD, CDA offers superior reconstruction of lordosis at 1m and more physiological ROM at 12m.

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Evaluating Posterior Fusion and Motion-Preserving Techniques in L5-S1 Degenerative Disease

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Introduction Lumbar degenerative disc disease (LDDD) is a leading cause of low back pain, frequently affecting the L4-L5 and L5-S1 levels. The L5-S1 segment is particularly prone to complications following stabilization due to its unique anatomy and sacral bone characteristics.
Methods A retrospective analysis was conducted on 151 patients treated between 2017 and 2022. Patients were divided into three groups: posterior rigid stabilization (n=30), posterior rigid stabilization with TLIF (n=35), and posterior dynamic stabilization (n=86). Clinical outcomes were assessed using Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) scores. Radiological evaluation included pseudoarthrosis, instrumentation failure, adjacent segment disease, and recurrent disc herniation. Multivariate logistic regression was performed to evaluate predictors of postoperative complications.
Results All groups demonstrated significant improvement in VAS and ODI scores postoperatively. The incidence of adjacent segment disease was significantly higher in the rigid stabilization group (20%) compared to rigid+TLIF (2.86%) and dynamic stabilization (2.33%, p=0.01). Pseudoarthrosis was most frequent in rigid fusion without TLIF. Revision surgery was more common in rigid stabilization compared to dynamic stabilization. Multivariate analysis confirmed that surgical technique independently predicted postoperative complications; rigid fusion was associated with higher odds of adjacent segment disease (adjusted OR 6.18, 95% CI 1.92–19.83, p=0.002) and revision surgery (adjusted OR 4.83, 95% CI 1.72–13.59, p=0.003) compared with dynamic stabilization. Instrumentation failure and recurrent disc herniation did not differ significantly between groups.
Conclusion Dynamic stabilization at L5-S1 reduces postoperative complication rates, including adjacent segment disease, pseudoarthrosis, and revision surgery, compared with rigid stabilization. These findings support dynamic systems as a motion-preserving alternative for carefully selected patients, although long-term prospective studies are warranted to confirm durability and sustained benefits.

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Novel Modular Implant for Lumbar PVCR: Morphometric-Guided Design and Finite Element Analysis Study in the Indonesian Population

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Background Posterior vertebral column resection (PVCR) is an effective procedure for severe rigid spinal deformity, but it produces substantial segmental instability that requires reliable reconstruction. Conventional titanium mesh cages remain widely used for anterior column support; however, limited endplate conformity and suboptimal load transfer may increase stress concentration, subsidence risk, and posterior instrumentation demand. This study evaluated a novel Vertebral Column Resection Modular Support System (VCR-MSS) designed using morphometric data from the Indonesian lumbar population.
MethodsThis study used a two-stage finite element framework. A preliminary ASTM F1717-21–adapted polyethylene block model was first used as a validation-oriented construct-level platform by comparing a posterior fixation prototype in biomechanical testing and finite element analysis (FEA). The main comparative study then evaluated a conventional mesh cage construct and the VCR-MSS construct using both an ASTM-based construct model under standardized loading and a vertebra-based lumbar model under physiological loading.
Results In the preliminary stage, the ASTM-based finite element model reproduced the overall mechanical behavior of the posterior fixation prototype and showed a similar pattern of stress concentration, supporting its role as a validation-oriented screening platform. In the main analysis, the VCR-MSS construct consistently demonstrated lower overall deformation than the conventional mesh cage construct across both standardized and vertebra-based models. The VCR-MSS also showed reduced mechanical demand on the posterior rod system in several loading conditions, suggesting improved load sharing within the reconstruction construct. Although stress redistribution varied according to loading direction, the overall findings indicated greater structural stability of the VCR-MSS construct compared with the conventional mesh cage construct.
Conclusion The VCR-MSS construct demonstrated a more favorable biomechanical profile than the conventional mesh cage construct by providing improved construct stability and reducing posterior mechanical burden. These findings suggest that the VCR-MSS may function as a more integrated reconstruction system for lumbar PVCR.

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Hybrid Cervical Arthroplasty for Multilevel Degenerative Disc Disease: Early Single-Centre Outcomes in the Context of Randomized Evidence

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Background Hybrid cervical constructs integrating cervical disc arthroplasty (CDA) with anterior cervical discectomy and fusion (ACDF) is a novel treatment to address the limitations of multilevel fusion, particularly adjacent segment degeneration and loss of motion. However, the effect and reliability of hybrid are still unclear compared with ACDF.
Objective To report early clinical and radiological outcomes of a single-centre hybrid cohort and critically contextualize these findings against contemporary randomized controlled trial (RCT) data.
Methods A retrospective analysis of 5 consecutive patients undergoing CDA cervical surgery was conducted. Outcomes included Neck Disability Index (NDI), Visual Analog Scale (VAS), and segmental range of motion (ROM). Results were interpreted in the context of high-level evidence, including FDA Investigational Device Exemption trials of Prestige LP and Mobi-C.
Results All patients demonstrated clinically meaningful improvement in NDI and VAS scores, with preservation of motion at arthroplasty levels. No major perioperative complications, device-related failures, or reoperations were observed. These findings parallel RCT data demonstrating that CDA achieves non-inferior or superior overall success compared to ACDF, with sustained ROM and reduced secondary intervention rates. The concordance between this series and Level I evidence supports the reproducibility of hybrid strategies in appropriately selected patients.
Conclusion This early experience reinforces hybrid cervical arthroplasty as a rational, evidence-aligned approach for multilevel DDD. While limited by small sample size and short-term follow-up, the observed consistency with randomized data underscores its clinical validity and warrants further prospective evaluation.

Keywords: Hybrid cervical surgery, disc arthroplasty, ACDF, motion preservation

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A Study on Intramedullary Signal Changes on Acute-Phase T2-Weighted MRI in Non-Traumatic Cervical Spinal Cord Injury

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Objectives Non-traumatic cervical spinal cord injury is common in Japan among the elderly with underlying conditions such as developmental spinal stenosis or OPLL, and the number of cases treated in emergency departments is increasing. Although diagnosis is ultimately made by MRI, there are few reports on the incidence of intramedullary signal changes on acute-phase T2-weighted MRI. We report the results of our investigation into acute-phase MRI findings.
Methods The study included 72 hospitalized patients who were transported to a Level 1 Trauma Center, underwent MRI within 24 hours of injury, and were classified as ASIA Impairment Scale (AIS) Grades A through D.There were 57 males and 15 females, ranging in age from 14 to 95 years (mean 72 years). The mechanisms of injury were falls from a height in 34 cases, falls from standing in 32 cases, traffic accidents in 4 cases, and other causes in 2 cases.
Results OPLL was observed in 20 of 72 cases (28%).The AIS at the time of injury was Grade A in 3 cases, Grade B in 8 cases, Grade C in 25 cases, and Grade D in 36 cases. MRI findings showed spinal canal stenosis in 66 cases and no spinal canal stenosis in 6 cases.Intramedullary signal changes on T2-weighted MRI were observed in 49 cases and were not observed in 23 cases. The incidence of intramedullary signal changes on T2-weighted MRI immediately after injury was 68% (49 cases) of all cases.
Conclusion In non-traumatic cervical spinal cord injuries, intramedullary signal changes on acute-phase T2-weighted MRI were observed in approximately 70% of cases. Since approximately 30% of cases showed no signal changes, diagnosis based solely on T2-weighted MRI has limitations, and it is important to make a comprehensive judgment in conjunction with clinical symptoms.

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BALANCING STABILITY AND INVASIVENESS: AN UPDATED META-ANALYSIS OF SHORT-SEGMENT VERSUS LONG-SEGMENT PEDICLE SCREW FIXATION IN THORACOLUMBAR BURST FRACTURES

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Background The optimal posterior fixation strategy for thoracolumbar burst fractures remains controversial, particularly regarding the balance between biomechanical stability and surgical invasiveness. This study aimed to compare the efficacy and safety of short-segment fixation (SSF) versus long-segment fixation (LSF).
Methods A systematic review and meta-analysis was conducted in accordance with PRISMA 2020 guidelines. A comprehensive search of PubMed, Scopus, Web of Science, and Cochrane Library was performed for comparative studies published between 2020 to 2026 evaluating SSF and LSF in thoracolumbar burst fractures. The primary outcomes were Cobb angle correction and loss of correction. The secondary outcomes included intraoperative blood loss and implant failure. Pooled analyses were conducted using a random-effects model, reporting mean differences (MD) and risk ratios (RR) with 95% confidence intervals (CI).
Results Eight comparative studies involving 540 patients were included. LSF demonstrated significantly superior radiological outcomes, with greater Cobb angle correction (MD -2.33°, 95%CI -2.92 to -1.74; p <0.00001) and substantially lower loss of correction (MD 3.36°, 95%CI 2.99 to 3.72; p <0.00001), indicating enhanced maintenance of sagittal alignment. In contrast, SSF was associated with significantly reduced intraoperative blood loss (MD -170.00 mL, 95%CI -185.00 to -155.00; p <0.00001), reflecting its less invasive nature. However, this advantage was offset by a significantly higher risk of implant failure in the SSF group (RR 2.75, 95%CI 1.46–5.18; p =0.002). Notably, heterogeneity across all outcomes was negligible (I^2 = 0%), demonstrating a highly consistent and robust treatment effect across included studies.
Conclusions LSF provides superior deformity correction and mechanical stability, whereas SSF offers advantages in reducing surgical invasiveness. Surgical strategy should be individualized based on patient-specific factors and treatment priorities. Further research are warranted to confirm these findings and evaluate long-term functional outcomes.
Keywords: Thoracolumbar Burst Fracture; Short-Segment Fixation; Long-Segment Fixation; Pedicle Screw; Spinal Stability

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Bridging the Gap: Can MIS Spine Surgery Address India's Spine Disease Burden? A Health Systems and Workforce Analysis

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Background Spine disorders are a leading cause of disability and healthcare burden in India, where care capacity remains limited. Minimally invasive spine surgery (MIS) offers perioperative advantages, but its ability to address the national treatment gap is uncertain.
Objective To estimate the burden of spine disorders, assess the spine surgery workforce, and evaluate whether MIS expansion can reduce the treatment gap in a resource-constrained setting.
Methods A mixed-methods analysis was performed using secondary data and modelling. Disease burden estimates were derived from global datasets and literature. Workforce size and distribution were compiled from professional sources. A demand–capacity model was developed, where surgical demand was estimated as a proportion of disease prevalence, and capacity was calculated based on surgeon numbers and annual surgical volume. Scenario analyses evaluated the impact of increased productivity with MIS. State-level variations were also assessed.
Results Spine disorders represent a substantial national burden, with millions potentially requiring surgical care annually. However, surgical capacity remains insufficient due to a limited and unevenly distributed workforce. Even under optimistic assumptions, current capacity meets only a fraction of demand, leaving a large unmet need. Regional disparities are pronounced, with better-served urban regions contrasting sharply with underserved high-population states. MIS-trained surgeons represent a minority and are concentrated in select private centers. Key barriers include cost, training limitations, and access issues.
Conclusion There is a significant mismatch between spine disease burden and surgical capacity in India. While MIS improves efficiency, it alone cannot bridge the treatment gap. A comprehensive strategy is required, including workforce expansion, structured training programs, and improved referral systems. Strengthening non-

surgical care and preventive strategies is equally important. These findings provide a framework for policy planning and highlight the need for scalable, system-level solutions to address spine care inequity.

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Paraspinal unilateral biportal endoscopic(Para-UBE) technique for lumbar foraminal and extraforaminal compression: A technical note and early clinical outcomes

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Introduction Lumbar foraminal and extraforaminal compression presents surgical challenges due to difficult access and risk of instability with conventional techniques. The paraspinal unilateral biportal endoscopic (Para-UBE) approach offers a minimally invasive alternative with targeted decompression. This study describes the surgical technique and evaluates early clinical outcomes.
Methods A retrospective analysis was conducted for patients undergoing paraspinal UBE between April 20, 2025, and December 31, 2025. A total of 27 patients were operated using this approach. 16 patients with concomitant central canal stenosis at the index or adjacent levels were excluded. 11 patients with isolated foraminal and/or extraforaminal compression were included. Clinical outcomes were assessed using Visual Analog Scale (VAS) for back and leg pain, Oswestry Disability Index (ODI), and modified MacNab criteria. Minimum follow-up was 3 months.
Results All patients showed improvement in VAS back, VAS leg, and ODI scores postoperatively and during follow-up. According to modified MacNab criteria: Excellent - 10 patients, Good - 1 patient. No major perioperative complications were observed.
Conclusion The paraspinal UBE technique is a safe and effective minimally invasive approach for lumbar foraminal and extraforaminal compression, providing favourable early outcomes. Larger studies with longer follow-up are required to validate these results.

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Same-Root Tandem Stenosis: Impact of Inferior-Level Foraminal Stenosis on Outcomes Following Lumbar Lateral Recess Decompression — A Propensity-Matched Cohort Study

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Tandem compression of a single lumbar nerve root at different anatomical levels is an under-recognised clinical entity. While lateral recess and foraminal stenosis have been extensively studied in isolation or at the same level, the impact of inferior level foraminal stenosis affecting the same nerve root remains poorly understood. This “same-root tandem stenosis” may represent a potential cause of persistent radiculopathy following otherwise adequate decompression.
We performed a retrospective analysis of patients with single level L4/5 lateral recess stenosis who underwent isolated lateral recess decompression between January 2022 and July 2025. Patients were grouped based on the presence or absence of radiologically confirmed inferior level foraminal stenosis (‘Tandem’ vs ‘Control’ groups, respectively). Propensity score matching in a 1:2 ratio was performed using age, sex, body mass index, diabetes mellitus, L4/5 listhesis, and baseline North American Spine Society (NASS) neurogenic symptoms scores. Patient reported outcomes included Visual Analogue Scale (VAS) back and leg pain scores and NASS back pain/disability, neurogenic symptoms and satisfaction domains. Complication and reoperation rates were also assessed.
20 patients in the Tandem group were matched to 40 patients in the Control group, achieving good post matching balance (standardized mean difference <0.2). At a median follow up of 5 months (interquartile range 1.75–7), patients with tandem stenosis demonstrated significantly less improvement in leg pain compared with controls (VAS leg change 4.3 ± 2.9 vs 6.0 ± 3.5; mean difference 1.7, 95% CI 0.0–3.5; p = 0.050). Postoperative NASS back pain/disability scores were significantly worse in the tandem group (p = 0.047).
Inferior level foraminal stenosis affecting the same nerve root is associated with inferior clinical outcomes following isolated lateral recess decompression. Recognition of ‘same root tandem stenosis’ is critical during preoperative assessment and may warrant consideration of extended decompression/fusion strategies to optimise outcomes.

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Who Benefits from Spinal Metastases Surgery? A Three-Variable Risk Score and Treatment-Naive Synchronous Presentation

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Objectives To develop a simple preoperative score for predicting 90-day mortality following surgery for spinal metastases and determine whether treatment-naive synchronous presentation independently influences survival.
Background Surgery for spinal metastases provides critical palliation but carries substantial perioperative risk. Existing prognostic tools are often complex with limited Southeast Asian validation. Whether treatment-naive patients presenting synchronously represent a distinct subgroup with more favourable outcomes remains unclear. Practical risk models based on routine preoperative variables may improve surgical selection.
Methods We retrospectively analysed 317 patients who underwent surgery for spinal metastases between 2003 and 2022. Two risk scores were developed: (1) a three-variable model assigning 1 point each for albumin <35 g/L, white blood cell count >11×10^9/L and visceral metastases (range 0-3), and (2) a blood-only model substituting neutrophil-to-lymphocyte ratio >5 for visceral metastases. Treatment-naive synchronous presentation was defined as spinal metastasis diagnosed within 3 months of primary cancer diagnosis without prior systemic therapy. Primary outcomes were 90-day and 1-year mortality, analysed via logistic regression and ROC analysis.
Results Overall 90-day and 1-year mortality were 17.4% and 45.7%, respectively. The three-variable score demonstrated stepwise discrimination for 90-day mortality: 4.7%, 6.8%, 33.7%, and 44.4% for scores 0 through 3, respectively (p<0.001). Score ≥2 identified high-risk patients (36.3% vs 6.1% 90-day mortality) with AUC 0.762 (95% CI 0.695-0.829). The blood-only model performed comparably with AUC 0.711 (95% CI 0.644-0.778). Treatment-naive synchronous presentation was independently associated with lower 1-year mortality (31.4% vs 54.0%, p<0.001), with benefit consistent across all risk strata.
Conclusions A simple three-variable score effectively stratifies short-term postoperative mortality, with score ≥2 identifying high-risk candidates requiring enhanced perioperative support. Treatment-naive synchronous presentation identifies a favourable prognostic subgroup, suggesting disease timing influences surgical candidacy. These tools provide an accessible framework for preoperative triage in spinal metastasis surgery.

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Single-Incision Multi-Level (SIML) Uniportal Endoscopic Decompression: a Technical Note with Case Illustrations in Complex Revision Lumbar Pathologies

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Introduction/Objectives Adjacent-level or revision decompression often requires multiple incisions or wider tissue dissection, partly offsetting the soft-tissue advantages of uniportal endoscopy. We describe single-incision multi-level (SIML) uniportal decompression and illustrate its technical application in two complex revision lumbar cases.

Materials and Methods We describe a uniportal endoscopic redocking technique that preserves a single sub-centimeter skin incision for adjacent-level access through a second fascial entry, thereby avoiding intervening muscle dissection. This strategy was applied in two revision patients: a gentleman in his 60s with recurrent radiculopathy after prior L3–4 and L4–5 TLIF, treated with two-level bilateral decompression; and a lady in her late 50s with Crohn's disease on immunomodulatory therapy, with left L4/L5 radiculopathy after prior L4–5 and L5–S1 TLIF from screw encroachment, treated with decompression, adhesiolysis around the screw-encroached nerve roots, and unilateral implant removal.

Result/Discussion Both procedures were completed fully uniportal endoscopically through a single incision, with no conversion or complications. Operative times were 2.5 and 4 hours. Both patients ambulated immediately, required only an overnight stay, and had marked symptom improvement. These cases highlight that the value of SIML extends beyond skin preservation, enabling maintenance of a uniportal access strategy in revision anatomy while minimizing wound burden such as in a high-risk immunosuppressed patient. However, this represents a two-case proof-of-concept, inherently subject to selection bias and operator dependence, and should be interpreted as feasible only in carefully selected cases by experienced endoscopic surgeons.

Conclusion SIML uniportal endoscopic decompression appears feasible in selected revision lumbar cases, including bilateral decompression and decompression with adhesiolysis and unilateral hardware removal. Its broader role remains to be defined, but these cases suggest that, in experienced hands and with appropriate case selection, SIML may extend the tissue-preserving advantages of uniportal endoscopy to more complex pathology.

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Subcrestal iliac screws, a novel paradigm for spinopelvic fixation: a single-center retrospective study of 100 cases.

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Intoduction/Objectives Two common methods of spinopelvic fixation are iliac screws and S2 alar-iliac (S2AI) screws. Both are acceptable fixation options; however, iliac screws are commonly associated with implant prominence requiring revision, whereas S2AI screws violate the sacroiliac joint and typically require fluoroscopic or navigational guidance. In this study, we report the outcomes and complications of a novel spinopelvic fixation technique using subcrestal iliac screws.

Materials and Methods A total of 100 patients who underwent spinopelvic fixation with subcrestal iliac screws at NUH between December 2010 and April 2025 were included. Patient demographics, surgical details, and visual analogue scale (VAS) scores for back and leg pain were recorded. Radiographs were reviewed for implant-related complications, including loosening and breakage.

Results/Discussion Median age of the patients was 69 years and the median follow-up was 27 months. 87 patients were operated for degenerative scoliosis, 8 for tumor, 4 for trauma and 1 for neuromuscular scoliosis. There was significant improvement in VAS-back and VAS-leg, from 5 (0-7) and 6 (5-8) preop, to 0 (0-0) and 0 (0-1.5) postop $p < 0.001$. The overall radiographic and clinical complications related to the subcrestal iliac screws was 19%, however, only 3% of the patients required revision of the subcrestal iliac screws; one screw was removed due to pain, two screws for loosening and one due to breakage. Patients with radiographic loosening had a median VAS-back and VAS-leg at 0.5 (0-4) and 0 (0-0) postop.

Conclusion Subcrestal iliac screws constitute an adequate method of spinopelvic fixation, with low revision rate. Notably, radiographic abnormalities did not necessarily correlate with poor clinical outcomes, as patients still demonstrated significant postoperative improvement in both back and leg pain.

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TIME-DEPENDENT NEUROLOGICAL RECOVERY IN ACUTE SPINAL CORD INJURY: A META-ANALYSIS OF EARLY VERSUS DELAYED SURGICAL DECOMPRESSION

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Background The optimal timing of surgical decompression in acute spinal cord injury (SCI) remains controversial, despite its potential to mitigate secondary injury and improve neurological recovery. This study aimed to evaluate the impact of early versus delayed decompression on neurological outcomes in acute SCI.

Methods A systematic review and meta-analysis was conducted in accordance with PRISMA 2020 guidelines. Electronic databases including PubMed/MEDLINE, Scopus, Web of Science, and Cochrane Library were searched for comparative studies published between January 2020 to March 2026. Early decompression was defined as ≤24 hours, and delayed decompression as >24 hours.

Results Six studies involving 1,057 patients were included. Early decompression significantly increased the likelihood of neurological improvement, with all included studies demonstrating a consistent direction of effect favoring early intervention. The pooled analysis showed a statistically significant benefit ($p < 0.001$), with no observed heterogeneity ($I^2 = 0\%$), indicating high consistency across studies. For continuous outcomes, early surgery resulted in a significantly greater improvement in ASIA motor scores (MD 5.97, 95% CI 4.98–6.97; $p < 0.001$), with similarly negligible heterogeneity ($I^2 = 0\%$). The largest study contributed the greatest weight to the pooled estimate. However, smaller studies demonstrated comparable effect sizes, reinforcing the robustness of the findings. Mortality analysis, based on two studies, showed a trend toward reduced risk in the early group (RR 0.59, 95% CI 0.32–1.08; $p = 0.09$; $I^2 = 0\%$), although this did not reach statistical significance.

Conclusion Early surgical decompression is associated with significantly improved neurological outcomes in acute SCI, supporting the concept of a time-sensitive therapeutic window. However, its effect on mortality remains inconclusive and requires further investigation. Further research is needed clarify its impact on outcomes beyond neurological recovery, including mortality and long-term functional independence.

Keywords : Spinal cord injury; Early decompression; Neurological recovery; Surgical timing; Meta-analysis

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Regional Bone Density Distribution in the Subaxial Cervical Lateral Mass: A CT Hounsfield Unit Analysis to Guide Screw Placement

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Introduction The long-term stability of posterior cervical instrumentation with lateral mass screws relies heavily on achieving strong bone purchase. Hounsfield Unit (HU) measurements from computed tomography (CT) scans offer a quantitative assessment of bone mineral density. However, there is limited data mapping the specific regional variations in bone density within the lateral mass itself, which could inform optimal screw trajectory. This study aimed to fill that knowledge gap. Our objective was to investigate the HU distribution across four distinct quadrants of the subaxial cervical lateral mass (C3-C6) and to determine if the quadrant adjacent to the pedicle consistently exhibits the highest bone density.

Materials and Methods We performed a retrospective CT analysis of seven patients who had undergone posterior cervical fixation. At each vertebral level from C3 to C6, the lateral mass was segmented into four quadrants (A-D). Mean HU measurements were recorded for each quadrant. The Wilcoxon signed-rank test was used to assess the statistical significance of the differences in HU values between the pedicle-adjacent quadrant ("A") and the others.

Results The analysis revealed a non-uniform bone density distribution within the lateral mass at all examined levels. The "A" quadrant, located nearest the pedicle, consistently demonstrated the highest median HU values. These elevated measurements were found to be statistically significant when compared to the other quadrants ($p=0.0078$), confirming the study's primary hypothesis.

Conclusion The subaxial cervical lateral mass possesses a heterogeneous bone density, with the strongest region located in the quadrant contiguous with the pedicle. This finding has direct clinical relevance, suggesting that screw trajectory aimed at this specific region may enhance fixation strength and improve biomechanical stability. While these results offer a valuable guideline for optimizing surgical technique, further research with larger sample sizes is required to validate these findings.

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Full Endoscopic Transforaminal Lumbar Interbody Fusion with Disc Preparation and Cage Insertion via an Accessory Portal: A Technical Note

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Background Full endoscopic transforaminal lumbar interbody fusion (FE-TLIF) using a posterolateral facet-sacrificing approach has emerged as one of the most minimally invasive surgical options for lumbar degenerative disease, offering direct neural decompression and endplate preparation with reduced muscle trauma and faster recovery compared to conventional minimally invasive TLIF. However, disc preparation and cage insertion within FE-TLIF remains challenging, with restricted visualization during these critical steps posing a risk of nerve root injury.

Objective To describe a novel accessory portal technique for disc preparation and cage insertion in uniportal FE-TLIF and to demonstrate its feasibility and safety in our initial clinical experience.

Methods The technique utilizes an 8.4mm full endoscope through the primary working portal, through which a nerve root retractor is deployed to continuously protect the nerve roots under direct endoscopic visualization. An accessory portal, co-located with the ipsilateral pedicle screw entry site, serves as the working channel for disc preparation instruments including shavers, curettes, and trials, followed by cage insertion. This configuration allows unobstructed disc preparation and safe cage delivery under continuous nerve root protection without requiring a separate additional skin incision.

Results Four female patients with grade 1 lumbar spondylolisthesis underwent single-level FE-TLIF using this accessory portal technique. Improvement in back and leg pain visual analogue scale scores and Oswestry Disability Index were observed in all patients postoperatively. No intraoperative or postoperative neurological complications were encountered and all patients were discharged within 3 days of surgery.

Conclusion The accessory portal technique for disc preparation and cage insertion in uniportal FE-TLIF allows continuous endoscopic nerve root observation and protection throughout the procedure, potentially reducing the risk of neural injury. This preliminary experience supports the feasibility and safety of this technique, which can be performed using standard endoscopic instrumentation without the need for additional specialized equipment.

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SAGGITAL ALIGNMENT AND SPINOPELVIC PARAMETERS AFTER UBE VS OPEN TLIF- Are we matching the gold standard?

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Introduction Unilateral biportal endoscopic fusion has gained increasing popularity as a minimally invasive spinal fusion technique ,owing to its advantages such as reduced intraoperative blood loss, lower postoperative analgesic requirements, shorter hospital stay and faster early pain relief. However concerns persist regarding its ability to achieve optimal radiological correction, particularly of lumbo-pelvic parameters when compared to conventional open fusion techniques.

Methods All consecutive patients who underwent single level lumbar fusion between 2024 and 2025 were retrospectively analysed. A total of 48 patients underwent single level TLIF, of whom 19 were treated using unilateral biportal endoscopic (UBE) techniques and 29 underwent conventional open TLIF. All cases were Radiological parameters including segmental lordosis and relevant lumbo-pelvic alignment measures were assessed on preoperative radiographs and at a minimum follow up of 6 months postoperatively.

Results UBE fusion demonstrated radiological outcomes comparable to open fusion techniques. Within group analysis- UBE-TLIF achieved a significant restoration of segmental lordosis (+ 3.16 degrees, $p = 0.015$) however, baseline adjusted (ANCOVA) analyses demonstrated no significant differences compared with Open TLIF across segmental, regional, global sagittal or pelvic parameters. Despite the minimally invasive nature of UBE, segmental lordosis correction at the operated level was similar to open fusion- which may be attributed to several factors like preservation of posterior tension band, reduced paraspinal muscle disruption, improved cage positioning, more effective end plate preparation facilitated by direct magnified endoscopic visualisation, which may offset perceived ability to correct alignment due to unilateral facetectomy.

Conclusion In single level TLIF, segmental and lower lumbar lordosis are the most relevant sagittal parameters. Single level UBE fusion appears capable of restoring key lumbopelvic parameters despite reduced surgical exposure, supporting its role as an effective alternative for single level lumbar fusion, not just an "alternative" for pain relief, but a biomechanically sound option for sagittal balance restoration.

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Awake Unilateral Biportal Endoscopy as a Physiological Model Reveals Instrument-Induced Transient Outflow Obstruction as the Mechanism of Pressure-Related Symptoms

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Introduction Continuous saline irrigation in Unilateral Biportal Endoscopic (UBE) spine surgery creates a pressurized operative environment. While complications such as intracranial hypertension are reported, the intraoperative triggers of pressure elevation remain poorly defined. Awake UBE provides a unique opportunity to detect physiological disturbances through real-time patient feedback.
Objective To utilize awake UBE as a physiological model to identify intraoperative triggers of pressure-related symptoms and derive clinically relevant preventive strategies.
Methods A prospective observational study was conducted in 47 consecutive patients undergoing awake UBE lumbar decompression under Spinal Anaesthesia. Continuous intraoperative patient feedback was recorded, with specific attention to neck discomfort. A time-synchronized event mapping protocol correlated symptom onset with surgical steps, including irrigation dynamics and instrument usage. Corrective interventions and symptom resolution were systematically evaluated.
Results Intraoperative neck discomfort occurred in 3/47 patients (6.4%). All cases demonstrated normal baseline irrigation ingress and egress, excluding sustained outflow compromise. Symptoms occurred exclusively during insertion and use of bulky rotating Kerrison rongeurs and were immediately relieved upon instrument removal. No symptoms were observed during other stages of surgery. These findings suggest transient, instrument-induced obstruction of fluid egress as the primary mechanism. Implementation of targeted technical modifications including avoidance of bulky instruments, enlargement of fascial incision, and head-end elevation prevented recurrence.
Conclusion Awake UBE functions as a real-time physiological model, revealing that pressure-related symptoms are driven by step-specific, instrument-induced transient obstruction of fluid outflow rather than global pressure elevation. Ensuring an unobstructed egress pathway during instrumentation is critical to preventing pressure-related complications.

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Ultrasonic Bone Scalpel Versus High-Speed Drill in Biportal Endoscopic Cervical Foraminotomy: A Randomized Study Demonstrating Superior Efficiency and Safety in Medial Pediculectomy

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Introduction Biportal endoscopic cervical foraminotomy requires precise decompression at the pedicle–nerve root interface. While high-speed drills (HSD) are effective for routine foraminotomy, their rotational mechanics may impair visualization and control in confined spaces, particularly during medial pediculectomy. The ultrasonic bone scalpel (UBS), a non-rotatory, vibration-based device with tissue-selective properties, may offer advantages in this critical step. This randomized study compares UBS and HSD with emphasis on procedural efficiency, visualization, and neural safety.
Methods Thirty-five patients with cervical radiculopathy were randomized into two groups undergoing unilateral biportal endoscopic decompression using UBS (n=17) or HSD (n=18). Primary endpoints included pediculectomy time, visualization score, and surgeon comfort score. Secondary outcomes included operative time, clinical outcomes (VAS, NDI), and complications. Statistical analysis was performed using SPSS, with significance set at $p < 0.05$.
Results Baseline characteristics were comparable between groups. Overall operative time and clinical outcomes showed no significant difference. However, UBS demonstrated significant advantages during medial pediculectomy. Pediculectomy time was significantly lower in the UBS group (14.8 ± 2.6 vs 20.5 ± 3.8 minutes, $p < 0.001$). Visualization scores (4.6 ± 0.5 vs 3.4 ± 0.7, $p < 0.001$) and surgeon comfort scores (4.7 ± 0.4 vs 3.5 ± 0.6, $p < 0.001$) were significantly higher with UBS. UBS also required fewer instrument adjustments (2.1 ± 0.8 vs 4.3 ± 1.2, $p < 0.001$). No dural tears or neurological deterioration were observed in either group.
Conclusion While both UBS and HSD are effective for cervical foraminotomy, UBS provides superior efficiency, visualization, and surgeon control during medial pediculectomy without altering overall clinical outcomes. Its non-rotatory, tissue-selective mechanism enhances safety at the pedicle–nerve root interface, representing a meaningful technical advancement in biportal endoscopic cervical spine surgery.

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Irrigation-Induced, Not Injury-Induced: Temporal MRI Evolution of Cervical Multifidus Following Unilateral Biportal Endoscopic Surgery – A Prospective Longitudinal Study

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Introduction Muscle preservation is a fundamental advantage of minimally invasive spine surgery, including unilateral biportal endoscopy (UBE). However, continuous saline irrigation during cervical UBE produces early postoperative MRI changes that may mimic muscle injury, risking misinterpretation. Their temporal evolution and clinical relevance remain unclear.
Objective To longitudinally characterize MRI changes in cervical multifidus following UBE and differentiate irrigation-related effects from true muscle injury using side-to-side internal control.
Methods In this prospective study, 35 patients undergoing cervical UBE discectomy were evaluated with MRI preoperatively, within 48 hours postoperatively, and at 15 days, 1, 3, and 6 months. Quantitative analysis included cross-sectional area (CSA), T2 signal intensity, and edema. Side-to-side comparison was performed using CSA ratio and edema index (operated/contralateral). Clinical outcomes were assessed using VAS and NDI. Repeated-measures ANOVA was used ($p < 0.05$).
Results Preoperative imaging showed symmetric multifidus morphology (CSA ratio ≈1.0; edema index ≈1.0). Immediate postoperative MRI demonstrated significant T2 hyperintensity and apparent muscle expansion on the operated side (CSA ratio 1.2–1.4; edema index 1.5–2.0; $p < 0.001$), without structural disruption. At 15 days, edema

decreased but persisted (CSA ratio 1.1–1.2; edema index 1.3–1.5; $p < 0.05$), with preserved architecture and no fatty infiltration. By 1 month, near normalization was observed, progressing to symmetry at 3 months and complete restoration at 6 months. Early MRI changes showed no correlation with clinical outcomes.

Conclusion Early postoperative multifidus changes after cervical UBE are irrigation-induced, transient, and non-injurious, not reflective of true muscle damage. Serial side-to-side MRI analysis reliably distinguishes these reversible changes from pathology, reinforcing the muscle-sparing nature of UBE and preventing misinterpretation of early imaging.

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Does Irrigation Direction Matter? A Prospective MRI-Based Comparative Study of Side-Throw Versus End-Throw Cannulas in Lumbar Unilateral Biportal Endoscopic Surgery

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INTRODUCTION Unilateral biportal endoscopy (UBE) relies on continuous saline irrigation for visualization and hemostasis. Irrigation dynamics may influence paraspinal muscle edema and postoperative tissue response. The effect of cannula design—side-throw versus end-throw—on muscle morphology and clinical outcomes remains unclear. This study compares their impact following lumbar UBE.

MATERIALS AND METHODS A prospective comparative study of 35 patients undergoing lumbar UBE decompression was performed. Patients were allocated into side-throw (n=15) and end-throw (n=20) cannula groups. MRI was obtained preoperatively, within 48 hours, and at 1 and 3 months. Quantitative parameters included multifidus cross-sectional area (CSA), T2 signal intensity, and intermuscular edema. Side-to-side comparisons were assessed using CSA ratio (operated/contralateral) and edema index. Clinical outcomes included Visual Analog Scale (VAS) and Oswestry Disability Index (ODI). Statistical analysis used independent t-tests and repeated-measures ANOVA ($p<0.05$).

RESULTS / DISCUSSION Baseline MRI parameters were comparable between groups. At <48 hours, the side-throw group demonstrated significantly greater muscle edema and expansion than the end-throw group (CSA ratio: 1.3–1.5 vs 1.1–1.3; edema index: 1.8–2.2 vs 1.4–1.7; $p<0.01$). At 1 month, edema persisted in both groups but remained higher in the side-throw group ($p<0.05$). By 3 months, both groups showed near-complete normalization with no significant differences. No fatty infiltration or chronic muscle injury was observed. Early postoperative back pain (VAS) was higher in the side-throw group ($p<0.05$), while ODI and long-term outcomes were comparable.

CONCLUSION Irrigation direction significantly influences early postoperative paraspinal muscle changes in lumbar UBE. Side-throw cannulas are associated with greater transient edema and early pain, although changes are reversible with no long-term impact. Optimizing irrigation dynamics may improve tissue preservation in UBE.

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Balancing Efficiency and Radiation Exposure in Percutaneous Trans-Kambin Lumbar Interbody Fusion: A Prospective Comparative Analysis of Single versus Dual C-Arm Fluoroscopy

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Introduction Minimally invasive Trans-Kambin lumbar interbody fusion (KLIF) relies on fluoroscopic guidance, typically using single or dual C-arm configurations. While dual C-arm systems allow simultaneous anteroposterior (AP) and lateral imaging and may improve workflow, they may increase radiation exposure. The trade-off between efficiency and radiation burden remains inadequately defined.

Objective To compare radiation exposure and procedural efficiency between single and dual C-arm fluoroscopy in KLIF.

Methods This prospective, single-center comparative study included 30 patients undergoing KLIF for degenerative spondylolisthesis. Patients were randomized into single C-arm and dual C-arm groups. Primary outcomes included radiation exposure measured by kerma–area product (KAP/DAP, $\mu Gy \cdot m^2$), fluoroscopy time, and number of C-arm shots. Procedural time was also recorded.

Results Radiation exposure was significantly lower in the single C-arm group ($1190.74 \pm 438.98\ \mu Gy \cdot m^2$) compared to the dual C-arm group ($1762.58 \pm 635.42\ \mu Gy \cdot m^2$; $p = 0.026$). This reduction corresponded with significantly shorter total fluoroscopy time (118.79 ± 42.49 s vs. 173.79 ± 63.14 s; $p = 0.028$). Projection-wise analysis demonstrated reduced exposure in both AP (44.70 ± 25.76 s vs. 68.68 ± 35.44 s; $p = 0.022$) and lateral views (74.09 ± 33.78 s vs. 105.11 ± 53.62 s; $p = 0.041$). The number of fluoroscopic shots also trended lower in the single C-arm group. Despite these differences, total procedural time remained comparable between groups, indicating no compromise in operative efficiency.

Conclusion In KLIF, single C-arm fluoroscopy using a standardized protocol significantly reduces radiation exposure without compromising procedural efficiency. Dual C-arm systems may be reserved for complex cases where simultaneous orthogonal imaging provides a clear procedural advantage.

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Ligamentous Instability in Structurally Stable Cervical Spine: A Paradigm Shift in the Mechanism of Dynamic Compression in Degenerative Cervical Myelopathy

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Introduction Degenerative cervical myelopathy (DCM) is classically conceptualized as a disease driven by static anterior and posterior compressive elements within a structurally "stable" cervical spine. Conventional assessment defines stability by vertebral alignment, absence of translation, and preserved segmental motion. Yet, clinical progression in many radiographically stable patients suggests an unrecognized biomechanical mechanism of neural compromise. This study introduces and characterizes a novel concept ligamentous instability wherein ligamentum flavum (LF) dynamically buckles under physiological axial loading despite intact vertebral stability.

Methods Fifty patients with clinically confirmed DCM and fifty age-matched controls with chronic axial neck pain underwent MRI in both supine and upright seated postures using an open MRI platform. Quantitative parameters included disc bulge (DB), ligamentum flavum thickness (LFT), sagittal spinal cord diameter (SSCD), cross-sectional spinal cord area (CCSA), cervical lordosis, and segmental angulation. Standard radiographic criteria confirmed the absence of vertebral or segmental instability in all subjects.

Results Upright loading demonstrated significant dynamic posterior encroachment in DCM patients without vertebral instability. Compared to controls, DCM patients showed greater posture-induced increases in DB (38.13% vs 8.07%) and LFT (25.98% vs 12.99%), with corresponding reductions in SSCD (14.05% vs 3.08%) and CCSA (14.45% vs 3.44%). Maximal dynamic stenosis was observed at C3–C4 during extension. No pathological translation or angulation was identified, confirming that LF buckling occurs in structurally stable spines.

Conclusions This study identifies ligamentous instability as a previously unrecognized mechanism of dynamic spinal cord compression in DCM. Unlike vertebral or segmental instability, ligamentous instability arises from load-dependent deformation of the LF and persists even when arthrodesis or motion-preserving procedures address anterior pathology. This paradigm challenges existing definitions of cervical stability and underscores need for posture-sensitive imaging and revised treatment algorithms. Recognition of ligamentous instability may reshape surgical decision-making by highlighting dynamic posterior compression as a driver of disease progression.

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Beyond the 8-Hour Window: Rapid Neurological Recovery Following Delayed Corticosteroid Therapy in Post-Traumatic Pediatric SCIWORA

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Introduction Delayed complete paraplegia in children after minor trauma is rare and often associated with poor recovery, particularly when treatment begins beyond conventional therapy. Diagnostic uncertainty arises when severe deficits occur despite normal radiographs. Spinal cord injury without radiographic abnormality (SCIWORA) is a recognized pediatric entity, but optimal management of role and timing of corticosteroids remains controversial. Although the NASCIS protocol use in adults, its application in children and beyond eight-hours after injury is unclear.

Case Presentation A five-year-old healthy boy developed progressive bilateral lower-extremity weakness and urinary retention five days after a two-meter fall onto a seated position. Neurological examinations show hypoesthesia below Th5. Intravenous methylprednisolone following a modified NASCIS III protocol was started despite delayed presentation. MRI demonstrated longitudinal T2 hyperintensity from C5 to Th10, consistent with spinal cord edema. Neurological improvement began within 48 hours, with complete motor and sphincter recovery occurred by day six without complications.

Discussion SCIWORA was initially suspected based on the clinical presentation and normal radiographs. MRI revealed an edema at the spinal cord suggesting post traumatic inflammatory response. Highlighting the importance of advanced imaging in children with severe neurological deficits after trauma. The rapid recovery after corticosteroid therapy suggests reversible inflammatory edema, rather than irreversible axonal injury. Improvement despite delayed therapy raises the possibility in selected cases, the therapeutic window for corticosteroids may extend beyond the traditional eight-hour limit.

Conclusion Delayed methylprednisolone administration may still be associated with rapid neurological recovery in pediatric spinal cord syndromes resembling SCIWORA but may involve reversible inflammatory mechanisms. Early MRI is essential to clarify pathology and guide treatment. In the absence of consensus guidelines, individualized clinical decision-making remains necessary. Further investigation is warranted to clarify potential role of NASCIS protocol in pediatric spinal cord injury and to better define the optimal timing of corticosteroid therapy.

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How Natural Standing Alters Lumbar Disc Microarchitecture & Solute Transport in Healthy, Hypermobile, and Immobile Segments - Insights from A Post-Contrast Upright MRI Radiomics Study

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INTRODUCTION / OBJECTIVES The relationship between spinal loading, segmental mobility, and nutrient transport in intervertebral discs remains poorly understood due to lack of in vivo assessment methods. Upright MRI enables evaluation under physiological loading. This study integrates standing MRI, radiomics, and delayed post-contrast imaging to characterize load-dependent microstructural and transport behavior in healthy, hypermobile, and fused lumbar discs.

MATERIALS AND METHODS Three motion phenotypes were studied: Group A (healthy), Group B (hypermobile; bilateral L5 spondylolysis), and Group C (fused; lumbosacral transitional vertebrae). Fifteen volunteers (n=5/group; Pfirrmann Grade I) underwent supine and standing MRI on a 0.25T upright scanner. Imaging included T2-weighted and pre-/post-contrast T1-weighted sequences, with delayed scans at 6 hours post-gadodiamide. Four regions (endplate zones, peripheral and central nucleus pulposus) were segmented. IBSI-compliant radiomics extracted first-, second-, and higher-order features. T2 metrics reflected mechanical strain; delayed ΔR1 quantified solute transport. Analysis used non-parametric tests with Bonferroni correction.

RESULTS / DISCUSSION Standing revealed distinct phenotype-specific responses. Healthy discs demonstrated balanced adaptation (T2 +10.1%, entropy +10.9%, ΔR1 +15.3%) with mild centripetal gradients (PNP/CNP 1.21). Hypermobile discs showed exaggerated deformation (T2 −26.5%, entropy +25%, contrast +35%) and increased transport (ΔR1 +32%), with steep radial gradients (1.34) and incomplete recovery (~35%). Fused segments were mechanically inert (T2 −4.1%) and transport-limited (ΔR1 +6%), lacking normal gradients (1.05). Entropy and ΔR1 increased progressively from fused to healthy to hypermobile, delineating quiescent, adaptive, and overactive states.

CONCLUSION This study provides first in vivo evidence that disc microstructure and solute transport vary predictably with segmental mobility under physiological loading. Upright MRI radiomics combined with delayed contrast imaging enables functional characterization of disc behavior beyond conventional imaging, offering a potential framework for early detection and biomechanical phenotyping of spinal health.

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Navigation-Assisted Transforaminal Endoscopic Thoracic Discectomy under Local Anesthesia: A Case Illustration and Technical Note

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Introduction Techniques and knowledge in endoscopic spine surgery has advanced tremendously in recent years, resulting in the expansion of its indications to include cervical and thoracic spine pathology. Alongside the progression of techniques, the concurrent development of navigation and robotic-assisted surgery have also enhanced surgical precision and accuracy. Together, these advances allow us to treat an increasingly wide spectrum of spinal pathologies safely, whilst utilizing

minimally-invasive techniques. We describe a case of a thoracic disc herniation managed with full-endoscopic spine surgery under local anesthesia combined with navigation guidance. We aim to share our experience and provide an overview of our surgical technique.

Materials and Methods A 66 year old lady presented with subjective unilateral left leg weakness and unsteady gait for the past 3 months. Magnetic resonance imaging (MRI) of the thoracic spine revealed a left paracentral thoracic disc herniation (TDH) at the T11-T12 level. A full-endoscopic transforaminal thoracic discectomy was planned with navigation guidance and under local anaesthesia.

Discussion We highlight several unique features in the treatment of this case which may be helpful in the treatment of TDH. Firstly, we utilised navigation for localisation and greater accuracy. We also performed the procedure under local anaesthesia, without any supplementary sedation. This allowed us to have feedback from the patient in case of any neural irritation or injury, and also allowed us to monitor for early signs of raised intracranial pressure from irrigation.

Conclusion Our case highlights the advantage of utilising navigation technology, combined with endoscopy surgery, in treating thoracic disc herniations. The use of local anaesthesia also improves patient safety and reduces systemic risk. Together, the integration of such techniques allow for the safe implementation of minimally invasive techniques such as full endoscopy spine surgery in complex spinal pathology.

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Effectiveness and Safety of Epinephrine-Supplemented Irrigation Fluid in Assisted Full-Endoscopic Spine Surgery (AFESS): A Retrospective Comparative Study

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Introduction Suboptimal visualization due to intraoperative bleeding is a factor increasing surgical difficulty and prolonging operative time in endoscopic spine surgery. While we have standardized the use of epinephrine-supplemented irrigation fluid during Assisted Full-Endoscopic Spine Surgery (AFESS), its efficacy and systemic safety remain to be fully quantified. This study aimed to evaluate the impact of epinephrine-added irrigation on surgical performance and perioperative outcomes.

Methods We retrospectively analyzed patients who underwent single-level bilateral decompression via AFESS between September 2023 and January 2026. Patients were divided into two groups: those receiving epinephrine-added irrigation fluid (Group E) and those receiving standard saline (Group N). Evaluated parameters included operative time, cumulative interruption time due to bleeding, frequency of topical hemostatic agent use, intraoperative blood pressure fluctuations, and the incidence of postoperative complications.

Results The median interruption time due to bleeding was significantly shorter in Group E (33 seconds) than in Group N (258 seconds) ($p = 0.008$). Consequently, the median operative time was significantly reduced in Group E (73.5 minutes) compared to Group N (93 minutes) ($p = 0.025$). Furthermore, the median frequency of topical hemostatic agent use was 0 in Group E versus 1 in Group N, demonstrating a trend toward reduced need for additional hemostasis ($p = 0.095$). No significant differences were observed between the two groups regarding hemodynamic stability or perioperative complications.

Conclusion The addition of epinephrine to irrigation fluid in AFESS significantly enhances visual clarity, thereby reducing intraoperative interruptions and overall operative time. While the potential influence of the learning curve for the AFESS technique during the study period should be considered, the marked reduction in bleeding-related interruptions suggests a direct and substantial benefit of epinephrine. These clinical advantages were achieved without increasing systemic hemodynamic risks, supporting this method as a safe and effective strategy for optimizing endoscopic spinal procedures.

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Root Anomaly Predictive Score (RAPS): A Prospective Validated Model for Preoperative Identification of Lumbosacral Nerve Root Anomalies

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INTRODUCTION / OBJECTIVES Lumbosacral nerve root anomalies (NRAs), particularly conjoined nerve roots, are underrecognized yet clinically significant causes of intraoperative complications in lumbar spine surgery. Conventional MRI frequently fails to detect these anomalies preoperatively. This study aims to develop and validate a comprehensive predictive model integrating clinical, radiographic, and MRI parameters to improve preoperative identification.

MATERIALS AND METHODS A prospective study of 103 patients undergoing lumbar spine surgery was conducted. Predictive variables were derived from a PRISMA-guided review of 47 studies and categorized into clinical, radiographic, and MRI domains. Seventeen variables were incorporated into the Root Anomaly Predictive Score (RAPS). All patients were scored preoperatively and correlated with intraoperative findings. Model performance was assessed using logistic regression, ROC analysis, and bootstrap validation.

RESULTS / DISCUSSION Conjoined nerve root anomalies were identified intraoperatively in 14 patients (13.6%). The mean RAPS score was significantly higher in the anomaly group (13.2 ± 1.8) compared to non-anomalous cases (5.8 ± 3.1; $p < 0.001$). The model demonstrated excellent discriminative ability (AUC 0.93), with sensitivity 87%, specificity 90%, and negative predictive value 98%. Key predictors included thickened nerve root, abnormal root take-off angle, corner sign, double nerve shadow, and aberrant coronal course. All confirmed anomalies occurred in the high-risk group, validating the score's clinical stratification. RAPS effectively translated heterogeneous imaging and clinical findings into a structured, reproducible decision-support tool.

CONCLUSION RAPS provides a validated, practical, and highly accurate method for preoperative prediction of nerve root anomalies. Its integration into surgical planning enhances preparedness, reduces intraoperative surprises, and improves safety in both open and minimally invasive spine surgery.

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Full-Endoscopic Decompression at L5/S1 with Enbloc Resection of the Lumbosacral Ligament: A Technical Note

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Background The lumbosacral ligament, extending from the L5 transverse process to the sacral ala, has been increasingly recognized as a potential source of extraforaminal nerve compression at the L5/S1 level. Hypertrophy or anatomical variation of this ligament can contribute to L5 radiculopathy, often mimicking more common causes such as disc herniation or foraminal stenosis. Advances in endoscopic spine surgery have enabled targeted, minimally invasive approaches to address such pathologies with improved precision and reduced morbidity.

Objective To describe the technique and clinical outcome of full-endoscopic decompression at L5/S1 with en bloc resection of the lumbosacral ligament for the treatment of extraforaminal L5 nerve root compression.
Methods A full-endoscopic transforaminal approach was utilized to access the L5/S1 extraforaminal region under fluoroscopic and endoscopic guidance. Following identification of the exiting L5 nerve root, the lumbosacral ligament was visualized and resected en bloc to achieve adequate decompression. Careful soft tissue dissection and bony contouring were performed as necessary to optimize exposure while preserving stability. Clinical outcomes were evaluated based on symptom relief, functional improvement, and perioperative parameters.
Results The endoscopic technique allowed clear visualization of the exiting L5 nerve root and the compressive lumbosacral ligament. En bloc resection resulted in immediate and effective neural decompression. The patient experienced significant postoperative pain relief and functional improvement, with minimal blood loss, reduced operative time, and rapid recovery. No intraoperative complications or postoperative instability were observed.
Conclusion Full-endoscopic decompression with en bloc resection of the lumbosacral ligament at L5/S1 is a safe and effective minimally invasive technique for treating extraforaminal L5 nerve root compression. This approach enables precise anatomical identification, minimizes tissue disruption, and offers favorable clinical outcomes. Recognition of the lumbosacral ligament as a potential pain generator is essential for accurate diagnosis and optimal surgical management.

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Knowledge, Attitude and Practices of Intra-operative Autologous Blood Cell Salvage in Tumour-related Spine Surgery: A Survey of Singapore Spine Society Members

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Introduction Intraoperative autologous blood cell salvage (IOCS) use in tumour-related spine surgery is limited due to concerns of tumour-cell reinfusion, even though studies suggest that risk is low. This study investigates the knowledge, attitudes and practices of Singapore Spine Society (SSS) members regarding IOCS use in metastatic spinal tumour surgery (MSTS) and primary spinal tumour surgery (PSTS).
Material and Methods An online questionnaire was sent to all 108 SSS members in July 2025. Participants rated support for IOCS on a five-point Likert scale, and listed their perceived benefits and concerns with IOCS use.
Results Out of 36 responses, majority are Orthopaedic surgeons (83.3% vs 16.7% Neurosurgeons), working in public hospitals (69.4%), with more than 10-year experience as a spinal surgeon (55.6%). Main perceived benefits of IOCS are reduced allogenic transfusion (86.1% MSTS vs 75.0% PSTS), decreased morbidity/complications (44.4% vs 50.0%), cost savings (38.9% vs 33.3%), and decreased mortality (27.8% vs 22.2%). Concerns include potential systemic tumour-seeding (63.9% MSTS vs 69.4% PSTS), coagulopathy (52.8% vs 38.9%), infection (36.1% vs 25.0%), and high costs (27.8% vs 27.8%). In MSTS, 77.8% support IOCS, but only 50.0% report usage. Support ratings are higher in public-hospital surgeons (4.24 vs 2.55 private-hospital, $p=0.003$), surgeons performing more than ten MSTS cases a year (4.16 vs 3.24, $p=0.040$), and those who use it (4.50 vs 2.94, $p<0.001$). In PSTS, 58.3% support its use, but only 22.2% use it. Support ratings in PSTS are higher in surgeons who use it (4.38 vs 2.61, $p<0.001$), with no significant difference based on practice settings (3.20 public vs 2.55 private, $p=0.234$). Overall mean support ratings are higher for MSTS than PSTS (3.72 vs 3.00, $p=0.006$).
Conclusion SSS members expressed support for IOCS in both MSTS and PSTS. Further studies defining the actual risk of systemic tumour-seeding may help spur IOCS adoption.

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UBE-Assisted Facet Decortication for Pseudarthrosis Following ALIF: Technical Note and Case Series of 6 Patients

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Introduction/Objectives The gold standard revision procedure for pseudarthrosis following standalone anterior lumbar interbody fusion (ALIF) is posterior fixation with bone graft augmentation. In the present study, we present the results of percutaneous pedicle screw fixation and endoscopic facet joint decortication and grafting with the unilateral biportal endoscopic (UBE) approach.
Materials and Methods A total of 7 patients that presented with symptomatic pseudarthrosis after an ALIF procedure (L4-5 n = 1, L5-S1 n = 6) were included. Firstly, the segments were fixated with percutaneous pedicle screws. Then, endoscopic decortication of the superior and of the inferior laminae with a burr was performed, and a partial facetectomy of the inferior articular process with an osteotome. Biological augmentation ensued with HA- or bioglass-based bone substitutes.
Results/Discussion Mean age at revision was 51.9 ± 16.4 years, and mean time from index ALIF to revision was 2.3 ± 0.9 years. Follow-up was complete in all patients at 12 months. ODI improved from 33.1 ± 10.2 preoperatively to 27.2 ± 15.4 at 3 months and 22.7 ± 19.3 at 12 months, with ODI MCID achieved in 1 patient at 3 months and 4 patients at 12 months. Back pain VAS decreased from 6.7 ± 1.1 preoperatively to 4.7 ± 1.9 at 3 months and 4.7 ± 2.4 at 12 months, while radicular pain VAS improved from 5.9 ± 2.3 to 2.6 ± 2.4 and 2.3 ± 2.6, respectively. CT-confirmed fusion was achieved in all patients by 12 months, with fusion documented as early as 3–4 months in 4 cases. No construct failures, index-level revisions, intraoperative complications, or new neurological deficits were observed.
Conclusion UBE-assisted facet decortication with posterior fixation is a safe and effective minimally invasive option for symptomatic pseudoarthrosis after standalone ALIF.

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BESS vs MIS Decompression and Fusion on Spondylolisthesis, which one to choose: a systematic review and meta analysis

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Objective To compare the clinical outcomes and effectiveness of biportal endoscopic spine surgery (BESS) decompression and fusion versus minimal invasive surgery (MIS) decompression and fusion in the management of spinal disorders.

Materials and Methods A meta-analysis was conducted, including randomized controlled trials (RCTs) and observational studies comparing BESS versus MIS decompression and fusion. Data sources included PubMed, Embase, and Cochrane Library databases, with searches conducted up to [insert date]. Key outcome measures included postoperative pain, functional recovery, and complications.

Results/ Discussion A total of 4 studies involving 184 patients were included BESS Decompression and Fusion demonstrated a statistically significant reduction in intraoperative Post Operative Backpain (early and late) and functional recovery compared to Minimal Invasive Spine Technique. Complication rates and Leg pain were comparable between the two techniques, hence not significant difference.

Conclusions BESS offers several advantages over MIS decompression and fusion techniques, better post operative backpain quicker functional recovery. Further high-quality RCTs are needed to correlate these findings and guide clinical decision-making.

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H-Line – A sagittal curve-specific K-line for selecting cervical laminoplasty

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Introduction The K-line is an established radiographic criterion for patient selection in cervical laminoplasty over laminectomy & fusion in patients with cervical spondylotic myelopathy and myelopathy secondary to ossification of the posterior longitudinal ligament. However, it fails to consider the size, shape and location of occupancy of the pathology, often assuming the cervical spine to be symmetrically lordotic.

Materials/Methods A retrospective study on 170 patients (mean age 65 ± 9.08 years; 126 males, 44 females) who underwent cervical laminoplasty at a single tertiary center was performed. Using the novel sagittal curve-specific K-line, known as the H-line, patients were stratified into 4 groups based on MRI scans: K+H+ (n=129), K−H− (n=6), K+H− (n=19), and K−H+ (n=16). Patient reported outcome measures (PROMs) including NDI, JOA, mJOA, EQ-5D, SF-36, and VAS were assessed at baseline, 6 months, 1 year, and 2 years. Radiographic parameters across 2 years including improvement in cervical lordosis, segmental lordosis and post-operative complications were compared across groups.

Results/Discussion All groups were well-matched at baseline ($p>0.05$). Both K+H+ and K−H+ groups achieved significant improvements in JOA, mJOA, EQ-5D, and SF-36 across 2 years ($p<0.01$). There was also significantly improved cervical lordosis at 1 year and 2 years amongst the K-H+ and K+H+ groups ($p<0.01$). Conversely, the K+H− group did not have significant changes in PROMs, and demonstrated an increased cervical kyphosis post-operatively ($p<0.01$). Post-operative complications were similar across all groups.

Conclusion H-line positivity demonstrated improved radiographic and clinical outcomes post-cervical laminoplasty in patients who are K-line negative, suggesting the importance of sagittal curve profile and pathology topography when selecting laminoplasty over laminectomy & fusion. The application of H-line as a new criterion in patient selection for laminoplasty is likely more predictive of positive outcomes and can be further confirmed in large prospective trials.

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A Deep Learning System Using Preoperative Lumbar CT to Predict Adjacent Segment Disease After Posterior Lumbar Interbody Fusion: A Retrospective Multicenter Study

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Introduction Lumbar degenerative disease is a leading cause of low back pain and functional limitation in middle-aged and older adults. Posterior lumbar interbody fusion (PLIF) is widely performed for its management; however, adjacent segment disease (ASD) remains a clinically relevant postoperative complication and a common reason for reoperation. We aimed to develop and validate a deep learning system based on preoperative lumbar computed tomography (CT) for predicting ASD after PLIF.

Materials and Methods This retrospective multicenter study included 331 patients with lumbar degenerative disease who underwent PLIF between January 2016 and June 2023 at one primary center and two additional institutions. The internal cohort comprised 301 patients, and the external cohort included 30 patients. After image standardization, spinal regions were segmented using a 3D U-Net. The segmented CT data were then analyzed with a 3D ResNet model to predict postoperative ASD. The internal dataset was split into training, testing, and validation sets at a ratio of 70:15:15. Online augmentation and cross-validation were applied to enhance model robustness. External validation was performed independently. Gradient-weighted class activation mapping (Grad-CAM) was used for visual interpretation of model predictions.

Results A total of 94,666 axial CT slices were analyzed. The proposed system achieved high segmentation accuracy and showed strong predictive performance for ASD. The ResNet50 model yielded an accuracy of 89%, sensitivity of 75%, and specificity of 95%. It outperformed the combined assessment of two spine surgeons in accuracy and specificity, and maintained superior performance in the external validation cohort.

Conclusion This deep learning system enabled accurate preoperative prediction of ASD after PLIF using lumbar CT and demonstrated robust performance across internal and external datasets. It may facilitate preoperative risk stratification and help reduce ASD-related reoperations.

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Global Burden of Low Back Pain in Older Adults and Its Attributable Risk Factors From 1990 to 2021

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Introduction Low back pain (LBP) is a leading cause of disability worldwide and poses a particularly substantial burden in older adults. Its epidemiological patterns vary considerably across regions, sexes, and age groups. This study aimed to evaluate temporal trends in the burden of LBP among older adults from 1990 to 2021, describe its demographic and geographic distribution, and identify the major attributable risk factors based on the Global Burden of Disease (GBD) 2021 study.
Materials and Methods Data on LBP were obtained from the Global Health Data Exchange. All estimates and 95% uncertainty intervals were derived from the GBD 2021 study using the Bayesian meta-regression tool DisMod-MR 2.1. Incidence, disability-adjusted life years (DALYs), and age-standardized rates were analyzed by age, sex, and region. Temporal trends were assessed using Joinpoint regression, and the future burden through 2035 was projected.
Results In 2021, an estimated 628.8 million people were affected by LBP globally, including approximately 266.9 million incident cases, with an age-standardized incidence rate of 3,176.6 per 100,000 population. Although the age-standardized incidence rate and age-standardized DALY rate in older adults declined compared with 1990, the absolute burden increased markedly. Women consistently showed a higher burden than men, and the greatest burden was observed in middle-aged and older populations. Projections to 2035 suggest continued declines in age-standardized rates; however, population ageing is likely to sustain a substantial absolute burden. Occupational factors, high body mass index, and smoking were the leading attributable risks, with occupational exposure contributing the most.
Conclusion Despite declining age-standardized rates, LBP remains a major and growing health challenge in older adults because of global population ageing. These findings underscore the need for targeted prevention and control strategies, particularly those focusing on occupational exposure, weight management, and smoking cessation.

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Risk Factors and Nomogram for Postoperative Coronal Imbalance After Corrective Surgery in Adults With Severe Rigid Scoliosis
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Introduction Coronal imbalance (CIB) has been extensively investigated in adolescent scoliosis and adult degenerative scoliosis, yet data remain limited for adults with severe rigid scoliosis (SRS). Persistent postoperative CIB may compromise radiographic correction and clinical outcomes. This study aimed to identify factors associated with postoperative CIB in adult SRS patients and to develop a predictive model to support surgical decision-making.
Materials and Methods We retrospectively reviewed adult SRS patients who underwent corrective fusion with single-level posterior column osteotomy at our institution between August 2012 and January 2019. Standing full-spine anteroposterior radiographs obtained preoperatively, immediately postoperatively, and at follow-up were analyzed. Potential predictors of postoperative CIB were screened using least absolute shrinkage and selection operator (LASSO) regression, and independent risk factors were identified by multivariable logistic regression. A nomogram was then constructed and internally validated.
Results Ninety patients met the inclusion criteria. The mean correction rate of the main curve was 54.17% ± 14.02%, while 24 patients (26.67%) showed CIB at follow-up. Three independent predictors of postoperative CIB were identified: preoperative CIB (OR 12.414, 95% CI 2.228-69.162, P=0.004), main curve flexibility <10% (OR 14.300, 95% CI 2.200-92.957, P=0.005), and immediate postoperative CIB (OR 5.169, 95% CI 1.387-19.263, P=0.014). Receiver operating characteristic and decision curve analyses demonstrated favorable discrimination and clinical utility of the nomogram.
Conclusion Preoperative CIB, poor main curve flexibility, and immediate postoperative CIB were significantly associated with postoperative coronal imbalance in adults with SRS. The proposed nomogram showed promising predictive value and may help optimize preoperative planning and postoperative alignment management in this challenging population.

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Surgical outcomes of cervical posterior fusion using the MICEPS Technique with 3D-CT navigation or robot-Assisted navigation
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Introduction/Objectives This report describes the MICEPS technique (posterior-lateral cervical approach) for posterior cervical fusion, which allows for the insertion of cervical pedicle screws with greater precision and less invasiveness compared to conventional posterior fusion methods. We present the practical details of our surgical procedure, which incorporates 3D CT navigation and robot-assisted navigation.
Materials and Methods The study included surgical cases in which cervical pedicle screws were inserted via a posterolateral approach. We compared three groups—15 cases performed under 3D CT guidance (O group), 20 cases performed with robotic assistance (R group), and 30 cases performed under fluoroscopic guidance (F group)—based on parameters such as operative time, blood loss, and pedicle screw insertion accuracy.
Result/Discussion It was found that Groups O and R demonstrated significantly greater precision in screw insertion compared to Group F. There were no significant differences in operative time or blood loss. Furthermore, there were no significant differences between Groups O and R across any of the data points.
Conclusion The MICEPS approach allows for the shortest route from the skin to the lateral mass, minimizing the dissection of soft tissues such as muscles compared to the conventional midline approach. Furthermore, it has been found that this approach allows for an adequate screw insertion angle without interference from muscles.

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Technique of segmental realignment in higher grade spondylolisthesis by the UBE fusion technique
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Introduction Unilateral biportal endoscopic (UBE) fusion has largely been described for low-grade or stable spondylolisthesis, where the primary goals are neural decompression and interbody fusion. Its role in achieving vertebral reduction in higher-grade slips remains limited. Although a reduction-first UBE strategy has been previously described, available reports are sparse.
Methods We present a 62-year-old female with severe neurogenic claudication and approximately 50% anterior degenerative spondylolisthesis. She underwent UBE transforaminal lumbar interbody fusion (TLIF) with cage placement and percutaneous pedicle screw fixation. Standard ipsilateral decompression with over-the-top contralateral decompression and ipsilateral facetectomy were performed. A contralateral sublaminar facetectomy was added to enhance segmental mobility and facilitate reduction. The key modification in our technique is the operative workflow. Contralateral pedicle screws were inserted at the beginning of the procedure, prior to portal

creation, preserving the option for temporary disc space distraction early in the case. Biportal endoscopic decompression and disc preparation were then completed without interruption. A cage sizer was maintained within the disc space to sustain distraction, acting as a mechanical pivot for controlled reduction of the listhesis. Ipsilateral pedicle screw placement was performed after completion of endoscopic work, with reintroduction of fluoroscopy.
Results Near-complete vertebral reduction was achieved with restoration of alignment parameters. The patient demonstrated significant symptomatic improvement with reduction in pain and improved function.
Conclusion A reduction-first UBE fusion strategy is feasible for higher-grade degenerative spondylolisthesis. Early contralateral pedicle screw placement improves operative workflow by preserving the option for temporary distraction while avoiding intraoperative interruption from fluoroscopic repositioning, while maintaining the minimally invasive adva

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MIS vs Open vs Hybrid approaches for Adult Spinal Deformity: Systematic Review and Meta-Analysis
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Background Minimally invasive (MIS) techniques have been increasingly adopted in adult spinal deformity (ASD) surgery to reduce perioperative morbidity. However, concerns remain regarding their ability to achieve comparable deformity correction and functional outcomes relative to open and hybrid approaches. This systematic review and meta-analysis aimed to compare perioperative, radiologic, and functional outcomes among MIS, hybrid, and open ASD surgery.
Methods A systematic search identified comparative studies evaluating MIS, hybrid, and open surgical techniques for ASD. Four retrospective cohort studies comprising 684 patients were included. Outcomes extracted included estimated blood loss (EBL), operative time, and changes in radiologic parameters (Cobb angle, sagittal vertical axis [SVA], pelvic incidence–lumbar lordosis [PI–LL]) and functional outcomes (Oswestry Disability Index [ODI], visual analogue scale [VAS] back and leg pain). Random-effects models were used where appropriate.
Results Among 684 patients, 192 underwent MIS, 221 hybrid, and 271 open surgery. MIS was associated with significantly reduced EBL compared to open surgery (mean difference [MD] −745 mL, 95% CI −980 to −510), but longer operative time (MD +52 minutes, 95% CI +10 to +94). Hybrid techniques demonstrated intermediate perioperative outcomes. Radiographically, hybrid and open techniques achieved greater correction in Cobb angle (MD −6.8° vs MIS) and PI–LL mismatch (MD −7.5° vs MIS), while improvements in SVA were comparable across groups. All approaches demonstrated significant improvements in functional outcomes. Changes in ODI (−18.5 MIS vs −20.2 hybrid vs −21.1 open) and VAS back and leg pain were comparable between groups, with no clinically significant differences observed.
Conclusions MIS techniques reduce perioperative morbidity but may achieve less radiographic correction compared to hybrid and open approaches. Hybrid techniques appear to offer a balance between reduced surgical invasiveness and effective deformity correction, while functional outcomes remain comparable across all techniques.

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Surgical Challenges in L5–S1 Hemivertebra with Lumbosacral Dysplasia: A Case Series
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Background Hemivertebra at the L5–S1 junction is a rare congenital anomaly often associated with lumbosacral dysplasia, leading to asymmetric loading, deformity, and technical difficulty during surgical correction. The abnormal sacral morphology and distorted disc space make standard interbody fusion strategies challenging, particularly in adolescent patients.
Methods We present three cases of adolescents (15–16 years) with symptomatic deformity secondary to L5–S1 hemivertebra and associated sacral dysplasia. Preoperative evaluation included detailed radiographic assessment of lumbosacral alignment, vertebral morphology, and pedicle anatomy. Surgical management involved deformity correction, stabilization, and interbody fusion where feasible. Particular emphasis was placed on intraoperative technical modifications required for safe cage placement.
Results All patients demonstrated significant anatomical distortion at the lumbosacral junction, including oblique disc spaces, asymmetric sacral endplates, and altered pedicle trajectories. Surgical exposure and instrumentation were technically demanding. Conventional ipsilateral cage insertion was not feasible due to restricted access and risk to neural elements. In all cases, the cage was carefully negotiated from the contralateral side to achieve adequate positioning across the disc space and optimize endplate contact. Deformity correction was achieved in all patients with satisfactory alignment restoration. No major intraoperative neurological complications were observed.
Discussion L5–S1 hemivertebra combined with sacral dysplasia presents unique challenges due to complex three-dimensional deformity and limited working corridors. Standard interbody techniques may not be applicable. The contralateral cage insertion technique offers a useful alternative, allowing safer access and improved implant positioning in distorted anatomy. Careful preoperative planning and intraoperative adaptability are critical in these cases.
Conclusion Surgical correction of L5–S1 hemivertebra in adolescents is demanding but feasible. Modified interbody strategies, including contralateral cage insertion, can help overcome anatomical constraints and achieve effective deformity correction with good early outcomes.

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LLIF Sandwich Technique for Anterior Column Reconstruction: A Case Series of 8 Patients
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Background Anterior column reconstruction for complex lumbar vertebral fractures requires sufficient biomechanical stability while minimizing surgical invasiveness. Recently, the lateral interbody fusion (LIF) sandwich technique, which utilizes multiple cages, has been proposed to enhance anterior column support; however, clinical evidence remains limited.
Methods We retrospectively reviewed 8 consecutive patients (4 males, 4 females; mean age, 54.0 years) who underwent anterior column reconstruction using the LLIF sandwich technique between 2022 and 2024. The procedure involved sandwiching the fractured vertebral body with LIF cages, combined with posterior fixation using percutaneous pedicle screws (PPS) in the lateral position. Perioperative parameters including operative time, blood loss, and length of hospital stay were evaluated.

Radiographic assessment included local kyphosis angle (LK) and vertebral kyphosis angle (VK). Low back pain was assessed using the Visual Analog Scale (VAS), and fusion status was evaluated at 1 year postoperatively.

Results The mean operative time was 253.3 minutes, mean blood loss was 351.4 mL, and mean hospital stay was 31.6 days. The correction rates were 88.8% for VK and 150.0% for LK, indicating substantial kyphosis correction. The mean VAS score improved markedly from 7.25 preoperatively to 1.87 postoperatively. Solid fusion was achieved in all cases at 1 year (fusion rate: 100%). Perioperative complications included one postoperative infection and one case of proximal junctional kyphosis (PJK).

Conclusion The LLIF sandwich technique provides effective kyphosis correction and significant pain relief, suggesting its utility for anterior column reconstruction. However, the occurrence of PJK highlights the need for careful consideration of fixation range, particularly in patients with osteoporosis.

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Robot-assisted Percutaneous Kyphoplasty for Severely Collapsed Osteoporotic Burst Fractures

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INTRODUCTION Robot-assisted spine surgeries have gained traction in recent years, offering the advantage of minimally invasive techniques which improve precision,[JO1.1] reduce bone cement leakage and minimizing radiation exposure. This can also result in better pain relief and faster return to function.

METHODS We present 2 patients who had undergone robot-guided percutaneous balloon kyphoplasty (rPBK). Both patients had sustained fragility fractures. Case 1 is a 77 year-old female who fell from standing height and sustained a severe T12 burst fracture with intact neurology in bilateral lower limbs. She also had multiple previous lumbar spine surgeries cumulating in an L2-S1 decompression, fusion and instrumentation in 2022. We had utilized the Mazor X robotic guidance system to aid with a minimally invasive segment rPBK. Case 2 is a 75 year-old female with a background of system lupus erythematosus, and osteoporosis who sustained a T11 burst fracture with severe vertebral collapse and bilateral lower limb radicular pain with L2 bilateral grade 4 power. Similarly, she had a rPBK done. The robotic workflow involves utilizing a pre-operative computer tomography (CT) scan for planning which is integrated into the Mazor robot to allow for more accurate pre-set trajectories for pedicle entries for injection of deployment of the balloons and subsequent cementing whilst minimizing the risks of complications.

RESULTS Both patients reported significant pain reduction post-operatively and were allowed for weight bearing with spinal orthoses post operatively. Both patients reported marked pain reduction post operatively and with intact neurology.

CONCLUSION Robotic-guided kyphoplasty offers a viable, minimally invasive, and safe option for patients where the margin for error is small. This allows for precise pre-operative planning and intraoperative confirmatory image intensifier shots. This also allows more accurate delivery of bone cement and reduces the chance of cement leakage or endplate injury.

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The OLIF Flip: Lessons from the F1 Pit Crew — A Quality Improvement Initiative to Optimise Turnover Time in Two-Position Oblique Lateral Interbody Fusion Surgery

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Background Oblique lateral interbody fusion (OLIF) combined with posterior instrumentation is increasingly utilised for lumbar degenerative pathology. The two-stage nature requires repositioning from lateral decubitus to prone, introducing an inter-stage turnover interval that increases total anaesthetic time and theatre inefficiency. This QI project aimed to characterise baseline turnover times and evaluate a structured repositioning protocol.

Methods Retrospective review of prospectively collected operative timing data was performed for consecutive two-position OLIF cases at a single institution (Tan Tock Seng Hospital). Inter-stage turnover time was defined as start of lateral wound closure to knife-to-skin in prone. Cases were stratified into pre-intervention (n=35) and post-intervention (n=19) cohorts, with the intervention implemented in September 2025. The "F1 Flip Protocol," modelled on the parallelised task structure of a Formula 1 pit stop, comprised three phases: concurrent team preparation during lateral closure, surgeon-directed repositioning with simultaneous surgical scrub, and parallel timeout with operative draping. Outcomes were compared using the Mann-Whitney U test (α=0.05).

Results Mean turnover time decreased from 53.8 minutes (SD 18.6) to 36.6 minutes (SD 9.5), a reduction of 17.2 minutes (32.0%; 95% CI 9.8–24.6 min; $p<0.001$; rank-biserial correlation 0.64). Procedural consistency improved markedly, with SD halved from 18.6 to 9.5 minutes.

Discussion The magnitude and consistency of improvement suggests that unstructured turnover represents a significant and modifiable inefficiency in two-position OLIF. Parallelising team roles — rather than sequential task completion — appears to be the key driver. Variability reduction is particularly valuable for theatre scheduling and anaesthetic planning.

Conclusion The F1 Flip Protocol significantly reduced inter-stage turnover time by 32% and improved procedural consistency. Prospective multi-centre validation may be pursued in future for wider adoptability of the protocol.

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Does Robotic Assistance Improve Surgical Efficiency in Lumbar Fusion? A Comparative Analysis with 3D Navigation

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Introduction This study aims to compare the timing efficiency of pedicle screw insertion between navigation-guided and robotic-guided techniques across various lumbar fusion procedures.

Materials and Methods A retrospective analysis was conducted of patients undergoing lumbar fusion with either 3D-navigation-guided (O arm) or robotic-assisted (Mazor) pedicle screw insertion. Procedural efficiency was quantified by "Total Screw Time" (minutes), defined as the duration from the insertion of the first screw to the

completion of the final screw. Subgroup analysis was performed based on the number of levels of fusions and instrumentation extending to the pelvis and between OLIF and MIS-TLIF procedures. Appropriate statistical tests (independent-samples t-test or Mann–Whitney U test) were used for continuous variables. A p-value of <0.05 was considered statistically significant.

Results A total of 208 patients undergoing spinal fusion (OLIF and MIS-TLIF) were included in the analysis, divided between Navigation (N) (96 patients) and Robotic-guided (R) (112 patients) cohorts. One-, two-, and three-level fusions were performed in 33 and 49; 33 and 35; and 12 and 11 patients in the Navigation (N) and Robotic-guided (R) groups, respectively. Four-level fusion was performed in nine and two patients in the N and R groups. Nine and fifteen patients underwent instrumentation spanning the pelvis (from T9/T10/T12 and lumbar) in both groups. In patients undergoing shorter fusion (1-3 Levels) surgeries, robotic and navigation assistance did not differ significantly in screw insertion timing in both the open and MIS groups (1 level: 33min vs 21min; 2 level: 38min vs 27min; 3 level: 49min vs 34min). Further subgroup analysis across the OLIF and MIS-TLIF cohorts did not show any statistical difference. However, in patients undergoing long-segment fusion surgeries (>3 levels) & Pelvis instrumentation, there was a statistically significant advantage for the robotic technique over navigation ($p<0.05$). Specifically, for MIS Pelvis fixations, the robotic-assisted technique was nearly twice as fast as navigation (P=0.01).

Conclusion Robotic- and navigation-guided techniques show similar efficiency with respect to pedicle screw insertion time in short-segment lumbar fusion (1–3 levels). However, in constructs involving more than three levels, particularly those extending to the pelvis, robotic assistance significantly reduces screw insertion time, offering a marked advantage—especially in minimally invasive pelvic fixation procedures.

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Determinants of intraoperative radiation dose during single-level tubular lumbar decompression

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Introduction/Objectives Minimally invasive tubular lumbar decompressions offer documented advantages over open techniques in clinical outcomes, length of stay, surgical-site infections, and narcotic use. Fluoroscopy is required to dock the tubular working portal, and understanding expected radiation exposure is important for surgeons considering adoption. Existing studies have relied on fluoroscopy time rather than absorbed dose, limiting quantification of tissue-level exposure, and patient- and case-level determinants remain poorly characterized beyond the learning curve. We aimed to identify determinants of intraoperative radiation dose during single-level tubular lumbar decompressions.

Materials and Methods A consecutive series of 114 single-level tubular unilateral lumbar decompressions performed by a single surgeon were analyzed. The primary outcome was cumulative radiation absorbed dose (mGy) recorded from the C-arm. Predictors included body mass index (BMI), operative level, age, sex, American Society of Anesthesiologists (ASA) class, laterality, preoperative diagnosis, and performance of discectomy.

Result/Discussion Median radiation dose was 2.13 mGy (IQR 1.28–3.50) over a median fluoroscopy time of 4.0 seconds (IQR 3.0–6.0). On multivariable analysis, each 1 kg/m² increase in BMI was independently associated with an 8.0% increase in dose ($p<0.0001$). Upper operative levels (L2-3 and L3-4) independently increased dose by 50.9% relative to lower levels (L4-5 and L5-S1) ($p = 0.015$). Dose-rate analysis revealed that high-BMI patients received significantly more radiation per second of fluoroscopy than low-BMI patients (Kruskal-Wallis $p = 0.0016$). Scenario modeling demonstrated a 7-fold dose difference between best-case (BMI 20, lower level: 1.28 mGy) and worst-case (BMI 40, upper level: 8.95 mGy) scenarios.

Conclusion BMI is a key determinant of intraoperative radiation during tubular lumbar decompression, acting primarily through increased C-arm output power. These findings have direct implications for preoperative radiation planning and patient counseling, particularly in obese patients undergoing upper lumbar decompressions. In this post-proficiency cohort, median fluoroscopy time was 4 seconds with a dose of 2.13 mGy, lower than previously reported ranges.

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Radiation stewardship in uniportal lumbar endoscopic decompression

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Introduction/Objectives Uniportal lumbar endoscopic decompression is fluoroscopy-dependent, and the two dominant approaches, transforaminal (TF) and interlaminar (IL), may impose distinct intraoperative targeting demands. We aimed to examine differences in radiation exposure based on technique and identify modifiable predictors beyond choice of approach.

Materials and Methods We identified 51 consecutive single-level uniportal lumbar endoscopic decompressions with and without unilateral erector spinae blocks (ESB). After excluding four bilateral procedures, two discography cases, and one bilateral ESB, 44 cases remained for analysis (16 TF, 28 IL). Of these, 38 received a single unilateral ESB, 4 received 2 ipsilateral ESBs, and 2 received none. Primary outcomes were intraoperative radiation dose (mGy), fluoroscopy time (seconds), and operative duration. Group comparisons used Mann-Whitney U and Kruskal-Wallis tests; multivariable regression adjusted for approach, laterality, age, BMI, and ESB injection count.

Result/Discussion TF cases delivered 1.8 times the radiation dose of IL cases (median 11.48 vs 6.25 mGy, $p<0.001$) and 2.4 times the fluoroscopy time (56 vs 23.5 seconds, $p<0.001$). In the adjusted model ($n=44$, $R^2=0.48$, F $p<0.00001$), TF approach was an independent predictor of radiation dose ($\exp(\beta)=1.83$, 95% CI 1.25–2.69, $p=0.003$), along with higher BMI ($\exp(\beta)=1.067$ per unit, 95% CI 1.02–1.11, $p=0.004$). In a restricted cohort limited to cases with a single ipsilateral ESB, the TF effect was preserved and IL-specific BMI sensitivity remained strong ($\rho=0.54$, $p=0.003$). A second ESB trended toward increased cumulative dose (95% CI 1.00–2.38, $p=0.051$).

Conclusion Within a single-surgeon uniportal endoscopic practice, intraoperative radiation dose was driven primarily by TF approach and elevated BMI. Because the approach effect persisted after adjustment, surgeons should consider BMI-sensitive technique refinement particularly for IL work. The transforaminal radiation premium is a modifiable cost to be anticipated and mitigated rather than a reason to abandon the approach. Where either approach is feasible, IL may confer benefit through decreased radiation exposure.

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Geographic catchment of patients undergoing tubular versus endoscopic single-level lumbar decompression: a zip-code–based analysis

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Introduction/Objectives Endoscopic spine surgery is marketed as a highly minimally invasive alternative to tubular decompression. While short-term outcome data are emerging, whether the associated branding broadens the geographic catchment of practices offering both techniques is unknown. We aimed to compare travel distance for patients undergoing single-level lumbar decompression by tubular versus endoscopic technique at a single tertiary spine practice.

Materials and Methods We retrospectively identified consecutive single-level lumbar decompressions performed by two fellowship-trained spine surgeons at a single hospital system between 06/2022 and 01/2026, yielding 115 tubular and 62 endoscopic cases with reportable zip codes. Multi-level decompressions were excluded. Straight-line distance from the home zip code to the hospital was the primary outcome. Between-group differences were tested with Welch's t-test and Mann–Whitney U. Robustness was assessed across seven outlier-handling scenarios. A multivariable linear regression modeled distance as a function of age, sex, and surgical group.

Result/Discussion Groups were matched on age (tubular 48.6±17.4 vs endoscopic 45.9±14.2 years, p=0.27) and sex. Mean distance was 217.9 miles (median 72.9) for tubular and 167.1 miles (median 75.7) for endoscopic (Welch p=0.38; Mann–Whitney p=0.85). No outlier-handling scenario produced a significant between-group difference (all p≥0.26). In multivariable regression, surgical group and age were not associated with distance (p=0.91; p=0.51). Female sex was independently associated with ~41% shorter distance (adjusted distance ratio 0.59, p=0.027), driven primarily by the tubular cohort (male median 81.5 vs female median 47.9 miles, p=0.004). Out-of-state tubular patients were disproportionately male (85% vs 48% in-state, Fisher p=0.003).

Conclusion Endoscopic patients did not travel farther than tubular patients at the same institution, robust to multiple outlier-handling strategies and adjustment for age and sex. These data do not support the hypothesis that endoscopic marketing broadens geographic catchment beyond state lines. Practice-level branding warrants further study, as does the unexpected association between female sex and shorter travel distance.

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Does motion preservation confer advantages over fusion for patient's mental health?

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Introduction/Objectives Cervical disc arthroplasty (CDA) preserves intersegmental motion compared with anterior cervical discectomy and fusion (ACDF). While trials have shown equivalence in physical disability and pain outcomes, the influence of CDA's motion-sparing capacity on mental health has not been directly studied. This study examines whether CDA yields greater improvement in mental health metrics at minimum 1-year follow-up compared with ACDF.

Materials and Methods A retrospective chart review was performed on subjects who underwent CDA or ACDF between December 2022 and May 2024 by a single surgeon at one hospital. Sixty-five subjects with paired preoperative and minimum 1-year postoperative PROMIS-10 outcomes were included (39 ACDF, 26 CDA). Age, sex, BMI, operative level(s), and PROMIS-10 Mental Health (MHT) and Physical Health (PHT) T-scores were collected. Continuous variables were compared using Welch's t-test, categorical variables using Pearson chi-square, within-subject baseline vs 1-year comparisons using Wilcoxon signed-rank, and between-group comparisons using Mann-Whitney U.

Result/Discussion Mean postoperative follow-up was 1.86±0.53 years for ACDF and 1.60±0.55 years for CDA. ACDF patients were significantly older (60.0±10.1 vs 44.7±8.5 years, p<0.0001). Median MHT change scores were similar between ACDF (5.7 [IQR 17.1]) and CDA (5.0 [IQR 14.7], p=0.305), while CDA trended toward larger median PHT gains (12.8 [IQR 9.2]) than ACDF (7.8 [IQR 14.1]) without reaching significance (p=0.312). Preoperative MHT trended lower in CDA than ACDF (48.3 vs 53.3, p=0.070). Both groups demonstrated statistically significant within-subject improvements in MHT and PHT, with comparable mental health gains.

Conclusion At 1-year follow-up, ACDF and CDA conferred comparable improvements in PROMIS-10 mental and physical health scores. Short-term outcomes may differ, as preserved motion with CDA could translate into earlier return to activity and more favorable perception postoperatively. Baseline differences including younger age and higher proportion of 1-level procedures among CDA patients may confound comparisons. Larger matched-cohort analyses with early time points are needed.

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Return to play in recreational hockey players after one-level minimally invasive Wiltse transforaminal lumbar interbody fusion — minimum 5-year follow-up

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Introduction/Objectives To evaluate return-to-play outcomes, pain outcomes, hockey-specific movement confidence, and psychological readiness in recreational hockey players following one-level Wiltse transforaminal lumbar interbody fusion (TLIF).

Materials and Methods A prospective registry was queried retrospectively for hockey players who underwent single-level Wiltse TLIF by a single surgeon between 2010 and 2020. Patient-reported outcomes included Visual Analog Scale (VAS) scores for low back and leg pain at minimum 5-year follow-up. Hockey-specific parameters included return-to-play status, time to return, pre- and postoperative confidence in 10 hockey-specific movements on a 5-point Likert scale, perceived barriers to return, and Fear of Return to Sport (FRESS) scores. Paired t-tests and Wilcoxon signed-rank tests were used for statistical comparisons.

Result/Discussion Sixteen patients (14 male, 2 female; mean age 44.9 years) were included with mean follow-up of 10.26 years. Significant improvements were observed in average low back pain VAS (4.2 to 1.7, p=0.001), worst low back pain VAS (6.4 to 2.7, p<0.001), and average leg pain VAS (3.2 to 0.9, p=0.023). Fifteen patients (93.8%) reported ability to return to hockey, while 12 (75.0%) returned; 75% resumed their preoperative level of play at a mean of 6.4 months. Postoperative movement confidence was equal to or higher than preoperative levels across all 10 movements. Mean FRESS score was 33.4 (SD 31.5), indicating variable psychological readiness.

Conclusion One-level Wiltse TLIF provides durable pain relief and high return-to-play rates in recreational hockey players. Psychological readiness varies considerably and should be incorporated into postoperative counseling alongside structured physical rehabilitation.

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Superb microvascular imaging detects exercise-induced blood flow changes in the lumbar multifidus: non-invasive monitoring of paraspinal muscle perfusion

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Introduction/Objectives The lumbar multifidus is the primary dynamic stabilizer of the lumbar spine, and its dysfunction is strongly implicated in low back pain. While minimally invasive spine (MIS) approaches aim to preserve paraspinal muscle integrity, most research has focused on structural changes such as cross-sectional area and fat fraction. Comparatively little is known about multifidus vascularity, despite evidence that impaired microvascular perfusion may contribute to muscle degeneration and that surgical retraction can compromise local blood supply. Superb microvascular imaging (SMI) is an ultrasound modality capable of detecting low-velocity microvascular flow without contrast agents. Whether SMI can reliably detect exercise-induced blood flow changes in the lumbar multifidus has not been established.

Materials and Methods Ten healthy subjects underwent SMI ultrasound of the right lumbar multifidus before and after prone back extensions (4×1-minute sets, 15-second rest). Images were acquired at five time points (pre-exercise, 1, 3, 5, and 10 minutes post-exercise). Red pixel frequency (% vascular pixels within the region of interest) and mean red intensity were calculated as perfusion proxies, using a data-driven classification threshold (R>40, dominance ratio 1.5×) validated via sensitivity analysis. Repeated-measures ANOVA assessed temporal changes; paired t-tests and Wilcoxon tests compared pre- versus 1-minute post-exercise values.

Result/Discussion At 1 minute post-exercise, red pixel frequency increased by 50.2% ($p=0.028$, Cohen's $d=0.83$) and mean red intensity by 14.2% ($p=0.031$, $d=0.81$), with increases in 8/10 and 9/10 subjects, respectively. ANOVA confirmed a significant effect of time for both frequency ($p=0.016$) and intensity ($p=0.026$), with peak perfusion at 1 minute and gradual recovery by 10 minutes. Results were robust across alternative thresholds (R>35, R>40, R>50; all $p<0.05$).

Conclusion SMI ultrasound can detect large-magnitude changes in lumbar multifidus perfusion following exercise, supporting SMI as a non-invasive, contrast-free tool for monitoring paraspinal muscle blood flow. This technique holds potential for assessing recovery after MIS procedures and guiding postoperative rehabilitation.

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Endoscopic management of a duplicate nerve root – technique

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Introduction/Objectives Congenital nerve root anomalies (NRAs) are rare yet clinically significant findings that can complicate lumbar spine surgery and lead to iatrogenic injury. While these anomalies have been reported in open and tubular microdiscectomy techniques, their management within an endoscopic framework remains undocumented. This report presents a case and technical note on the management of a duplicated exiting nerve root encountered during endoscopic decompression and describes a reproducible surgical approach for safe management.

Materials and Methods A 69-year-old woman presented with right lower extremity radicular pain and progressive foot drop following a far-lateral L5-S1 disc herniation. Conservative management with physical therapy and anti-inflammatory medications failed to relieve symptoms. MRI revealed severe foraminal stenosis compressing the right L5 nerve root. The patient underwent a right L5-S1 far-lateral endoscopic microdiscectomy.

Result/Discussion Intraoperatively, a duplicate right L5 exiting nerve root was identified within the foramen. Careful dissection and visualization were emphasized to avoid iatrogenic injury. A novel "rotating neural blockade" technique was employed. Postoperatively, the patient experienced early transient neural irritation followed by steady improvement. At 3-month follow-up, she had complete resolution of radicular pain, full motor strength recovery, and full return to work and recreational activities.

Conclusion This case represents the first documented report of an endoscopically managed duplicate nerve root. The "rotating neural blockade" technique enhances intraoperative safety and may be incorporated into routine endoscopic spine procedures to mitigate the risk of neural injury, even in normal anatomy. This case highlights the importance of meticulous preoperative imaging review and emphasizes that endoscopic visualization, despite a smaller working corridor, offers enhanced visualization that aids in management of complex nerve variations.

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Evolution and Clinical Validation of a Novel Square Expandable Cannula for Uniportal Interlaminar Endoscopic Lumbar Interbody Fusion (Endo-ILIF)

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Objective Uniportal interlaminar endoscopic lumbar interbody fusion (Endo-ILIF) is constrained by a safety versus size paradox: a small corridor protects neural elements but forces an undersized cage, while a larger corridor accepts a conventional cage at the cost of greater dilation trauma to the exiting nerve root. The authors describe a reversibly expandable square cannula that decouples incision size from cage footprint.

Methods A four-component modular cannula was built around a reversible circle-to-square transition. It enters through a 12 mm skin incision in a collapsed circular profile, expands in situ to an 18 mm outer width with a 12mm internal square corridor for disc preparation and cage delivery, and collapses for withdrawal through the same incision. The prototype was scored against nine bench metrics and applied in 36 consecutive patients undergoing uniportal interlaminar Endo-ILIF with continuous intraoperative neurophysiological monitoring (IONM). Primary endpoints were new postoperative neurologic deficit and change in the Oswestry Disability Index (ODI).

Results Bench testing confirmed reproducible expansion-collapse cycling, structural integrity under simulated cage impaction, and spatial fit within the L3 to S1 interlaminar windows. In the clinical cohort (23 female, 13 male; mean operative time 152 min, 135 min for single-level cases; mean follow up 22.9 ± 9.4 months), the cannula accepted conventional 8 to 16 mm PEEK cages through the 12 mm incision in every case. No patient (0/36) sustained a new postoperative deficit. IONM detected transient nerve contact in 3 patients (8.3%), all at L5 to S1, all resolving with repositioning. ODI improved from 24.1 ± 3.8 to 5.0 ± 2.2 (Wilcoxon $W = 666$, $p < 0.001$).

Conclusions A reversibly expandable square cannula addresses the safety versus size paradox of Endo-ILIF, permitting conventional cage delivery through a 12 mm incision with a favorable safety profile and meaningful functional improvement at nearly two years. Clustering of IONM alerts at L5 to S1 reinforces that mechanical shielding and neurophysiological surveillance remain complementary at the lumbosacral junction.

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Clinical Outcomes of Interlaminar Full-endoscopic Versus Conventional Decompression for Lumbar Spinal Stenosis: Part 1 of the ENDO-F Randomized Controlled Trial

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Conflict of Interest Statement
Jin-Sung Kim reports consultancy relationships with RIWOSpine (Germany), Elliquence (USA), Nexon Medical AG (Switzerland), Moving Spine (Switzerland), Simulatory (Switzerland), and VistaRobotics (USA), none of which are relevant to the content of this manuscript. Junseok Bae reports a consultancy relationship with Joimax (Germany). All other authors declare no conflicts of interest.

Background Lumbar spinal stenosis (LSS) is commonly treated by surgical decompression. While conventional decompression remains the standard, interlaminar full-endoscopic (uniportal) decompression has emerged as a less invasive alternative. A companion trial (ENDO-B Trial) recently demonstrated equivalence between biportal endoscopic and microscopic laminectomy. However, whether uniportal full-endoscopic decompression achieves equivalent outcomes remains unestablished by Level I evidence.
Questions/purposes We asked: (1) Does interlaminar full-endoscopic lumbar decompression result in equivalent functional outcomes as measured by the Oswestry Disability Index (ODI) compared with conventional decompression? (2) Are pain relief, patient satisfaction, and perioperative outcomes similar between techniques? (3) Is decompression alone without fusion effective regardless of the presence of degenerative spondylolisthesis?
Methods We conducted a multicenter RCT in South Korea. Between August 2021 and February 2024, 117 patients with LSS were randomized to interlaminar full-endoscopic lumbar decompression (n = 60) or conventional decompression (n = 57). Of these, 105 (89.7%) achieved minimum follow-up and met inclusion criteria (53 endoscopic, 52 conventional). Three patients were excluded post hoc for multi-level pathology and confounding pain sources. Mean follow-up was 20.8 ± 10.1 months (range 9–48). Baseline characteristics were well balanced. The primary outcome was the ODI, with an equivalence margin of ±12.8 points (MCID). Degenerative spondylolisthesis (Grade 1) was present in 48 patients (45.3%). All underwent decompression alone without fusion.
Results ODI at final follow-up showed no difference (10.7 ± 11.3 vs 10.0 ± 11.8, mean difference +0.7 [95% CI -3.7 to 5.1]; p = 0.655), demonstrating equivalence. Both groups improved substantially (ODI Δ -26.5 and -27.1, both p < 0.001). VAS pain, satisfaction, and walking capacity were similar at all timepoints. The endoscopic group had smaller incisions (12.9 vs 43.1 mm, p < 0.001), shorter hospital stays (107 vs 136 hr, p < 0.001), and less drainage (67 vs 144 mL, p < 0.001), but longer operative times per level (129 vs 85 min, p < 0.001). Operative time in the endoscopic group increased with stenosis severity (Schizas B: 95 min, C: 132 min, D: 143 min; p = 0.029), whereas conventional surgery was unaffected (p = 0.740). In the spondylolisthesis subgroup, decompression alone was equally effective in both groups, with no slip progression in the endoscopic group versus 22.2% in the conventional group. In the spondylolisthesis subgroup, slip progression occurred in 0% of endoscopic vs 22.2% of conventional patients (p = 0.037). Adverse event rates were numerically higher in the conventional group (17.3% vs 9.4%) without reaching statistical significance (p = 0.265).
Conclusion Interlaminar full-endoscopic lumbar decompression achieved equivalent functional outcomes to conventional decompression, with perioperative advantages but longer operative time that increased with stenosis severity. Overall adverse event rates were numerically higher in the conventional group without reaching statistical significance. Decompression alone without fusion was effective regardless of Grade 1 lumbar spondylolisthesis, with equivalent clinical improvement and significantly less slip progression in the endoscopic group.
Level of Evidence Level I, therapeutic study.

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Postoperative Spinal Epidural Hematoma(POSEH) in Full Endoscopic Spine Decompressive Surgery: A Case Series and Clinical Review on Drainage, Hemostasis, and Topical Sealants

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Introduction/Objectives Postoperative spinal epidural hematoma (POSEH) is a rare but clinically significant complication after lumbar decompression surgery. While the role of routine postoperative drainage remains controversial, the importance of intraoperative hemostasis and the implications of topical hemostatic agents deserve greater attention. This study aimed to present symptomatic POSEH after full-endoscopic unilateral laminotomy for bilateral decompression (FEULBD) and to highlight the clinical relevance of intraoperative bleeding control and hemostatic material use.
Materials and Methods We retrospectively reviewed 84 consecutive patients with symptomatic lumbar spinal stenosis who underwent FE-ULBD at a single center between January 2022 and January 2024 without routine postoperative drainage. Clinical outcomes included Oswestry Disability Index (ODI), visual analog scale (VAS) for leg pain, complications, and reoperation rates. Two patients with symptomatic POSEH requiring reintervention were analyzed in detail.

Results/Discussion Mean operative time was 137.4 minutes, estimated blood loss was 7.2 mL, and mean hospital stay was 2.3 days. ODI improved from 29.23 preoperatively to 11.3 at 12 months, and VAS leg pain improved from 7.0 to 1.09 (both $p<0.001$). The overall complication rate was 2.3% (2/84), and the reoperation rate was 4.7% (4/84). One patient developed delayed symptomatic epidural hematoma requiring urgent evacuation, whereas another developed recurrent claudication after intraoperative use of Floseal for persistent epidural venous and bony oozing. These cases highlight that postoperative compressive lesions may still occur after endoscopic decompression and that Floseal may complicate postoperative symptom and imaging interpretation.

Conclusion Symptomatic POSEH remains an uncommon but important complication after FE-ULBD. These cases underscore that meticulous intraoperative hemostasis is critical in endoscopic decompression and that topical hemostatic agents such as Floseal should be used judiciously. Careful postoperative assessment is essential, especially when recurrent symptoms and equivocal imaging findings are encountered. The preventive role of routine postoperative drainage remains uncertain.