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RESEARCH

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Comparison of clinical efficacy and radiological findings of interspinous dynamic stabilization system versus unilateral biportal endoscopy for lumbar spinal stenosis: a retrospective cohort study

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Abstract

Background Posterior lumbar interbody and fusion (PLIF) for lumbar spinal stenosis (LSS) has declined in recent years, with non-fusion techniques such as the interspinous dynamic stabilization system (IDSS) and unilateral biportal endoscopy (UBE) gaining prominence. However, there remains a paucity of comparative studies directly evaluating the therapeutic efficacy between these two distinct non-fusion approaches—IDSS as a motion-preserving stabilization method and UBE as a minimally invasive decompression technique. This investigation seeks to systematically assess and contrast both clinical efficacy and radiological findings associated with IDSS and UBE interventions in LSS management.

Methods This retrospective cohort study analyzed 209 patients with LSS treated between January 2015 and January 2022, stratified into two cohorts: the IDSS group ($n = 112$) and the UBE group ($n = 97$). Demographic and perioperative parameters, including age, gender, body mass index (BMI), hospital stay, operative time, intraoperative fluoroscopy frequency, blood loss, incision length and postoperative complications, were systematically documented for comparative analysis. Clinical outcomes were evaluated using the Visual Analogue Scale (VAS) for low back and leg pain and the Oswestry Disability Index (ODI) at four intervals: Preoperative, 1-month postoperative, 3-month postoperative, and the final follow-up. Therapeutic efficacy was further quantified at the final follow-up utilizing the modified MacNab criteria. Radiographic findings compared preoperative and final follow-up measurements across four parameters: segmental range of motion (SROM), intervertebral space height (ISH), facet joint preservation rate (FJPR) and dural sac cross-sectional surface area expansion rate (DSCAER).

Results Baseline characteristics including age, sex, BMI, surgical levels, and intraoperative fluoroscopy frequency showed no statistically significant differences between groups ($P > 0.05$). Regarding clinical outcomes, the UBE

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group demonstrated superior performance than the IDSS group, including operative duration (61.10 ± 10.39 vs. 70.59 ± 11.21 min), estimated blood loss (32.06 ± 10.11 vs. 52.94 ± 12.85 ml), incision length (1.85 ± 0.26 vs. 5.68 ± 0.69 cm), hospital stay (4.17 ± 0.93 vs. 5.82 ± 1.16 days), and complication rates (18.75% vs. 9.28%) (all $P < 0.05$). Both groups exhibited significant postoperative improvements in low back pain VAS, leg pain VAS, and ODI scores at 1-month, 3-month, and final follow-up intervals compared to preoperative baselines ($P < 0.05$). Intergroup comparisons of these functional outcomes revealed no significant differences across all timepoints ($P > 0.05$). Modified MacNab criteria showed comparable excellent/good rates between cohorts (IDSS: 84.82% vs. UBE: 89.69%, $P > 0.05$). Radiographic findings: At final follow-up, the UBE group maintained preoperative SROM in the operated segments ($P > 0.05$), whereas the IDSS group showed significant SROM restriction (ΔSROM=-2.09 ± 0.91°, $P < 0.05$). No significant differences were observed in ISH, FJPR, and DSCAER between the two groups postoperatively compared to preoperative values, or in intergroup comparisons ($P > 0.05$).

Conclusion Both IDSS and UBE can effectively alleviate pain and improve quality of life in patients with LSS, achieving satisfactory clinical outcomes. Compared to IDSS, UBE is associated with minimized tissue trauma, fewer surgical complications and better preservation of SROM. These advantages position UBE as the preferentially recommended surgical approach for LSS.

Keywords Interspinous dynamic stabilization system (IDSS), Unilateral biportal endoscopy (UBE), Lumbar spinal stenosis (LSS), Clinical efficacy, Radiological findings

Background

With the advancement of minimally invasive concepts in spinal surgery and in-depth biomechanical research, the application of posterior lumbar interbody and fusion (PLIF) in treating lumbar spinal stenosis (LSS) has shown a significant decline [1, 2]. Compared to the rigid fixation of spinal motion units in traditional fusion techniques, non-fusion approaches represented by interspinous dynamic stabilization systems (IDSS) and unilateral biportal endoscopy (UBE) techniques are gradually emerging as clinical focus due to their advantages in preserving segmental mobility and reducing the risk of adjacent segment degeneration [3–5].

Currently, two mainstream non-fusion techniques exhibit distinct characteristics: Firstly, IDSS achieve dynamic stability by implanting elastic devices to maintain intervertebral space height without requiring vertebral fusion [6]; Secondly, UBE enables precise nerve decompression through visualized channels, combining minimally invasive advantages with rapid recovery [7]. However, existing studies predominantly focus on efficacy analysis of single techniques, lacking systematic comparisons between these two approaches regarding postoperative pain relief, functional recovery, complication control, and improvements in radiographic parameters.

This study aims to comprehensively evaluate the clinical efficacy and radiological findings differences between IDSS and UBE for LSS through a retrospective cohort design. Key analyses will focus on core indicators including postoperative VAS scores, ODI indices, the modified MacNab criteria, segmental range of motion (SROM), intervertebral space height (ISH), facet joint preservation rate (FJPR) and dural sac cross-sectional surface area expansion rate (DSCAER), thereby providing evidence-based guidance for clinical surgical selection.

Materials and methods

Patient characteristics

A retrospective analysis was conducted on patients with LSS treated with IDSS and UBE in our department from January 2015 to January 2022. Patients meeting the following criteria were included in this study. Inclusion criteria: (1) Preoperative imaging indicated single-segment lumbar spinal stenosis; (2) Imaging findings consistent with clinical symptoms; (3) Symptoms affecting daily life with poor response to conservative treatment; (4) No lumbar instability at the affected segment (preoperative hyperextension-flexion lateral X-rays showed an angular difference of < 10° between adjacent vertebral endplates or vertebral translation distance < 4 mm) [8]. **Exclusion criteria**: (1) Patients with multi-level lumbar spinal stenosis; (2) Accompanying lumbar spondylolisthesis, degenerative scoliosis, or spinal instability; (3) History of previous lumbar surgery; (4) Lumbar tuberculosis, tumors, disc infection, ankylosing spondylitis, fractures, etc.; (5) Patients with coagulation disorders.

According to the inclusion and exclusion criteria, a total of 209 patients with LSS were enrolled in this study. Patients were divided into two groups: the IDSS group ($n = 112$) and the UBE group ($n = 97$) depending on the different surgical techniques they received. There was no statistically significant difference in demographic or clinical characteristics between the two groups (Table 1). Preoperative and postoperative radiographic assessments, including lateral and dynamic X-rays, computed tomography (CT) and magnetic resonance imaging (MRI) examinations of the lumbar spine were completed

Table 1 Patient characteristics (Mean ± SD)

Characteristic	IDSS group (*n* = 112)	UBE group (*n* = 97)	*P*-Value
Age, years	62.12 ± 10.28	64.18 ± 9.90	0.305
Sex			0.730
Male	50	41	
Female	62	56	
Body mass index (kg/l^2)	25.21 ± 2.01	25.44 ± 2.31	0.595
Surgical segments			0.584
L3/4	18	15	
L4/5	61	47	
L5/S1	33	35	

IDSS interspinous dynamic stabilization system, UBE unilateral biportal endoscopy; $P < 0.05$, statistical significance

in both groups before and after surgery. All procedures were performed by the same surgeon who had experience in more than 150 cases of IDSS and UBE surgery.

Surgical techniques

IDSS group

After general anesthesia, the patient was placed in the prone position. The surgical field was routinely sterilized and draped. A posterior midline incision was made. The paraspinal muscles were dissected bilaterally to expose the laminae, with careful preservation of the supraspinous ligament. Bilateral laminotomy and decompression were performed under direct visualization, maintaining protection of the facet joint structures. The neural foramen was enlarged, and the nerve roots were thoroughly explored. When intervertebral disc herniation causing nerve root compression was identified, the protruding disc material was excised. After confirming adequate nerve root decompression, the supraspinous ligament was separated from the upper and lower spinous processes and retracted. The interspinous ligament and ligamentum flavum were resected to expose the posterior aspect of the dural sac1. The superior and inferior edges of the spinous processes were trimmed. A trial spacer was inserted to confirm appropriate tension, followed by implantation of an IDSS (Coflex) of suitable size between the spinous processes, maintaining a 2 mm safety distance from the dural sac. The device was securely fixed, and the supraspinous ligament was reattached through drill holes in the spinous processes. The wound was closed in layers with routine suturing.

UBE group

Following general anesthesia, the patient was positioned prone. The target intervertebral space was confirmed using C-arm fluoroscopy. Two vertical incisions were made centered on the spinous process base of the superior vertebra. The proximal incision served as the endoscopic observation portal for inserting a 0° spinal endoscope, while the distal incision functioned as the working channel for surgical instruments. Through the working channel, soft tissues overlying the lamina and ligamentum flavum were dissected using plasma radiofrequency ablation. Partial resection of the lamina edge and medial inferior articular process exposed the superior and inferior borders of the ligamentum flavum. After separating and removing the ligamentum flavum, the dural sac was visualized. The medial aspect of the superior articular process was partially resected to expose the nerve root. Herniated discs compressing neural structures were excised when identified. For bilateral symptoms requiring contralateral decompression, the endoscope and working channel were redirected to perform contralateral spinal canal decompression. Partial resection of the spinous process base created adequate space for undercutting contralateral decompression. The hypertrophied contralateral ligamentum flavum was removed, with medial facet joint resection performed as needed to expose the contralateral nerve root. Throughout the procedure, facet joint integrity was preserved to maintain spinal stability. Final confirmation included verifying nerve root mobility and satisfactory dural sac pulsation. Following meticulous hemostasis, instruments and endoscopes were withdrawn, and incisions were closed in layers.

Clinical and radiological assessment

Comprehensive perioperative data were systematically collected, encompassing demographic variables (age, sex, body mass index (BMI)), procedural details (surgical segment levels, operative duration, fluoroscopy utilization frequency), and outcome metrics (estimated blood loss, incision length, hospital stay duration). Postoperative complications were rigorously documented. Patient-reported outcomes including low back and leg pain severity were quantified using Visual Analogue Scale (VAS) scores, while functional disability was assessed via the Oswestry Disability Index (ODI). These evaluations were performed at four time points: preoperatively and at 1-month, 3-month, and final postoperative follow-up assessments. Treatment success was ultimately determined using modified MacNab criteria during terminal follow-up.

Comparative radiographic analysis between cohorts included the following parameters measured preoperatively and at final follow-up (Fig. 1): (i) Segmental Range of Motion (SROM) [9]: Defined as the angular difference between the inferior endplate of the cephalad vertebra and superior endplate of the caudal vertebra in flexion-extension radiographs. (ii) Intervertebral Space Height (ISH) [10]: Calculated as the mean distance between the inferior endplate of the superior vertebra and superior endplate of the inferior vertebra at the operative level. (iii) Facet Joint Preservation Rate

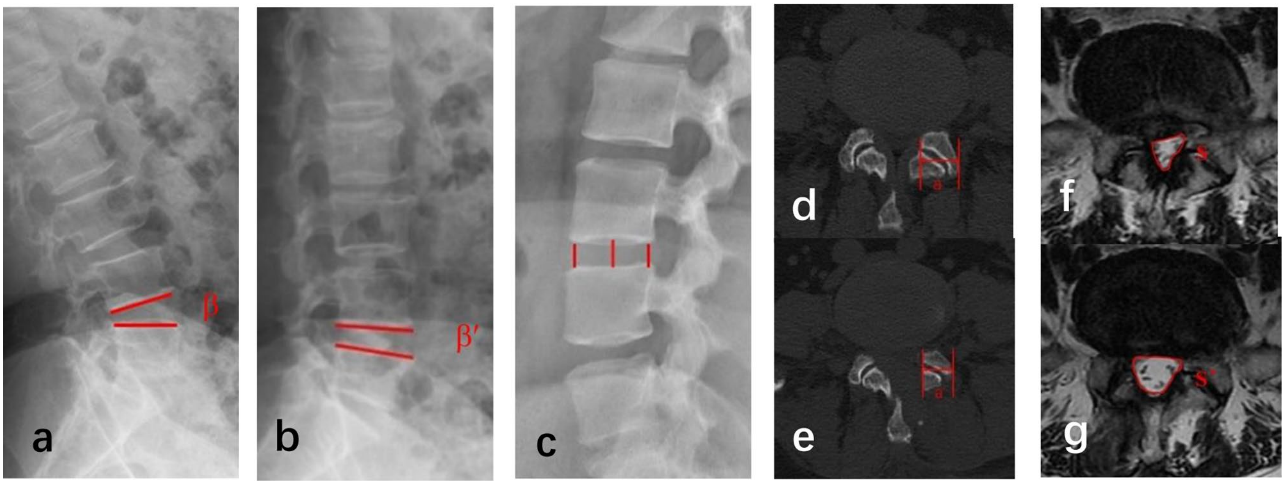

Fig. 1 **a-b** Segmental Range of Motion (SROM): Calculated as the angular difference between extension and flexion radiographs, where SROM = β (extension measurement) - β′ (flexion measurement). **c** Intervertebral Space Height (ISH): Quantified as the mean vertical distance between the inferior and superior vertebral endplates. **d-e** Facet Joint Preservation Ratio (FJPR): Two parallel lines are drawn perpendicular to the superior articular surface, anchored at its innermost and outermost anatomical margins, respectively. The horizontal separation between these two lines quantifies the facet joint width [distances a (preoperative) and a′ (postoperative)]. Determined using the formula FJPR = (a′/a) × 100%, where distance a represents preoperative facet joint width and distance a′ indicates postoperative facet joint width. **f-g** Dural Sac Cross-sectional Area Expansion Rate (DSCAER): Computed as [(S′ - S)/S] × 100%, where S denotes the preoperative dural sac cross-sectional area on MRI, and S′ corresponds to the postoperative measurement

(FJPR) [11]: FJPR=(Postoperative FJ Width/Preoperative FJ Width)×100%. (iv) Dural Sac Cross-sectional surface Area Expansion Rate (DSCAER) [12]: DSCAER (%)=(Postoperative DCSA – Preoperative DCSA)/Preoperative DCSA×100%.

Statistical analysis

The statistical analyses were conducted using SPSS 19.0 software. Normally distributed continuous variables were presented as mean ± standard deviation (SD). Intergroup comparisons of continuous data were performed using independent samples t-tests, while categorical variables were analyzed using chi-square tests. Longitudinal changes in clinical scores across multiple time points within groups were evaluated through one-way repeated-measures analysis of variance (ANOVA). Intragroup comparisons of preoperative and postoperative outcomes, including clinical scores and radiographic parameters, were assessed using paired t-tests. All statistical tests were two-tailed, and a probability threshold of $P < 0.05$ defined statistical significance..

Results

Clinical efficacy

Comparative analysis of baseline demographic characteristics (including age, sex, BMI, and surgical segments) revealed no statistically significant differences between the two groups ($P > 0.05$) (Table 1). The UBE group demonstrated superior perioperative outcomes, achieving statistically significant advantages in multiple metrics: shorter operative time ($P < 0.05$), reduced estimated blood loss ($P < 0.05$), minimized incision length ($P < 0.05$), and abbreviated hospital stay duration ($P < 0.05$) compared to the IDSS group (Table 2). Notably, intraoperative fluoroscopy frequency showed no significant intergroup variation ($P > 0.05$) (Table 2).

Table 2 Comparison of perioperative indicators between two groups (Mean ± SD)

Index	IDSS Group (*n* = 112)	UBE Group (*n* = 97)	*P*-Value
Operative duration (min)	70.59 ± 11.21	61.10 ± 10.39	0.000
Fluoroscopy Frequency	4.35 ± 0.87	4.58 ± 0.70	0.134
Estimated Blood Loss (ml)	62.94 ± 12.85	32.06 ± 10.11	0.000
Incision Length(cm)	5.68 ± 0.69	1.85 ± 0.26	0.000
Hospital Stay duration (days)	5.82 ± 1.16	4.17 ± 0.93	0.000
Complications	21	9	0.042
Dural Tear	2	3	
Intraspinal Hematoma	3	2	
Incision Infection	2	0	
Transient Leg Pain or Numbness	4	3	
Spinous Process Fracture	3	0	
Implant Displacement	4	0	
Revision Surgery	3	1	

$P < 0.05$, statistical significance

Comparative analysis of complication profiles revealed statistically significant intergroup difference ($P < 0.05$) (Table 2). In the IDSS cohort (follow-up range: 36–120 months), a complication rate of 18.75% (21/112) was documented, including: 2 dural tears, 3 intraspinal hematomas, 2 incision infections, 4 transient leg pain or numbness, 3 spinous process fractures, 4 implant

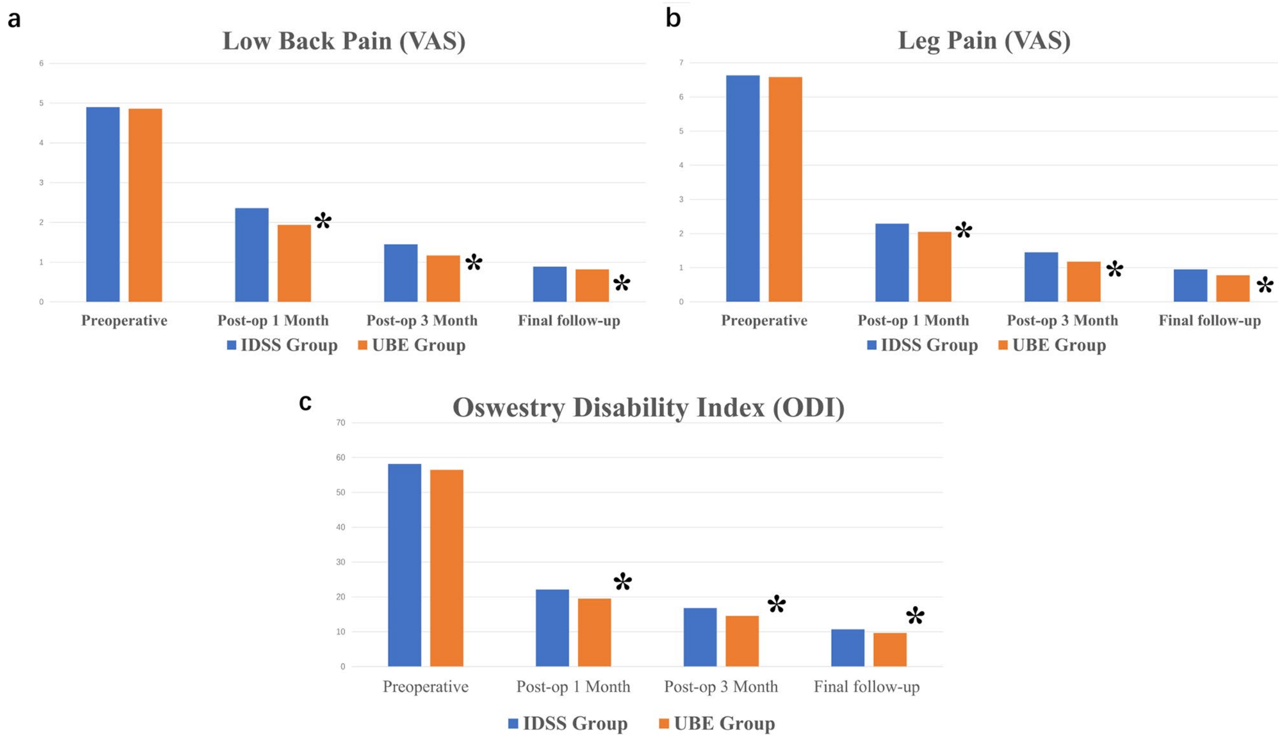

Fig. 2 The visual analogue scale (VAS) and Oswestry Disability Index (ODI) were showed at each point in time. * Statistically significant change compared to preoperative period in each group through ANOVA, $P < 0.05$. IDSS: Interspinous Dynamic Stabilization System, UBE: Unilateral Biportal Endoscopy

Table 3 Modified MacNab outcome assessment of patient satisfaction

Index		IDSS group ($n = 112$)	UBE group ($n = 97$)
Modified MacNab Criteria	Excellent	84	79
	Good	11	8
	Fair	13	7
	Poor	4	3
Excellent/good rate(%)		84.82%	89.69%
P-value	0.285		

$P < 0.05$, statistical significance

displacements, and 3 revision surgeries. In contrast, the UBE group (follow-up range: 36–60 months) demonstrated a comparatively lower complication rate of 9.28% (9/97), with complications limited to 3 dural tears, 2 intraspinal hematomas, 3 transient leg pain or numbness, and 1 revision surgery. If implant-related complications are excluded, the adjusted complication rate for IDSS would be 12.50% (14/112) versus 9.28% (9/97) for UBE. Statistical analysis revealed that non-implant-related complications were comparable between the two groups, with no statistically significant difference ($P > 0.05$).

Both techniques achieved significant clinical improvement across all evaluated parameters. Within-group comparisons showed progressive reductions in low back pain VAS, leg pain VAS, and ODI scores from preoperative baselines to 1-month, 3-month, and final follow-up assessments (all $P < 0.05$) (Fig. 2). Intergroup analysis revealed no statistically significant differences in these functional outcomes at any timepoint ($P > 0.05$) (Fig. 2). At final follow-up, clinical outcomes assessed using the modified MacNab criteria revealed excellent/good rates of 84.82% (95/112) in the IDSS group and 89.69% (87/97) in the UBE group, with no statistically significant intergroup difference in therapeutic efficacy ($P > 0.05$) (Table 3).

Radiological findings

The IDSS cohort demonstrated significant restriction in postoperative SROM at the operative level compared to preoperative measurements (ΔSROM=-2.09 ± 0.91°,$P < 0.05$). In contrast, the UBE group maintained comparable SROM values between preoperative and postoperative assessments ($P > 0.05$). While preoperative SROM parameters showed no intergroup disparity ($P > 0.05$), postoperative analysis revealed significantly greater mobility preservation in the UBE group versus IDSS ($P < 0.05$) (Table 4). ISH remained stable in both cohorts, with no statistically significant alterations detected within groups or between groups ($P > 0.05$). Comparative analysis of anatomical preservation metrics showed equivalent performance in FJPR ($P > 0.05$) and DSCAER ($P > 0.05$) (Table 4). Representative cases are shown in Figs. 3 and 4.

Table 4 Comparison of radiological parameters between the two groups (Mean ± SD)

Index	IDSS Group (n = 112)	UBE Group (n = 97)	P-Value*
SROM(°)			
Preoperative	6.47 ± 1.03	6.69 ± 0.81	0.161
Last follow-up	4.54 ± 0.80	6.61 ± 0.73	0.000
P-Value$^{\Delta}$	0.000	0.113	
ISH (mm)			
Preoperative	7.88 ± 0.83	7.76 ± 1.23	0.564
Last follow-up	7.84 ± 0.77	7.79 ± 1.16	0.426
P-Value$^{\Delta}$	0.568	0.274	
FJPR(%)	72.24 ± 5.81	71.12 ± 5.43	0.318
DSCAER	89.53 ± 5.52	87.98 ± 56.47	0.196

SROM: Segmental Range of Motion; ISH: Intervertebral Space Height; FJPR: Facet Joint Preservation Ratio; DSCAER: Dural Sac Cross-sectional Area Expansion Rate

Δ indicates intragroup comparisons, * Indicates intergroup comparisons. P < 0.05, statistical significance

Discussion

Driven by advancements in minimally invasive spinal technologies, motion-preserving strategies have emerged as alternatives to fusion paradigms [1, 2]. IDSS and UBE exemplify this paradigm shift, demonstrating comparable pain relief to traditional fusion while preserving segmental mobility [4–7]. These techniques reduce surgical trauma through muscle-sparing approaches, enabling shortened hospitalization time and reduced reoperation rate for adjacent segment degeneration compared to fusion cohorts [6–7]. Biomechanical studies confirm IDSS maintains near-physiological load distribution while UBE's dual-portal design achieves 360° decompression and effectively preserves facet joint [13, 14]. Their synergistic benefits—enhanced recovery, reduced iatrogenic instability, and adjacent segment degeneration prevention—are reshaping surgical algorithms for degenerative lumbar pathologies [15, 16].

IDSS achieves decompression and nerve root release at the surgical segment through partial resection of the ligamentum flavum and facet joints, combined with enlargement of the nerve root canal [4, 6]. Literature reports indicate that this technique can provide clinical improvement comparable to that of PLIF [2, 15, 17–20], while offering distinct advantages of reduced surgical injury and preservation of partial segmental mobility (approximately 5.01° range of motion retention) [21]. In this study, postoperative analysis revealed a significant reduction in surgical segment mobility compared to preoperative measurements (P < 0.05), a finding that aligns well with previous reports in medical literature [21, 22]. Notably, IDSS demonstrates dual clinical benefits: it not only maintains therapeutic equivalence to traditional fusion procedures but also preserves physiological motion to a certain extent, potentially reducing adjacent segment degeneration risks associated with rigid fixation [15, 21].

Current endoscopic approaches for LSS primarily include UBE, micro-endoscopy (MED), and percutaneous endoscopic lumbar discectomy (PELD), all demonstrating favorable clinical outcomes in literature [23–25]. Comparative studies reveal UBE's technical advantages: Eun et al. [5] reported equivalent decompression efficacy between UBE and MED, but with UBE requiring smaller incisions. Pranata's meta-analysis [26] confirmed comparable functional improvement, while highlighting UBE's superior perioperative metrics—shorter hospitalization, faster ambulation recovery, and reduced postoperative opioid requirements. When compared to PELD, Heo

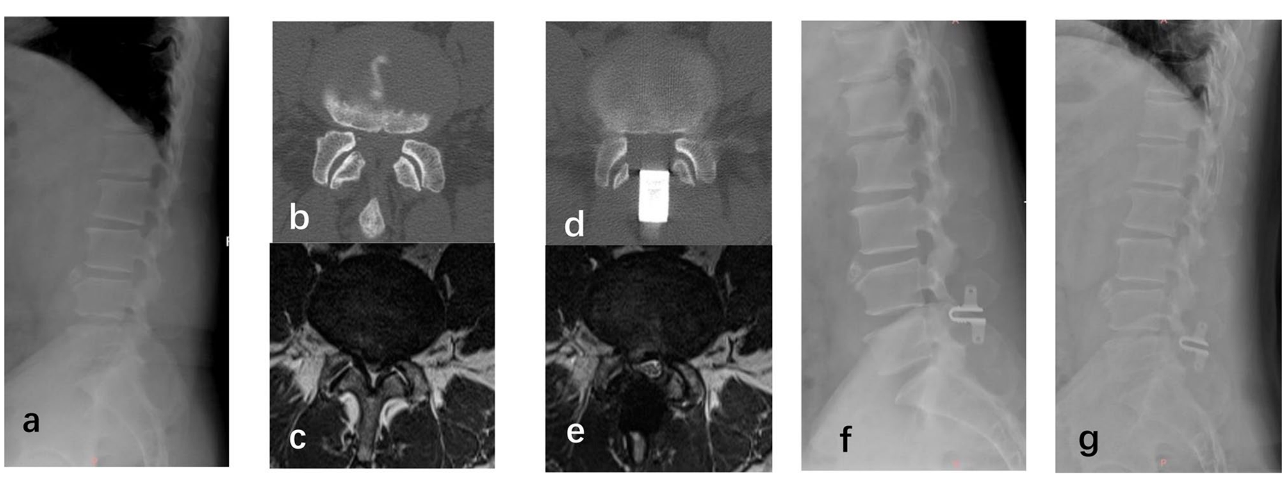

Fig. 3 IDSS was surgically implanted at the L4/5 segment. **a** Preoperative radiographic evaluation revealed stable L4-5 alignment without evidence of spondylolisthesis or segmental instability. **b-c** Preoperative lumbar CT and MRI demonstrated L4-5 spinal canal stenosis with bilateral nerve root compression. **d-e** Postoperative CT and MRI follow-up confirmed optimal implant positioning depth with partial bilateral facetectomy. Quantitative analysis demonstrated FJPR of 71.3% (right) and 83.4% (left), accompanied by SCAER of 124%. **f-g** Final follow-up dynamic flexion-extension radiographs revealed preserved segmental stability at L4/5, though with significant reduction of SROM compared to preoperative measurements. ISH maintained consistency with preoperative baseline values

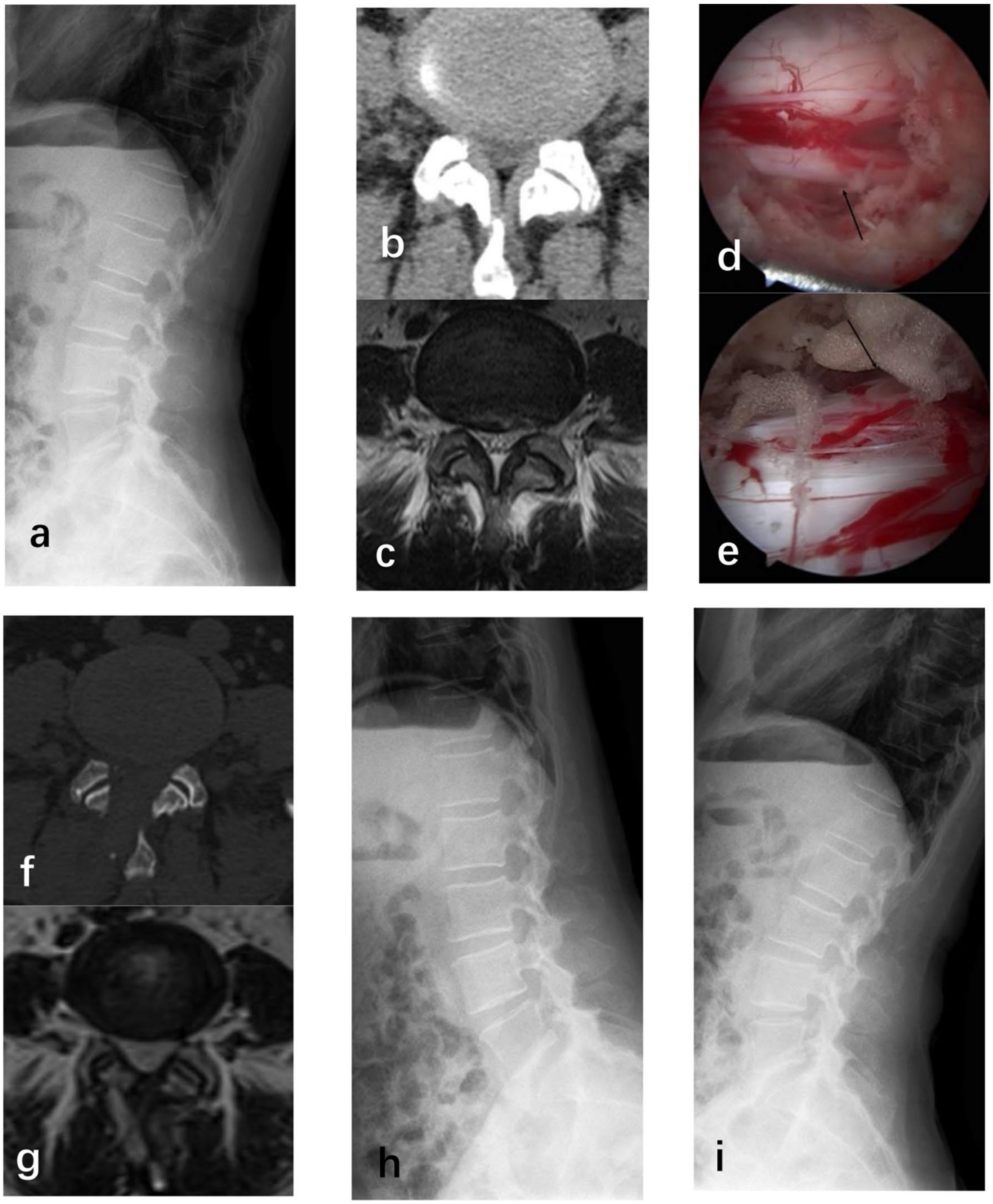

Fig. 4 UBE procedure performed through a left-sided approach for bilateral decompression at L4/5. **a** Preoperative radiograph demonstrated preserved segmental stability at L4/5 without evidence of spondylolisthesis or lumbar instability. **b-c** Preoperative CT and MRI revealed bilateral lateral recess stenosis at L4/5 with significant compression of both L5 nerve roots. **d-e** Intraoperative visualization confirmed adequate decompression and relaxation of bilateral L5 nerve roots following the procedure. **f-g** Postoperative imaging demonstrated partial resection of the left medial facet joint, with quantitative analysis showing FJPR of 73.4% and DSCAER of 98%. **h-i** Dynamic flexion-extension radiographs at final follow-up demonstrated maintained segmental stability of L4/5, with preservation of preoperative SROM. ISH measurements remained consistent with preoperative baseline parameters

et al. [23] demonstrated UBE's enhanced decompression capacity through its dual-channel design, achieving 88.9° facet resection angles versus 92.9° in uniportal techniques, thereby preserving more facet joint integrity. Hwa et al. [27] emphasized UBE's surgical familiarity, replicating open surgery anatomy with direct visualization of contralateral ligamentum flavum and neural structures in the medial foraminal region. These technical merits establish UBE as a viable minimally invasive option for LSS [5, 23, 26, 27].

IDSS and UBE demonstrated significant clinical improvement in patients' symptoms. However, UBE showed statistically superior outcomes in multiple parameters ($P<0.05$). Notably, the UBE group exhibited significantly lower complication rates compared to IDSS. Specific complications observed in the IDSS cohort included spinous process fractures (2.7%) and implant displacement (3.6%), both attributable to the inherent requirement for internal fixation devices in this procedure. In contrast, UBE's completely implant-free approach eliminated these device-related complications entirely. Excluding implant-related complications, adjusted rates were 12.5% (14/112) for IDSS vs. 9.28% (9/97) for UBE ($P>0.05$). While our study specifically highlights the advantages of UBE decompression over IDSS, we acknowledge that other minimally invasive approaches may similarly avoid spacer-related complications by prioritizing direct neural decompression without implants [3, 21–23].

Surgical site complications showed marked disparity between groups. The UBE technique demonstrated zero incision infections, likely due to its continuous saline irrigation system that maintains a sterile fluid medium throughout the procedure. Conversely, IDSS's air-medium environment and longer incision length (average 5.68 ± 0.69 cm vs. UBE's 1.85 ± 0.26 cm) resulted in a 1.9% incision infection rate in our case series. Additional advantages of UBE included shorter operative duration (61.10 ± 10.39 vs. 70.59 ± 11.21 min), reduced estimated blood loss (32.06 ± 10.11 vs. 62.94 ± 12.85 ml), and shorter hospital stays (4.17 ± 0.93 vs. 5.82 ± 1.16 days), all reaching statistical significance ($P<0.05$). These findings suggest that UBE represents a less invasive alternative with superior safety profile compared to IDSS, offering reduced tissue trauma, lower complication risks, and faster postoperative recovery - advantages that align with modern minimally invasive surgical principles [3].

Both techniques demonstrated excellent FJPR (mean preservation rate exceeding 70%) while achieving significant spinal canal expansion, as evidenced by postoperative lumbar 3D-CT reconstructions. This preservation of facet joint integrity maintained the stability of articular processes, aligning with Pao et al.'s biomechanical principle that facet resection below 50% preserves lumbar stability [28]. Follow-up dynamic radiographs in our cohort demonstrated no cases of postoperative instability or spondylolisthesis. These findings confirm that both IDSS and UBE effectively preserve segmental stability in LSS treatment. Regarding ISH parameters, both techniques showed comparable outcomes ($P>0.05$). While some literature reports ISH increase after IDSS implantation [9], our long-term follow-up (at least 36 months) revealed eventual return to preoperative levels in both groups, suggesting minimal lasting impact on intervertebral geometry. A notable distinction emerged in segmental mobility preservation. Quantitative motion analysis revealed significantly better preservation of SROM in UBE-treated segments ($6.61\pm0.73°$) compared to IDSS ($4.54\pm0.80°$, $P<0.05$). This discrepancy stems from IDSS's inherent design: as a semi-rigid implant positioned in the interspinous space, it mechanically restricts segmental motion during flexion-extension cycles [29]. UBE's complete absence of implanted hardware allows for more physiological motion preservation.

Conclusions

Both IDSS and UBE demonstrate comparable efficacy in pain relief and enhancing functional outcomes for LSS, with satisfactory postoperative recovery observed in clinical practice. However, UBE exhibits distinct advantages over IDSS, including minimized tissue trauma, fewer surgical complications, and better preservation of segmental mobility due to its minimally invasive nature. The dual-portal design of UBE allows simultaneous visualization and instrument manipulation through separate channels, enabling precise decompression while minimizing soft tissue disruption. These technical merits position UBE as the preferred surgical strategy for LSS management.

Abbreviations

PLIF	Posterior lumbar interbody and fusion
LSS	Lumbar spinal stenosis
IDSS	Interspinous dynamic stabilization system
UBE	Unilateral biportal endoscopy
BMI	Body mass index
SROM	Segmental range of motion
ISH	Intervertebral space height
FJPR	Facet joint preservation rate
DSCAER	Dural sac cross-sectional surface area expansion rate
CT	Computed tomography
MRI	Magnetic resonance imaging
SD	Standard deviation
ANOVA	One-way repeated-measures analysis of variance

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Author contributions

Dongyue Li: Conceptualized the study design, authored the manuscript, and drafted of the paper. Yunzhong Cheng and Xuanyu Chen: Conducted data collection and performed statistical analysis. Peng Yin: Collaborated in data interpretation and revised the manuscript. Qingjun Su: Contributed to the study's methodological framework, oversaw project revisions, and provided supervisory oversight throughout the research process.

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Data availability

All data used and analyzed during this study are available from the corresponding author upon reasonable request.

Declarations

Competing interests
The authors declare no competing interests.

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