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ORIGINAL RESEARCH

Therapeutic Efficacy of Full-Endoscopic Unilateral Laminotomy with Bilateral Decompression for Degenerative Cervical Myelopathy: A Retrospective Cohort Study

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Background: This study aims to evaluate the efficacy and potential advantages of full-endoscopic unilateral laminotomy with bilateral decompression (FE-ULBD) for degenerative cervical myelopathy (DCM) as a minimally invasive posterior decompression technique.

Methods: We retrospectively reviewed 123 patients treated between January 2020 and January 2025. Procedures were selected based on predefined clinical/imaging indications and shared decision-making. FE-ULBD was primarily applied to 1–2-level posterior compression, whereas multilevel disease underwent laminoplasty or laminectomy with internal fixation. Patients were assigned to Group A (FE-ULBD, n=28), Group B (single-door laminoplasty, n=60), and Group C (laminectomy with internal fixation, n=35). Baseline characteristics, perioperative parameters (operative time, blood loss, length of stay), clinical outcomes (mJOA at multiple time points and modified MacNab criteria), and complications were compared among groups. In Group A, intervertebral height, C2–C7 Cobb angle, and dural sac cross-sectional area (DSCA) were evaluated pre- and postoperatively. Outcomes were assessed preoperatively, at 3 months postoperatively, and at final follow-up (mean 8.07 ± 2.24 months).

Results: Group A had significantly shorter operative time, reduced blood loss, and a shorter hospital stay compared to Groups B and C (all $P<0.05$). mJOA improved significantly from baseline in all groups at 3 months and at final follow-up (within-group $P<0.05$). No significant between-group differences were observed in absolute mJOA or ΔmJOA at either time point (all $P>0.05$). The excellent/good rate by modified MacNab criteria at final follow-up was 89.3% in Group A, 76.7% in Group B, and 77.1% in Group C ($P>0.05$). The overall complication rate was lower in Group A ($P<0.05$). In Group A, intervertebral height and C2–C7 Cobb angle showed no significant postoperative change, whereas DSCA increased significantly ($P<0.05$).

Conclusion: In this retrospective cohort, FE-ULBD was associated with less perioperative morbidity and fewer complications while providing neurological recovery comparable to conventional posterior approaches in selected DCM patients.

Keywords: degenerative cervical myelopathy, unilateral laminotomy with bilateral decompression, minimally invasive cervical spine surgery, full-endoscopic spine surgery, radiological outcomes

Background

Degenerative cervical myelopathy (DCM) is a progressive disorder primarily caused by chronic spinal cord compression from degenerative changes, with secondary ischemic and inflammatory mechanisms also involved.[1,2] These pathophysiological changes are primarily attributed to degenerative alterations in the cervical intervertebral discs, accompanied by secondary inflammatory responses, hypertrophy, and osteophyte formation in adjacent anatomical structures.[3] DCM predominantly affects individuals aged > 55 years,[4] with clinical manifestations typically presenting as progressive impairment of hand motor function and lower limb dysfunction,[5] which significantly compromise the patients' physical and psychological well-being.

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The therapeutic management of DCM primarily includes conservative and surgical interventions. Conservative strategies generally involve immobilisation, postural correction, lifestyle modifications, and pharmacological pain control. However, accumulating evidence indicates that conservative treatment offers limited efficacy in halting disease progression or improving neurological deficits.[6,7] Given the progressive nature of DCM, surgical intervention is widely regarded as the mainstay of treatment. The main objectives of surgery include achieving adequate spinal canal decompression, relieving spinal cord compression, and restoring or maintaining cervical spinal stability, thereby facilitating neurological recovery and alleviating clinical symptoms.

Traditional surgical approaches for DCM comprise anterior cervical discectomy and fusion (ACDF), posterior cervical single-door laminoplasty, and posterior cervical total laminectomy with internal fixation.[8] These conventional approaches differ in indications and limitations. ACDF is mainly used for predominant anterior compression but entails fusion-related trade-offs. Laminoplasty is commonly applied to multilevel stenosis with maintained lordosis, yet may be associated with axial symptoms. Laminectomy with internal fixation offers reliable decompression and stabilization but may cause greater soft-tissue disruption.[9] This clinical context supports exploring minimally invasive posterior decompression strategies such as FE-ULBD in selected patients.

With the growing emphasis on minimally invasive surgical techniques, minimally invasive spinal surgery has increasingly become an integral component in treating degenerative spinal diseases. The unilateral laminotomy with bilateral decompression (ULBD) technique, first introduced by Spetzger et al in 1997, has undergone substantial refinement and has been progressively extended from the lumbar to the thoracic and cervical spine.[10,11] However, owing to the complex anatomical configuration of the cervical spine and inherent surgical risks, reports on endoscopic approaches for treating DCM remain limited. Furthermore, the clinical adoption of ULBD for cervical spine conditions has been growing, and it is important to highlight its potential role in improving patient outcomes compared to traditional methods.

Therefore, in this study, we aim to compare the clinical outcomes of two conventional posterior surgical techniques with those of the full-endoscopic unilateral laminotomy with bilateral decompression (FE-ULBD) approach. By systematically evaluating the surgical efficacy and potential advantages of FE-ULBD in treating DCM, this study provides evidence-based support for its clinical application and further development in managing the condition.

Methods

General Data

This was a retrospective observational cohort study conducted at our institution with no randomization. We retrospectively reviewed 123 patients diagnosed with degenerative cervical myelopathy (DCM) who underwent surgical treatment between January 2020 and January 2025. The surgical approach was primarily selected according to predefined clinical and imaging-based indications and confirmed through shared decision-making with patients; surgeon expertise and the availability of endoscopic equipment were also considered. Full-endoscopic unilateral laminotomy with bilateral decompression (FE-ULBD) was mainly applied to patients with 1–2-level posterior compression (eg, ligamentum flavum hypertrophy), whereas multilevel disease was generally managed with posterior cervical laminoplasty or laminectomy with internal fixation when broader decompression and/or stabilization was required. Patients were assigned to three groups according to the procedure performed: Group A underwent FE-ULBD (n = 28; 11 men and 17 women), Group B underwent posterior cervical single-door laminoplasty (n = 60; 42 men and 18 women), and Group C underwent posterior cervical total laminectomy with internal fixation (n = 35; 17 men and 18 women). The allocation to the groups was based on clinical assessment and surgeon recommendation, considering the severity and extent of the disease, as well as the available surgical options.

This study was approved by the Institutional Ethics Committee of our hospital, and all procedures were conducted in accordance with the Declaration of Helsinki. Because of the retrospective observational design, trial registration was not applicable.

Inclusion Criteria

Patients were included if they met the following criteria: ① aged 50 years or older; ② diagnosed with DCM confirmed by both clinical manifestations and imaging examinations; ③ presenting with primary posterior compression (eg, ligamentum flavum hypertrophy) or multilevel spinal stenosis and disc herniation; and ④ voluntarily consented to surgical treatment with complete clinical data available.

Exclusion Criteria

Patients were excluded from the study if they met any of the following criteria: ① presence of cervical kyphosis or other conditions contraindicating posterior surgical approach; ② diagnosed with cervical radiculopathy, severe osteoporosis, or spondylolisthesis exceeding grade I; ③ previous history of cervical spine surgery; or ④ incomplete clinical documentation.

Surgical Procedures

Group A

Following successful induction of general anaesthesia, patients were placed in the prone position with the head fixed on a surgical head frame. The body was adjusted to a slight head-up, feet-down inclination to facilitate surgical access. Target lamina levels were identified using C-arm fluoroscopy in both anteroposterior and lateral views. A puncture point was marked approximately 0.5 cm lateral to the midline of the spinous process on the side corresponding to the dominant clinical symptoms.

The surgical field was prepared with standard skin disinfection, and sterile drapes and adhesive film were applied. At the puncture site, subcutaneous and fascial layers were infiltrated with normal saline containing epinephrine to reduce intraoperative bleeding. Under real-time fluoroscopic guidance, a spinal needle was advanced to the posterior margin of the target lamina space. A skin incision of approximately 8 mm was made, and the underlying musculature was bluntly dissected to expose the lamina. Sequential dilation was performed, and a working cannula was introduced to the posterior lamina surface. The position was confirmed using C-arm imaging.

An endoscopic system was introduced through the working cannula, and anatomical landmarks were confirmed. Soft tissue overlying the lamina was carefully removed to identify the V-point and base of the spinous process. A high-speed burr was used to perform a unilateral laminotomy. The ipsilateral ligamentum flavum was identified, dissected, and removed using a rongeur. After completing ipsilateral decompression, contralateral decompression was performed through the same interlaminar space by removing the contralateral lamina and ligamentum flavum. The spinal canal was inspected for adequate decompression, and the dural sac was observed to be freely mobile without compression. The working cannula was then removed, a drainage tube was inserted, and the incision was closed with sutures (Figure 1).

Group B

After successful general anaesthesia, patients were placed prone with the abdomen suspended to reduce intra-abdominal pressure and improve venous return. The head was fixed in a head frame. Standard skin preparation and draping were performed.

A posterior midline longitudinal incision was made. The skin, subcutaneous tissue, and deep fascia were sequentially incised. The nuchal ligament was preserved and retracted laterally. Subperiosteal dissection of the paraspinal muscles was carried out along the spinous processes and laminae to the lateral borders of the facet joints. Haemostasis was achieved using electrocautery.

One side was selected as the opening side, with the contralateral side serving as the hinge. A trough was created along the junction of the lamina and facet joint using an ultrasonic bone scalpel and rongeur. On the opening side, the lamina was completely removed down to the ligamentum flavum, while on the hinge side, only the inner cortical layer was removed, preserving the outer cortex as a bony hinge.

Using a curette, the lamina was gently elevated from the opening side towards the hinge side, expanding the spinal canal by approximately 1 cm. The ligamentum flavum overlying the dural sac was excised, allowing for adequate expansion of the dural sac. An appropriately sized titanium plate and screws were applied on the opening side to stabilise the construct. The surgical field was irrigated with sterile saline, and haemostasis was confirmed. A single drainage tube

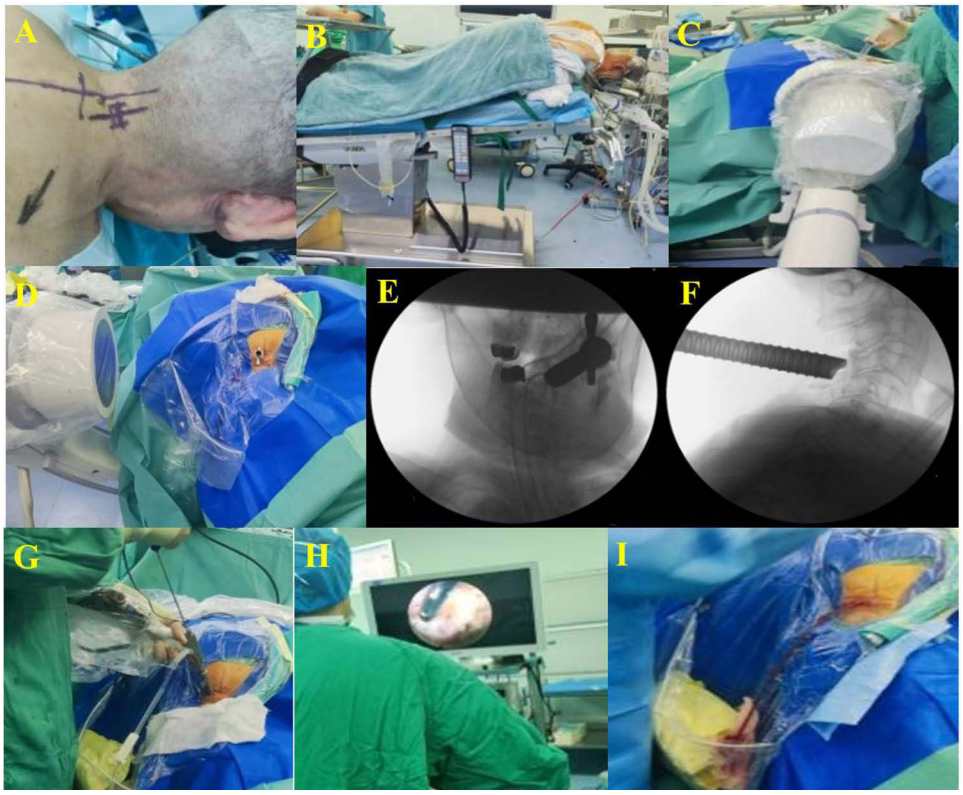

Figure 1 Surgical Operations. (**A** and **B**) Pre - operative fluoroscopy and marking. (**C**) Injection of Adrenaline. (**D**–**F**) Placement of the channel and re - localization. (**G** and **H**) Intra - operative operations. (**I**) placement of the drain.

was placed. After a complete count of instruments and sponges, the wound was closed in layers, and sterile dressings were applied.

Group C

Following successful general anaesthesia, patients were placed in prone position with abdominal support and pelvic fixation using a restraint strap. The head was fixed in a head frame. Standard skin preparation and draping were performed.

A posterior midline longitudinal incision was made. The skin, subcutaneous tissue, and deep fascia were sequentially incised. The nuchal ligament was preserved and retracted laterally. Subperiosteal dissection of the paraspinal musculature was carried out along the spinous processes and laminae to the lateral borders of the facet joints. Electrocautery was used for haemostasis.

At the junction of the facet joints and laminae bilaterally, longitudinal osteotomies were performed using either a high-speed burr or ultrasonic bone scalpel. The ligamentum flavum was removed, and the spinous process and bilateral laminae were excised en bloc in a "lid-lifting" manner. Adequate decompression was confirmed by observing dural sac expansion. Bilateral lateral mass screws of appropriate length were inserted into the lateral masses. Positioning was verified using intraoperative C-arm fluoroscopy. A pre-bent connecting rod was then placed, and the locking nuts were tightened to secure the construct.

The surgical field was irrigated with sterile saline, and thorough haemostasis was confirmed. A single drainage tube was inserted. After verifying the count of surgical instruments and sponges, the incision was closed in layers.

Intraoperative Neuromonitoring

Multimodal intraoperative neuromonitoring was used in all patients, including somatosensory evoked potentials (SSEPs) and motor evoked potentials (MEPs). A significant alert was defined as a ≥50% decrease in MEP amplitude and/or a ≥50% decrease in SSEP amplitude. When an alert occurred, potential reversible causes were immediately evaluated and

managed, including optimization of anesthesia, correction of blood pressure and oxygenation, and temporary cessation of surgical manipulation until signals recovered.

Postoperative Management

After surgery, all patients received intravenous corticosteroids, mannitol, and non-steroidal anti-inflammatory drugs according to an institutional postoperative protocol aimed at reducing spinal cord edema and postoperative inflammation (typically administered for 48–72 h). The steroid regimen was applied across groups. The use (and dosing strategy) of corticosteroids and mannitol followed the same institutional protocol in all three groups, thereby minimizing between-group differences related to postoperative pharmacologic management; nevertheless, it was considered a potential confounder. The quantity and characteristics of wound drainage were closely monitored. Once the drainage tube was removed, patients were allowed to begin ambulation with the support of a cervical orthosis. Hospital discharge was permitted in the absence of major postoperative complications.

Patients were instructed to maintain cervical immobilisation with the orthosis for 6–8 weeks postoperatively. Scheduled outpatient follow-up visits were conducted at 3, 6, and 12 months after surgery to evaluate clinical outcomes and monitor for potential complications. For the present analyses, clinical outcomes were assessed preoperatively, at 3 months postoperatively, and at the final available follow-up visit (defined as the most recent documented outpatient assessment for each patient). These follow-up assessments included comprehensive neurological examinations, functional outcome measurements, and imaging evaluations (eg. X-rays, CT scans, or MRI) to assess spinal stability, decompression efficacy, and overall recovery progress.

Evaluation Indicators

General and Perioperative Data

Demographic and perioperative data comprised age, sex, body mass index (BMI), disease duration, operation time, intraoperative blood loss, hospital stay, and surgical complications, including cerebrospinal fluid leakage, C5 nerve palsy, and axial symptoms.[12] Axial symptoms are characterised by persistent pain in the neck and shoulder, limited movement, and postural fatigue, which seriously affect postoperative rehabilitation and quality of life.

Efficacy Evaluation Indicators

Neurological function was assessed using the modified Japanese Orthopaedic Association (mJOA) score for degenerative cervical myelopathy (range, 0–18; higher scores indicate better neurological function).[13] The mJOA score was selected because it is a widely used, validated functional scale for DCM and allows longitudinal assessment of neurological recovery. Surgical outcomes were assessed using the modified MacNab efficacy evaluation criteria,[14] which classify results as excellent, good, fair, and poor, with poor indicating no significant improvement or worsening of symptoms. Modified MacNab criteria were additionally applied to provide a global patient-centered assessment of perceived symptom relief. Outcomes were assessed preoperatively, at 3 months postoperatively, and at the final follow-up. The follow-up period ranged from 6 to 12 months, with a median follow-up of 9 months and a mean follow-up of 8.07 ± 2.24 months. For analysis, both absolute mJOA scores and changes from baseline were recorded at each postoperative time point.

Imaging Evaluation Indicators

All patients underwent preoperative and postoperative CT and MRI examinations as part of routine clinical assessment. Given the focus on the minimally invasive technique, detailed radiographic measurements (intervertebral height, C2–C7 Cobb angle, and dural sac cross-sectional area [DSCA]) were quantitatively analyzed in Group A (FE-ULBD) preoperatively and postoperatively. Measurements were independently performed by three surgeons, and the mean value was used for analysis. (Figure 2).

(1) DSCA: Three consecutive T2WI cross-sectional images were obtained at the level of the intervertebral disc in the affected segment. The dural sac boundaries were delineated to calculate its average cross-sectional area at three levels.

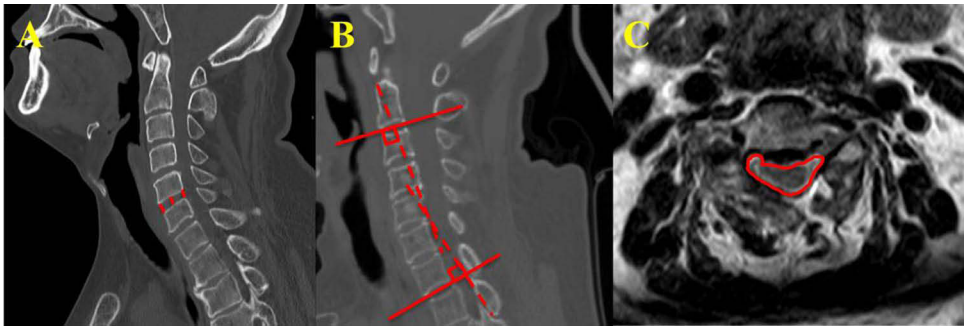

Figure 2 Radiological Measurements. (**A**) Intervertebral height: The distance between the lower endplate of the superior vertebra and the upper endplate of the inferior vertebra was measured at the disc space. The intervertebral height is reported as the average of these measurements. (**B**) Cobb angle of C2 - C7: Measured by drawing lines parallel to the inferior endplates of C2 and C7; the angle was then measured at the intersection of lines drawn perpendicular to these two endplate references. (**C**) Area of the dural sac: The region of interest (ROI) for area measurement is defined by tracing the inner border of the dural sac.

(2) Postoperative DSCA improvement rate = (postoperative dural sac cross-sectional area - preoperative dural sac cross-sectional area)/preoperative dural sac cross-sectional area × 100%.

Statistical Methods

Statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Categorical variables were presented as frequencies and percentages and were compared using the chi-square test or Fisher's exact test, as appropriate. Continuous variables are expressed as mean ± standard deviation (SD). Normality was assessed using the Shapiro–Wilk test. Between-group comparisons of continuous variables were performed using one-way analysis of variance (ANOVA); when the homogeneity-of-variance assumption was violated, the Kruskal–Wallis *H*-test was used. For ANOVA with significant results, post hoc pairwise comparisons were performed with Bonferroni adjustment.

Neurological function was evaluated using the modified Japanese Orthopaedic Association (mJOA) score (range, 0–18). To account for repeated measurements within individuals, longitudinal mJOA trajectories (preoperative, 3 months, and final follow-up) were analyzed using repeated-measures ANOVA with factors of time and group, including the time-by-group interaction. In addition, change from baseline was calculated (ΔmJOA = postoperative mJOA − preoperative mJOA) at 3 months and at final follow-up, and ΔmJOA was compared between groups using ANOVA (or the Kruskal–Wallis test when appropriate). Within-group improvements were examined using model-based pairwise comparisons with multiplicity adjustment. Within-group changes from baseline were assessed using paired-samples *t*-tests. A two-sided $P < 0.05$ was considered statistically significant.

Results

Baseline Characteristics

No significant intraoperative MEP/SSEP changes were recorded, and no new postoperative neurological deficits were observed. No significant differences were observed among the three patient groups in age, BMI, or disease duration ($P > 0.05$). Baseline characteristics are summarized in Table 1.

Perioperative outcomes differed across groups. Compared to Groups B and C, Group A demonstrated better outcomes, with significantly shorter operation time, smaller incision length, less intraoperative blood loss, shorter hospital stay, and lower incidence of postoperative complications (all $P < 0.05$), as summarised in Table 1.

Patient Efficacy Evaluation Results

All three groups demonstrated significant postoperative improvement in mJOA scores compared with baseline. Changes from baseline (ΔmJOA) at 3 months and at final follow-up did not differ significantly among the three groups ($P > 0.05$). Similarly, no significant intergroup differences were found in the modified MacNab efficacy criteria at the final follow-up assessment ($P > 0.05$). Consistent with the longitudinal analysis, there was significant improvement over time, whereas the time-by-group interaction was not significant.

Table 1 General Characteristics and Perioperative Data of Patients

	Group A	Group B	Group C	P value
Age (years)	63.75±9.02	63.22±8.59	62.91±10.14	0.936
Body Mass Index (kg/m2)	24.97±2.76	25.61±2.72	26.21±3.66	0.274
Duration of Illness (months)	17.39±16.52	19.78±38.71	10.37±12.21	0.311
Surgical Duration (minutes)	117.18±31.15	135.25±35.07	141.71±36.10	0.018
Incision Length (cm)	0.95±0.08	10.85±1.91	9.86±1.61	<0.001
Intraoperative Blood Loss (mL)	19.11±6.09	123.83±93.12	123.71±46.41	<0.001
Hospital Stay Duration (days)	5.86±1.48	8.90±3.19	12.53±3.89	<0.001
Postoperative Surgical Complications (n, %)	2 (7.14%)	21 (35.00%)	13 (37.14%)	0.013
Axial Symptoms	2	18	12	0.031
Cerebrospinal Fluid Leak	–	1	–	–
C_5 Nerve Root Palsy	–	1	–	–
Wound Healing Complications	–	1	–	–
Hematoma	–	–	1	–

No significant intergroup differences were found in the modified MacNab efficacy criteria at the final follow-up assessment ($P > 0.05$). The excellent/good rate was 89.3% in Group A, 76.67% in Group B, and 77.14% in Group C (Table 2).

Imaging Evaluation Results

In Group A, no significant changes were observed in intervertebral height or Cobb angle in Group A from pre- to postoperation ($p > 0.05$). However, compared with preoperative values, the DSCA improved significantly after surgery ($p < 0.05$; Table 3). Representative preoperative and postoperative CT/MRI findings, together with intraoperative endoscopic views, are shown in Figure 3.

Table 2 Assessment of Clinical Efficacy

	Group A	Group B	Group C	P value
mJOA Score (points)				
Preoperative	9.61±0.83	9.27±0.80	9.49±0.78	0.145
3 months Postoperative	11.89±0.84	12.10±0.82	12.31±1.76	0.363
Final Follow up	14.32±1.12	14.28±1.16	14.23±1.40	0.955
ΔmJOA (3 months − baseline)	2.29±0.81	2.83±1.03	2.83±1.96	0.164
ΔmJOA (final − baseline)	4.71±1.27	5.02±1.41	4.74±1.31	0.502
Modified Macnab Criteria (n, %)				0.355*
Excellent	20(71.43%)	33(55.00%)	22(62.86%)	
Good	5(17.86%)	13(21.67%)	5(14.29%)	
Fair	2(7.14%)	11(18.33%)	6(17.14%)	
Poor	1(3.57%)	3(5.00%)	2(5.71%)	

Notes: ΔmJOA = postoperative mJOA − baseline mJOA. *Excellent/Good vs Fair/Poor.

Table 3 Radiological Indicators of Group A Before and After Surgery

Indicator	Mean ± SD	P value
Intervertebral height (cm)		0.685
Preoperative	0.37±0.06	
Postoperative	0.37±0.07	
Cobb angle (°)		0.13
Preoperative	12.62±10.78	

(*Continued*)

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Table 3 (Continued).

Indicator	Mean ± SD	P value
Postoperative DSCA (cm^2)	16.78±13.14	<0.001
Preoperative	0.98±0.28	
Postoperative	1.21±0.26	
Improvement rate of the dural sac after surgery (%)	27.29±22.32	

Discussion

DCM is a clinical syndrome resulting from degenerative changes in cervical intervertebral discs and subsequent pathological alterations, which lead to spinal cord compression and impairment of its blood supply, ultimately causing progressive spinal cord dysfunction. Prolonged spinal cord compression can result in ischemia and neuronal damage.[15] Therefore, surgical intervention is often considered for symptomatic or progressive cases to decompress the spinal cord, alleviate neurological symptoms, and prevent irreversible injury.[16]

With advances in minimally invasive spine surgery, ULBD has been widely used for lumbar stenosis and has been extended to selected thoracic and cervical pathologies.[17] Senturk et al demonstrated favourable outcomes in patients with cervical stenosis caused by ligamentum flavum hypertrophy treated with microscopic ULBD.[18] Shen et al conducted a retrospective analysis of 21 patients undergoing ULBD surgery and reported significant clinical improvements.[19] Similarly, Hernandez et al[11] reported notable improvements in VAS, ODI, and mJOA scores without any postoperative complications among 15 patients with DCM treated with microscopic ULBD. Collectively, these studies support the safety and efficacy of ULBD in managing cervical spine disorders.

In the present study, we employed a full-endoscopic technique, also referred to as single-axis endoscopic technology, which integrates illumination, imaging, irrigation, and instrument channels within a compact system. Compared with microendoscopic systems, the smaller working profile may help reduce soft-tissue disruption. In addition, fluid-based

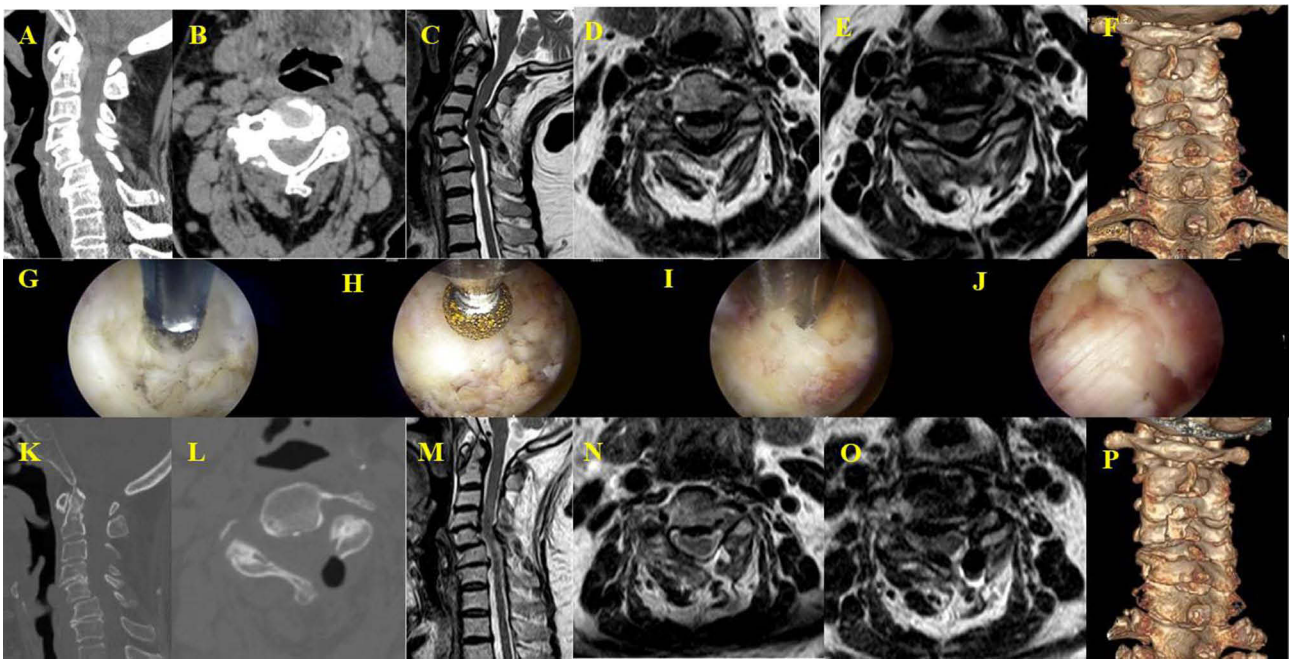

Figure 3 A Typical Case. A 71-year-old woman was diagnosed with degenerative cervical myelopathy (DCM) and underwent full-endoscopic unilateral laminotomy with bilateral decompression (FE-ULBD). (**A**–**F**) Preoperative imaging data, providing a comprehensive overview of pre-surgical anatomical and pathological features. (**G**–**J**) Intraoperative endoscopic images, illustrating key surgical steps and real-time visualization of the operative field. (**K**–**P**) Postoperative imaging assessment, evaluating the extent of decompression and post-surgical anatomical changes.

full-endoscopy (FE), as opposed to air-based microscopic endoscopy, not only reduces intraoperative bleeding and maintains a clear operative field but also reduces the risk of postoperative infection.[20]

The ULBD approach is performed via a posterior cervical route, avoiding the complex anterior anatomical structures. A small incision is sufficient to accommodate the working cannula, eliminating the need for extensive dissection of the posterior cervical musculoligamentous structures. This approach preserves the integrity of the posterior musculoligamentous complex, which plays a critical role in maintaining both static and dynamic cervical stability as well as physiological curvature.[21] As integral components of the spinal three-joint complex, facet joints are essential for spinal stability.[22] The absence of significant changes in intervertebral height and Cobb angle in Group A before and after surgery further supports that ULBD does not compromise postoperative cervical stability.

Moreover, patients in Group A were generally able to ambulate with a cervical collar and start rehabilitation as early as postoperative day 1, which may help mitigate posterior cervical muscle deconditioning. Given the minimal tissue disruption and the absence of fusion devices, this technique significantly reduces the incidence of postoperative axial symptoms.[23,24]

Owing to the unique anatomical features of the cervical spine, several key considerations should be emphasised when performing this surgical approach. First, accurate localisation is critical. The V-point or its medial/lateral deviation should be determined based on the intended decompression range and size of the working channel. Following placement of the working tube, fluoroscopic confirmation should be performed to ensure correct positioning of the target segment and to prevent displacement caused by angular changes during insertion.

Second, intraoperative use of a high-speed burr under endoscopic visualisation can be employed to thin the lamina and base of the spinous process, which may help reduce operative time. However, this technique carries a risk of neural injury. To minimise this risk while maintaining efficiency, we first used the burr to carefully thin the lamina, followed by complete removal using a pituitary rongeur along with the ligamentum flavum. This combined approach shortens the operative duration while significantly lowering the risk of spinal cord injury.

Additionally, meticulous haemostasis should be maintained throughout the procedure. The use of tranexamic acid, continuous saline irrigation, and bipolar radiofrequency coagulation can effectively minimise intraoperative bleeding, ensure a clear surgical field, and reduce the likelihood of complications. Furthermore, intraoperative neurophysiological monitoring should be routinely utilised. This monitoring system not only helps prevent intraoperative neurological damage and reduce surgical risks but also provides an objective reference for assessing surgical efficacy and neural function recovery,[25] thereby ensuring complete decompression and procedural safety.

Complications associated with minimally invasive posterior approaches for DCM are relatively rare and primarily include dural tears, spinal cord or nerve root injuries, and epidural hematomas.[26] In Group A, no major surgery-related complications were observed, including dural tear, iatrogenic spinal cord/nerve root injury, or postoperative epidural hematoma. Only one patient experienced suboptimal postoperative symptom relief, which we attributed to insufficient decompression. Subsequent anterior cervical decompression and fusion resulted in considerable symptom improvement. This technique is particularly suitable for posterior compressive pathologies, especially spinal stenosis caused by ligamentum flavum hypertrophy. However, it is less effective for addressing anterior compression mechanisms such as intervertebral disc herniation.

In summary, FE-ULBD represents a viable surgical option for patients with DCM with 1–2 levels of posterior compressive pathology. Compared to traditional posterior approaches, this technique may offer the advantages of less tissue trauma, faster recovery, and fewer complications. However, when decompression is required at ≥3 levels, FE-ULBD may necessitate additional working corridors and may increase operative time compared with conventional laminoplasty. Moreover, cervical endoscopic surgery is technically demanding and requires substantial experience and a prolonged learning curve.[27]

This study is limited by its retrospective, single-center observational design, relatively small sample size, and short follow-up. Treatment allocation was not randomized and may have been influenced by surgeon preference and endoscopic equipment availability, introducing potential selection bias and residual confounding. In addition, all patients received postoperative intravenous corticosteroids per institutional protocol; although the regimen was identical across groups, it may have affected early neurological recovery and pain control, particularly in short-term assessments. Finally,

although mJOA is widely used, it may be less reliable in severe DCM and may overestimate postoperative improvement.[28] Future studies should involve larger, multicenter prospective cohorts to generate higher-level evidence.

Conclusion

FE-ULBD may represent a safe and effective posterior decompression option for selected patients with DCM, with reduced surgical trauma and fewer perioperative complications observed in this retrospective cohort. However, given the retrospective design and relatively small sample size, larger, multicenter prospective studies are needed to validate these findings and further assess the long-term safety and efficacy of this technique.

Data Sharing Statement

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

This study was approved by the Medical Ethics Committee of the Affiliated Hospital of Qingdao University (Approval No. QYFY WZLL 29649). Written informed consent was obtained from all participants. All methods were performed in accordance with the relevant guidelines and regulations.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no competing interests in this work.

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