Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

A Retrospective Comparative Study of 3-Month Early Outcomes Between L-Unitary Soft Endoscopy-Assisted Anterior Cervical Discectomy and Fusion and Conventional Open Anterior Cervical Discectomy and Fusion for Single-Level Cervical Spondylotic Myelopathy

Zhaokui Yan
West China Medical Center of Sichuan University
Qingchu Li
The Third Affiliated Hospital of Southern Medical University
Xiaobing Pu
windhiq@163.com

West China Medical Center of Sichuan University

Research Article

Keywords: cervical spondylotic myelopathy, anterior cervical discectomy and fusion, L-Unitary Soft Endoscopy (LUSE), minimally invasive spine surgery, early clinical outcomes, retrospective study

Posted Date: November 18th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11586788/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Objective

To compare the 3-month early clinical outcomes of L-Unitary Soft Endoscopy (LUSE)-assisted anterior cervical discectomy and fusion (ACDF) versus conventional open ACDF in the treatment of single-level cervical spondylotic myelopathy (CSM), and to evaluate the perioperative safety and early feasibility of LUSE-assisted ACDF, thereby providing a reference for clinical decision-making.

Methods

A retrospective comparative study was conducted on patients with single-level CSM who underwent ACDF at our hospital between January 2025 and June 2026. Patients were divided into two groups according to the surgical approach: the LUSE-assisted ACDF group (Group A) and the conventional open ACDF group (Group B). Perioperative parameters (operative time, intraoperative blood loss, incision length, length of hospital stay, and perioperative complications) were recorded. The Japanese Orthopaedic Association (JOA) score, JOA improvement rate, and Visual Analogue Scale (VAS) scores for overall neck/shoulder pain were assessed preoperatively and at 3 months postoperatively and compared between the two groups. The 1-month postoperative assessment was used primarily for safety monitoring. Statistical analysis was performed using SPSS 27.0.

Results

A total of 63 patients were enrolled, including 30 in Group A and 33 in Group B. No statistically significant differences were observed between the two groups in baseline characteristics, including age, sex, height, weight, BMI, and affected segment ($P > 0.05$). Compared with Group B, Group A had a significantly shorter operative time, less intraoperative blood loss, and a shorter incision length ($P < 0.05$). No statistically significant difference was found in length of hospital stay between the two groups ($P > 0.05$). At 3 months postoperatively, both groups showed significant improvements in JOA scores, JOA improvement rates, and VAS scores for overall neck/shoulder pain compared with preoperative values ($P < 0.05$), with no statistically significant between-group differences in any of these outcomes ($P > 0.05$).No severe complications occurred in either group during the 1-month safety monitoring period, and the difference in complication rates was not statistically significant ($P > 0.05$).

Conclusion

Compared with conventional open ACDF, LUSE-assisted ACDF for single-level CSM showed no statistically significant difference in early neurological improvement at 3 months, while offering advantages including a smaller incision, less intraoperative blood loss, and a shorter operative time.

These findings indicate that LUSE-assisted ACDF is technically feasible and safe in this preliminary series.

Introduction

Conventional open anterior cervical discectomy and fusion (ACDF) is a classic anterior cervical approach, and its therapeutic efficacy in cervical spondylotic myelopathy (CSM) and cervical spondylotic radiculopathy (CSR) has been well recognized [1]. However, the deep anterior cervical surgical field is relatively narrow, which limits hemostatic maneuvers during intraoperative bleeding. In addition, the boundaries of critical anatomical structures, such as the posterior longitudinal ligament and the dural sac, are difficult to identify under direct vision, thereby increasing the surgical difficulty and the risk of dural and spinal nerve injury [2]. With the continued advancement of minimally invasive spinal surgery techniques, various approaches, including full-endoscopic [3–7], endoscope-assisted [5], and microscope-assisted [8] techniques, have been progressively applied to cervical spine surgery in an effort to overcome the limitations of conventional open procedures. Compared with traditional approaches, full-endoscopic or endoscope-assisted ACDF magnifies the surgical field through a built-in light source and camera system, providing a clear and enlarged view while reducing soft tissue retraction injury. Theoretically, this may lower the incidence of approach-related complications such as postoperative dysphagia and recurrent laryngeal nerve injury, thereby facilitating early postoperative recovery [9, 10].

Recently, L-Unitary Soft Endoscopy (LUSE) has emerged as a novel minimally invasive spinal surgical system. Unlike other endoscopic ACDF procedures, LUSE employs an air medium rather than a water medium. It combines the intuitive and straightforward operative characteristics of conventional ACDF with the clear visualization and adequate illumination of full-endoscopic ACDF. As a single-channel minimally invasive spinal auxiliary system integrating a soft endoscope, an illumination and camera system, and matched operative instruments, LUSE can mitigate the limitations of conventional open ACDF and rigid endoscopic ACDF; these features suggest potential for application in anterior cervical spine surgery. However, English-language studies specifically comparing the 3-month early clinical outcomes of LUSE-assisted ACDF versus conventional open ACDF for single-level CSM remain scarce, and robust evidence regarding its short-term safety and feasibility is still lacking. This study retrospectively compared the 3-month early clinical outcomes and perioperative parameters of LUSE-assisted ACDF and conventional open ACDF in the treatment of single-level CSM, with the aim of providing a reference for the clinical application of LUSE technology.

Materials and Methods

We retrospectively analyzed the clinical data of 63 patients with single-level CSM who underwent anterior cervical discectomy and decompression and fusion (ACDF) at our hospital between January 2025 and June 2026. Patients were allocated to groups based on the chronological introduction of the LUSE technique at our institution: consecutive patients treated before its introduction constituted the

historical control group (Group B), and consecutive patients treated after its introduction constituted the LUSE group (Group A). Baseline characteristics, including sex, age, height, weight, BMI, affected segment, preoperative JOA score, and preoperative VAS score for overall neck/shoulder pain, were recorded for both groups.

This study was conducted in accordance with the Declaration of Helsinki. This study was approved by the Ethics Committee of West China Fourth Hospital, Sichuan University. Because of the retrospective design, the requirement for informed consent was waived.

Thirty patients underwent LUSE-assisted ACDF (Group A), including 19 men and 11 women, with a mean age of 59.63 ± 11.25 years (range, 33-78 years), a mean height of 167.10 ± 7.59 cm, a mean weight of 66.43 ± 9.77 kg, and a mean BMI of 23.65 ± 1.56 kg/m². The operated segments in Group A were C3/4 in 1 case, C4/5 in 6 cases, C5/6 in 18 cases, and C6/7 in 5 cases. Thirty-three patients underwent conventional open ACDF (Group B), including 16 men and 17 women, with a mean age of 57.42 ± 12.07 years (range, 36-78 years), a mean height of 164.82 ± 8.23 cm, a mean weight of 64.09 ± 10.39 kg, and a mean BMI of 23.42 ± 2.42 kg/m². The operated segments in Group B were C3/4 in 2 cases, C4/5 in 9 cases, C5/6 in 16 cases, and C6/7 in 6 cases.

Inclusion criteria:

(1) Patients with single-level CSM definitively diagnosed based on clinical symptoms, signs, and imaging findings (cervical MRI and CT); (2) patients who failed to respond to standard conservative treatment or exhibited progressive neurological deterioration, with clear surgical indications; (3) patients undergoing anterior cervical surgery for the first time; (4) patients with complete clinical and follow-up data.

Exclusion criteria:

(1) Patients with multilevel spinal cord compression, or those with multilevel pathologies such as ossification of the posterior longitudinal ligament (OPLL) or developmental cervical spinal stenosis; (2) patients with a history of prior cervical spine surgery, or those with cervical trauma, infection, or tumor; (3) patients with severe cervical instability or significant kyphotic deformity; (4) patients with severe comorbidities involving the heart, lungs, liver, kidneys, or other vital organs, or those with coagulopathy who were unable to tolerate surgery; (5) patients with missing follow-up data or those lost to follow-up.

The flexible endoscopic minimally invasive cervical spine system (Invention Patent: CN116983066A) was developed by the research team of one of the authors at Southern Medical University and is manufactured by Guangzhou Minyi Medical Technology Development Co, Ltd. The system consists of two components: (1) a flexible endoscope with an integrated imaging system (Figure 1a); and (2) a minimally invasive cervical dilation system (Figure 1b, Figure 1c).

The flexible endoscope has a shaft length of 20-40 mm, a field of view ranging from 0° to 30°, and a diameter of 1.8 mm. It is available in various specifications with different illumination intensities, and the viewing angle can be adjusted intraoperatively by rotating the endoscope in any direction. The minimally

invasive cervical dilation system features a specialized hinged multi-joint structure that allows adjustable dilation angles, as well as adjustable dilator width and depth to accommodate the surgical incision. When combined with a fixation device, the dilation system provides enhanced self-stability, eliminating the need for intraoperative assistance with retraction.

Surgical methods

All procedures in both groups were performed by the same surgical team, with the primary surgeon being the same physician. The anesthesia protocol and perioperative management regimen were identical between groups.

Group A: The surgical technique is illustrated using C5/6 ACDF as an example. After induction of general anesthesia, the patient was placed in the supine position with a pillow beneath the neck and the head and neck moderately extended. Routine disinfection and draping were performed. The cricoid cartilage was identified, and surface landmarks were used to determine the corresponding segmental level. A right transverse cervical incision approximately 2-3 cm in length was made. The skin and subcutaneous tissue were incised, and the platysma was split longitudinally under upward traction. Blunt dissection was performed along the plane between the carotid sheath and the visceral sheath medial to the sternocleidomastoid muscle to expose the vertebral bodies and intervertebral disc at the target segment. Cervical retractors were used to retract the soft tissues bilaterally. A localizing pin was inserted into the C6 vertebral body, and C-arm fluoroscopy was used to confirm the correct segment. Bone traction pins were then placed into the anterior aspect of the C5 and C6 vertebral bodies, and a cervical vertebral distractor was applied. The longus colli muscles on the anterior vertebral surface were released using electrocautery. A cervical soft-tissue retractor was used to retract the bilateral muscles, carotid sheath, and visceral sheath laterally. The fixation arm was connected to the soft-tissue retractor, and the flexible endoscope was inserted into its docking slot (Figure 2a and Figure 2b).

Under endoscopic visualization, electrocautery was used to incise the anterior longitudinal ligament at the C5/6 level. A small round blade was used to incise the C5/6 annulus fibrosus along the endplates, and a distractor was applied to open the C5/6 intervertebral space. Rongeurs were used to remove anterior vertebral osteophytes and a portion of the intervertebral disc. Curettes were used to remove residual disc material at C5/6 until punctate bleeding was observed on the endplates. A gun-shaped Kerrison rongeur was used to resect osteophytes from the anteroinferior edge of the C5 vertebral body and the anterosuperior edge of the C6 vertebral body; the harvested bone was preserved, and bone wax was applied to seal the bleeding surfaces. A high-speed burr was used to remove bone at the posterior aspect of the intervertebral space, with the bone dust collected for later use. Posterior decompression was carried out to the anterior aspect of the dural sac (Figure 2d and Figure 2e). The posterior longitudinal ligament was resected, and adhesions involving the spinal dural sac and nerve roots were released (Figure 2f). Bilateral decompression extended to the facet joints, with alternating use of the burr and Kerrison rongeur to resect the posterior half of the facet joints. Intraspinal bleeding was controlled

with bipolar electrocautery and hemostatic agents. After irrigation with normal saline, trial sizers were used to assess the C5/6 intervertebral space, and an appropriately sized cage was selected.

The preserved bone and bone dust were packed into the cage, which was then inserted into the C5/6 intervertebral space. Two screws were placed superiorly and inferiorly and locked, and fluoroscopy was repeated to confirm satisfactory positioning. The surgical field was irrigated and hemostasis was achieved. The decision to place a drain was based on intraoperative bleeding. The incision was closed in layers.

Group B: Conventional anterior cervical ACDF was performed. Discectomy, spinal canal and nerve root decompression, endplate preparation, cage implantation, and titanium plate internal fixation were completed under conventional light source assistance. The operative steps and internal fixation selection were identical to those in Group A.

Postoperative management

Antibiotics were administered on the day of surgery. Intravenous mannitol and glucocorticoids were routinely administered for 3 days. The drain was removed 24 hours postoperatively. Patients were required to wear a cervical collar when ambulating. Neurotrophic and symptomatic treatments were administered. Absorbable sutures were used for wound closure, eliminating the need for suture removal. Patients were instructed to continue wearing the cervical collar for 8-12 weeks. Beginning 3 weeks postoperatively, patients were advised to remove the collar twice daily for gentle neck exercises, 15 minutes per session.

Outcome measures

Perioperative parameters: operative time, intraoperative blood loss, incision length, length of hospital stay, and perioperative complications.

Clinical efficacy parameters: The Japanese Orthopaedic Association (JOA) score (17-point scale) was recorded preoperatively and at 3 months postoperatively. The improvement rate was calculated as follows: improvement rate = (postoperative score − preoperative score) / (17 − preoperative score) × 100%. Lower scores indicate more severe neurological impairment, and higher improvement rates represent more satisfactory surgical outcomes. The Visual Analogue Scale (VAS) was used to assess the intensity of overall neck/shoulder pain, with scores ranging from 0 to 10, where higher scores indicate more severe pain. VAS assessed overall neck/shoulder pain rather than neck pain and shoulder pain separately.VAS and JOA scores were also recorded at 1 month postoperatively; this assessment was used primarily for safety monitoring and was not designated as a primary efficacy comparison.

Complications: The occurrence of nerve injury, esophageal injury, vertebral artery injury, incision infection, cervical hematoma, hoarseness, dysphagia, cerebrospinal fluid leakage, and internal fixation loosening or displacement was recorded.

Follow-up: Patients were followed up in the outpatient clinic at 1 and 3 months postoperatively. Clinical and radiological assessments were performed by physicians who were not involved in the surgical procedure and were blinded to the surgical approach. The 1-month follow-up focused on recording complications and safety indicators, and the 3-month follow-up was the primary assessment time point for early efficacy.

Statistical analysis

All analyses were performed using SPSS 27.0. Normality was assessed using the Shapiro-Wilk test. Normally distributed continuous variables are presented as mean ± standard deviation and were compared using the independent-samples t test; non-normally distributed variables are presented as median (IQR) and were compared using the Mann-Whitney U test. Categorical variables are presented as counts (%) and were compared using the chi-square test or Fisher's exact test. Within-group comparisons were performed using the paired t test or Wilcoxon signed-rank test. This study was a retrospective exploratory analysis; no formal sample size calculation was performed, and no adjustment for multiple comparisons was applied. A two-sided $P < 0.05$ was considered statistically significant.

Results

Comparison of baseline characteristics

A total of 63 patients were enrolled, including 30 in Group A and 33 in Group B. No statistically significant differences were observed between the two groups in sex, age, height, weight, BMI, or operative segment ($P > 0.05$) (Table 1).

Comparison of perioperative parameters

Compared with Group B, Group A had a significantly shorter operative time, less intraoperative blood loss, and a shorter incision length (Figure 2c) ($P < 0.05$). No statistically significant difference was found in length of hospital stay between the two groups ($P > 0.05$) (Table 2).

Comparison of clinical outcomes

No significant differences were observed between the two groups in preoperative VAS scores for overall neck/shoulder pain or JOA scores ($P > 0.05$). At 3 months postoperatively, VAS scores for overall neck/shoulder pain and JOA scores were significantly improved compared with preoperative values in both groups ($P < 0.05$), with no statistically significant differences between the two groups ($P > 0.05$). The 3-month JOA improvement rate showed no statistically significant difference between the two groups ($P > 0.05$) (Table 3).The 1-month VAS and JOA data are also presented in Table 3 for descriptive purposes and safety monitoring; they were not used as a primary efficacy comparison.

Complications

Complications occurred in 2 patients in Group A and 6 patients in Group B, with no statistically significant difference between the two groups (P > 0.05). In Group A, 1 patient developed hoarseness and 1 developed dysphagia; in Group B, 4 patients developed dysphagia, 1 developed hoarseness, and 1 developed cerebrospinal fluid leakage. All complications resolved within 2 weeks. No severe complications such as nerve injury, esophageal injury, vertebral artery injury, incision infection, cervical hematoma, or internal fixation loosening/displacement occurred in either group, and no patient required reoperation due to complications.

Discussion

Most endoscopic systems currently reported for clinical applications use rigid working channels. The endoscope body is non-flexible, leaving blind spots in the visualization of deep and lateral structures, limiting operational flexibility, requiring relatively complex installation, and substantially increasing intraoperative fluoroscopy frequency [11]. Meanwhile, conventional water-based endoscopic techniques are associated with a steep learning curve. The limited field of view provided by the endoscope contrasts with that of open surgery. Surgeons may readily experience disorientation during the procedure, which may prolong operative time; this loss of orientation may also increase the risk of injury to neural structures or other critical tissues [12–14].

In this retrospective comparative study of 63 patients, LUSE-assisted ACDF was associated with a shorter operative time, less intraoperative blood loss, and a shorter incision length than conventional open ACDF, while length of hospital stay did not differ significantly between the two groups. Previous studies have reported ACDF performed with large-channel endoscopic assistance [3], which shares a similar principle with the LUSE technique.Compared with the aforementioned approaches, the LUSE technique uses a dedicated flexible endoscope and a matched instrumentation set. The endoscope we used was a purpose-built, flexible soft endoscope capable of bending freely; its small lens can be stably and simply mounted on a dedicated retractor without the need for additional endoscopic fixation devices, thereby avoiding visual field obstruction caused by the endoscope itself. This allows the primary surgeon to perform decompression under direct visualization while simultaneously viewing the entire surgical field on an external monitor. The integrated workflow, clear surgical field, and matched instruments shortened the operative time. Because the flexible endoscope operates in an air medium rather than a water medium, hemostatic agents such as bone wax and gelatin sponge can be used effectively, reducing intraoperative blood loss and achieving more reliable hemostasis. The clear visualization and magnification also allowed an adequate surgical field through a smaller incision and with less retraction force, reducing disturbance to the trachea, esophagus, and other critical structures. As shown in the results, Group A was superior to Group B in intraoperative blood loss, operative time, and incision length (P < 0.05). However, these perioperative advantages should not by themselves be interpreted as evidence of superior clinical efficacy.

At 3 months postoperatively, VAS scores for overall neck/shoulder pain and JOA scores were significantly improved compared with preoperative values in both groups, with no significant differences

between the two groups in VAS scores, JOA scores, or JOA improvement rates (P > 0.05). These results indicate that, in this cohort, LUSE-assisted ACDF achieved early neurological and pain improvement comparable to that of conventional open ACDF.The 3-month time point was selected as the primary early efficacy endpoint because previous studies have shown that a substantial proportion of patients with CSM achieve the minimal clinically important difference (MCID) within 3 months after surgery [15, 16], whereas further improvement may continue up to 12 months [17]. The 1-month assessment was used primarily for safety monitoring and was not a primary efficacy comparison. Several studies have suggested that anterior cervical endoscopic ACDF may achieve better clinical outcomes than conventional open ACDF [3, 5]; however, a meta-analysis noted that the most consistent advantage of minimally invasive anterior cervical surgery lies in reducing the extent of surgical exposure, rather than in demonstrating clear superiority in short-term clinical outcomes [18]. The latter conclusion is consistent with the findings of this study. Endoscopic and other minimally invasive techniques have not fundamentally overturned the conceptual basis of ACDF; rather, they serve as complements and refinements.

Anterior cervical surgery is a high-risk procedure, and postoperative complications such as hematoma, infection, arterial injury, esophageal injury, and nerve injury can lead to catastrophic consequences. In this study, among the 63 patients, 8 developed postoperative complications: 2 cases of hoarseness, 5 cases of dysphagia, and 1 case of cerebrospinal fluid leakage. None of the aforementioned severe complications occurred, and all complications resolved within 2 weeks. The complication rate was 6.67% in Group A and 18.18% in Group B, with no statistically significant difference between the two groups (P > 0.05); however, given the small number of events, the sample size is insufficient to establish equivalence in safety, and this finding should be interpreted cautiously.

Several limitations must be acknowledged. First, this was a single-center retrospective study with a relatively small sample size, and treatment allocation was not randomized; selection bias and surgeon-related bias cannot be excluded. Second, follow-up was limited to 3 months, which is sufficient to assess early recovery and perioperative safety but insufficient to evaluate fusion rates, late complications, cage subsidence, adjacent-segment degeneration, or long-term neurological outcomes. Third, no formal sample size calculation was performed, and no adjustment for multiple comparisons was applied; therefore, the secondary outcome analyses should be regarded as exploratory. Long-term efficacy and validation in larger samples require further confirmation through prospective, multicenter studies.

Conclusion

LUSE-assisted ACDF is a novel minimally invasive endoscopic technique characterized by a flexible endoscope and dedicated distraction-decompression instruments. This study indicates that the technique is technically feasible, improves neurological function and pain symptoms at 3 months postoperatively, and is not associated with severe postoperative complications. The complication rate did not differ statistically from that of conventional open ACDF. Furthermore, LUSE-assisted ACDF

showed clear advantages over conventional open ACDF in operative time, intraoperative blood loss, and incision length.

Abbreviations

ACDF, anterior cervical discectomy and fusion

BMI, body mass index

CSM, cervical spondylotic myelopathy

CSR, cervical spondylotic radiculopathy

CT, computed tomography

IQR, interquartile range

JOA, Japanese Orthopaedic Association

LUSE, L-Unitary Soft Endoscopy

MCID, minimal clinically important difference

MRI, magnetic resonance imaging

OPLL, ossification of the posterior longitudinal ligament

SD, standard deviation

SPSS, Statistical Package for the Social Sciences

VAS, Visual Analogue Scale

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki. This study was approved by the Ethics Committee of West China Fourth Hospital, Sichuan University (approval number: HXSY-EC-2026115;date of approval: September 21, 2026.). Because of the retrospective design, the requirement for informed consent was waived.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available because they contain patient-identifiable clinical information, but are available from the corresponding author on reasonable request.

Competing interests

The LUSE system was developed by the research team of one of the authors (Qingchu Li; Invention Patent CN116983066A). The authors declare that they have no financial competing interests related to the commercial development of the device.

Funding

No funding was obtained for this study.

Authors' contributions

Zhaokui Yan contributed to the study design, data acquisition, statistical analysis, and drafting of the manuscript. Qingchu Li contributed to the development of the LUSE system, surgical technique guidance, and critical revision of the manuscript. Xiaobing Pu contributed to the study conception, surgical procedures, data interpretation, and critical revision of the manuscript. All authors read and approved the final manuscript.

Acknowledgements

Not applicable.

References

1. Fehlings MG, Tetreault LA, Riew KD, et al. A clinical practice guideline for the management of patients with degenerative cervical myelopathy:Introduction, Rationale, and Scope. Global Spine J. 2017;7(3 Suppl):S70–83. 10.1177/2192568217703088.
2. Ahn Y. Anterior endoscopic cervical discectomy: surgical technique and literature review. Neurospine. 2023;20(1):11–8. 10.14245/ns.2346118.059.
3. Christian Morgenstern. Full-endoscopic anterior cervical decompression and fusion for cervical myelopathy. Neurospine. 2024;21(4):1119–25. 10.14245/ns.2448796.398.
4. Huang C-C, Fitts J, Huie D, et al. Evolution of cervical endoscopic spine surgery: current progress and future directions—a narrative review. J Clin Med. 2024;13(7):2122. 10.3390/jcm13072122.
5. Wu Z-P, Song Z-YWX-L. Comparison of efficacy between endoscope-assisted anterior cervical discectomy and fusion (ACDF) and open ACDF in the treatment of single-segment cervical spondylotic myelopathy. J Orthop Surg Res. 2024;19:35. 10.1186/s13018-023-04514-w.

6. Ma Y, Xin Z, Kong W, et al. Transcorporeal decompression using a fully-endoscopic anterior cervical approach to treat cervical spondylotic myelopathy: surgical design and clinical application. BMC Musculoskelet Disord. 2022;23(1):1031. 10.1186/s12891-022-06001-5.
7. Zhao XB, Ma YJ, Ma HJ, et al. Clinical efficacy of posterior percutaneous endoscopic unilateral laminotomy with bilateral decompression for symptomatic cervical spondylotic myelopathy. Orthop Surg. 2022;14(5):876–84. 10.1111/os.13237.
8. Giuseppe MV, Barbagallo F, Certo. Three-dimensional, high-definition exoscopic anterior cervical discectomy and fusion: a valid alternative to microscope-assisted surgery. World Neurosurg. 2019;130:e244–50. 10.1016/j.wneu.2019.06.049.
9. Sun MS, Yuchi CX, Cai XY, et al. Parametric study of anterior percutaneous endoscopic cervical discectomy (APECD). Comput Methods Biomech Biomed Engin. 2021;24:687–99. 10.1080/10255842.2020.1846186.
10. Tacconi L, Giordan E. A novel hybrid endoscopic approach for anterior cervical discectomy and fusion and a meta-analysis of the literature. World Neurosurg. 2019;131:e237–46. 10.1016/j.wneu.2019.07.122.
11. Srinivasan D, Than KD, Wang AC, La Marca F, Wang PI, Schermerhorn TC, et al. Radiation safety and spine surgery: systematic review of exposure limits and methods to minimize radiation exposure. World Neurosurg. 2014;82:1337–43. 10.1016/j.wneu.2014.07.041.
12. Ji-Jun H, Hui-Hui S, Zeng-Wu S, et al. Posterior full-endoscopic cervical discectomy in cervical radiculopathy: a prospective cohort study. Clin Neurol Neurosurg. 2020;195:105948. 10.1016/j.clineuro.2020.105948.
13. Ahn Y, Keum HJ, Shin SH. Percutaneous endoscopic cervical discectomy versus anterior cervical discectomy and fusion: a comparative cohort study with a five-year follow-up. J Clin Med. 2020;9:371. 10.3390/jcm9020371.
14. Akiyama M, Koga H. Early experience of single level full endoscopic posterior cervical foraminotomy and comparison with microscope-assisted open surgery. J Spine Surg. 2020;6:391–6. 10.21037/jss-20-491.
15. Khan I, Archer KR, Wanner JP, et al. Trajectory of improvement in myelopathic symptoms from 3 to 12 months following surgery for degenerative cervical myelopathy. Neurosurgery. 2020;86(6):763–8. 10.1093/neuros/nyz325.
16. Evaniew N, Coyle M, Rampersaud YR, et al. Timing of recovery after surgery for patients with degenerative cervical myelopathy: an observational study from the Canadian Spine Outcomes and Research Network. Neurosurgery. 2023;92(2):271–82. 10.1227/neu.0000000000002213.
17. Berlin C, Marino AC, Mummaneni PV, et al. Determining the time frame of maximum clinical improvement in surgical decompression for cervical spondylotic myelopathy when stratified by preoperative myelopathy severity: a cervical Quality Outcomes Database study. J Neurosurg Spine. 2022;37(5):758–66. 10.3171/2022.5.SPINE211425.

18. Zihua Ding J, Liu H, Xu Y, Liu, et al. Technical evolution and short-term outcomes of minimally invasive versus conventional open anterior cervical discectomy and fusion: a systematic review and meta-analysis. J Orthop Surg Res. 2026;21:420. 10.1186/s13018-026-06929-7.

Tables

Tables 1 to 3 are available in the Supplementary Files section.

Figures



Figure 1

Components of the LUSE system.

a External appearance of the flexible endoscope.

b Vertebral body distraction device.

c Soft tissue distraction device.

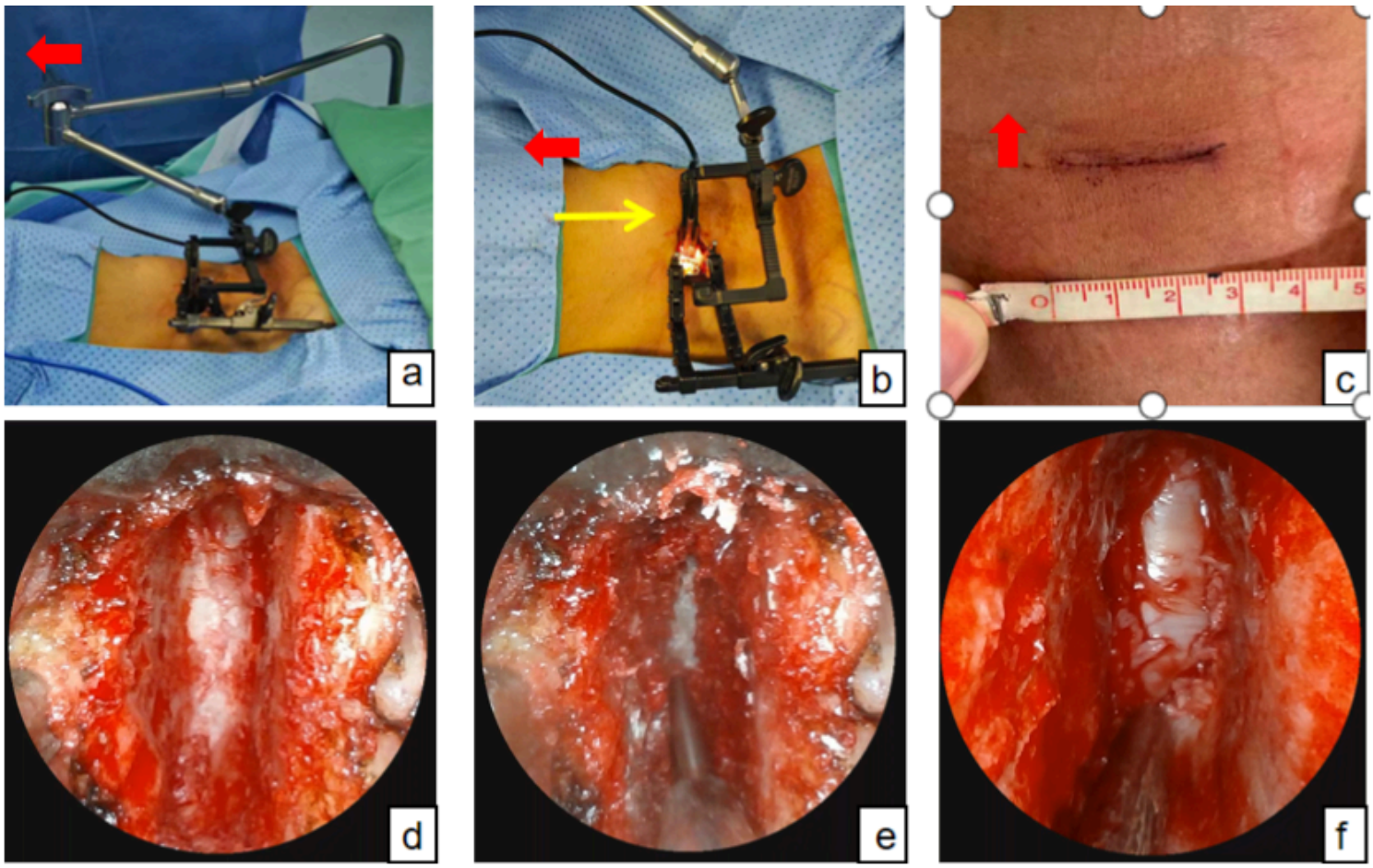


Figure 2

Intraoperative and postoperative views of LUSE-assisted ACDF.

a.Lateral view of the LUSE system in the surgical field (red arrow indicates the cranial direction).

b.Top view of the LUSE system in the surgical field (red arrow indicates the cranial direction; yellow arrow indicates the flexible endoscope of the LUSE system).

c.Postoperative photograph of the patient's incision (red arrow indicates the cranial direction).

d.Intraoperative image of the posterior margin of the intervertebral space.

e.Use of a specially designed "matchstick-head" burr to drill the posterior vertebral osteophytes.

f.Adequate spinal canal decompression with clear exposure of the dural sac and visible dural pulsation.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Table123.docx