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Observation of the Improvement Effect of Unilateral Biportal Endoscopy on Neurogenic Symptoms in Lumbar Spinal Stenosis

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Abstract: *Objective:* To investigate the clinical efficacy of unilateral biportal endoscopy (UBE) in patients with lumbar spinal stenosis (LSS), with particular attention to the improvement of neurogenic symptoms. *Methods:* A retrospective analysis was performed on the clinical data of 35 patients with LSS admitted to Linhe District People's Hospital between January 2023 and April 2026. All patients underwent UBE surgery. Preoperative and postoperative visual analog scale (VAS) scores for low back pain, Japanese Orthopedic Association (JOA) scores for low back pain disorders, operative time, intraoperative blood loss, and early postoperative bedside ambulation time were recorded. Paired *t*-tests were used to compare preoperative and postoperative scores, and surgical safety and efficacy were analyzed. *Results:* All 35 patients successfully completed surgery, and no severe complications occurred. Postoperative low back pain VAS scores were significantly lower than preoperative scores ($P < 0.05$), JOA scores were significantly higher than preoperative scores ($P < 0.05$), and neurogenic intermittent claudication was markedly improved. The mean operative time was 78.5 ± 15.2 min, the mean intraoperative blood loss was 45.8 ± 12.3 mL, and the mean early postoperative bedside ambulation time was 6.2 ± 1.8 h. No serious complications such as infection or nerve injury occurred during follow-up. *Conclusion:* UBE is safe and effective in the treatment of LSS. It can significantly improve neurogenic symptoms, relieve low back pain, and enhance quality of life, with the advantages of minimal trauma, rapid recovery, and few complications. It is worthy of clinical promotion.

Keywords: Unilateral biportal endoscopy; Lumbar spinal stenosis; Neurogenic symptoms; Minimally invasive surgery; Clinical efficacy

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1. Introduction

Lumbar spinal stenosis is a common degenerative disease in spine surgery. Its main symptoms include neurogenic intermittent claudication and low back and leg pain, which cause considerable suffering. According to statistics from the Spine Surgery Branch of the Chinese Medical Association for 2020–2024,

the prevalence of lumbar spinal stenosis among people aged over 60 years in China has reached 15.3%, a marked increase from 12.7% in 2019. Although traditional open surgery is effective, it causes substantial trauma, considerable blood loss, and a long recovery period. Consequently, an increasing number of surgeons have begun to investigate minimally invasive procedures [1]. The *National Report on Medical Quality and Safety of Spine Surgery (2023 Edition)*, issued by the National Health Commission, shows that the proportion of minimally invasive spine surgeries has risen from 35.2% to 58.7% over the past five years, indicating that minimally invasive techniques are playing an increasingly important role in the treatment of spinal diseases.

Unilateral biportal endoscopy (UBE) is a new minimally invasive spine surgery technique that has emerged in recent years. Through a single surgical approach, two working channels are established for endoscopic spinal canal decompression. This not only ensures a good surgical field but also minimizes damage to normal anatomical structures. A 2022 survey by the Spinal Endoscopy Professional Committee of the Chinese Medical Doctor Association showed that the application rate of UBE in large and medium-sized hospitals in China was 42.8%, and postoperative patient satisfaction was 91.3%, far exceeding the 76.5% associated with traditional surgery [2]. As population aging in China continues to intensify and the prevalence of lumbar spinal stenosis rises year by year, finding a more precise, safe, and effective minimally invasive treatment is of great significance for improving patients' quality of life and reducing social burden.

2. Materials and methods

2.1. Inclusion and exclusion criteria

This study selected 35 patients with lumbar spinal stenosis admitted to Linhe District People's Hospital between January 2023 and April 2024. Inclusion criteria were as follows: typical clinical manifestations, such as neurogenic intermittent claudication, low back and leg pain, or imaging-confirmed diagnosis of lumbar spinal stenosis; ineffective conservative treatment for more than 3 months; age between 18 and 80 years; completion of necessary preoperative examinations; and no surgical contraindications. Exclusion criteria were: lumbar spondylolisthesis above grade II; severe osteoporosis; infectious diseases; history of lumbar surgery; severe cardiovascular or cerebrovascular disease making surgery intolerable; and psychiatric disorders preventing cooperation with treatment and follow-up.

2.2. Surgical method and procedure

The patient was placed in the prone position with the abdomen suspended. The operating table was adjusted so that the target intervertebral space was perpendicular to the floor. Under general anesthesia, a C-arm X-ray machine was used to determine the location of the affected vertebral body. Two skin incisions were made on the affected side approximately 2–3 cm from the posterior midline. The working channel incision was about 10 mm, and the viewing channel incision was about 5 mm, with a distance of 20–30 mm between the two incisions [3]. The deep fascia was incised. Initial dilators were inserted through the cranial and caudal incisions, respectively. After fixation, dilating cannulas were inserted sequentially. The viewing channel was dilated to grade II or III, and the working channel was dilated to grade IV. A spinal endoscope and a semi-cannula were then inserted separately. The surgical field was thoroughly irrigated, and soft tissue was cleared using a plasma radiofrequency electrode. Under direct endoscopic vision, soft tissue was dissected layer by layer until the lamina was reached. A burr and rongeur were used to remove part of the lamina, fully exposing the structures within the spinal canal. The hypertrophic ligamentum flavum and osteophytes were removed,

the spinal canal volume was enlarged, and the nerve roots and dural sac were adequately decompressed, achieving complete release of neural tissue and thorough spinal canal decompression. During surgery, pulsation of the dural sac and nerve roots was carefully observed. After confirming adequate decompression, hemostasis was performed, the wound was irrigated, and the incision was closed layer by layer [4].

2.3. Observation indicators and assessment tools

The main observation indicators included pain severity, functional status, surgery-related indicators, and complications. The visual analog scale (VAS) was used to evaluate low back pain, with scores ranging from 0 to 10; higher scores indicated more severe pain. The Japanese Orthopedic Association (JOA) score for low back pain disorders was used to evaluate lumbar function, with a total score of 29 points, comprising subjective symptoms, clinical signs, and activities of daily living. Perioperative indicators such as operative time, intraoperative blood loss, and early postoperative ambulation time were recorded. The incidence of postoperative complications and readmission rate were also documented.

2.4. Statistical analysis

SPSS 31.0 statistical software was used to process the clinical data. Continuous data were expressed as mean ± standard deviation (SD). Preoperative and postoperative low back pain VAS scores and JOA scores were compared using paired-sample *t*-tests. Continuous variables such as operative time, intraoperative blood loss, and early postoperative ambulation time were analyzed using descriptive statistics, and means, standard deviations, minimum values, and maximum values were calculated. Categorical data were expressed as numbers and percentages, and comparisons between groups were performed using the chi-square test or Fisher's exact test.

All statistical tests were two-sided, and $P < 0.05$ indicated a statistically significant difference. For paired preoperative and postoperative data, normality testing was first performed. Data conforming to a normal distribution were analyzed using paired *t*-tests, while data not conforming to a normal distribution were analyzed using the Wilcoxon signed-rank test. All statistical analyses were performed by professionals with a statistical background to ensure the accuracy and credibility of the data analysis. A 95% confidence interval was used to evaluate efficacy, and effect size was calculated to determine clinical significance.

3. Results

3.1. Baseline characteristics of patients

Among the 35 patients, 19 were male and 16 were female. Their ages ranged from 45 to 76 years, with a mean age of 62.3 ± 8.7 years. The disease course ranged from 6 months to 5 years, with a mean course of 2.1 ± 1.3 years. The distribution of affected segments was as follows: L4–L5 in 21 cases, L3–L4 in 9 cases, and L5–S1 in 5 cases. The main preoperative clinical manifestations included low back pain in 32 cases (91.4%), lower limb pain in 30 cases (85.7%), neurogenic intermittent claudication in 35 cases (100%), and lower limb numbness in 28 cases (80.0%). All patients underwent preoperative lumbar X-ray, CT, and MRI examinations and were diagnosed with lumbar spinal stenosis. Among them, 18 cases were complicated by disc herniation, 35 cases by hypertrophic ligamentum flavum, and 26 cases by facet joint hyperplasia.

3.2. Analysis of perioperative indicators

All 35 patients successfully underwent UBE surgery, and none were converted to open surgery. The mean operative time was 78.5 ± 15.2 min, with a minimum of 55 min and a maximum of 110 min. The mean intraoperative blood loss was 45.8 ± 12.3 mL, far lower than that of traditional open surgery. The mean postoperative hospital stay was 4.2 ± 1.5 days. All patients had good postoperative incision healing, and no infection occurred. The mean early postoperative bedside ambulation time was 6.2 ± 1.8 h. Postoperative pain was mild, and patients tolerated activity well. See **Table 1**.

Table 1. Statistical results of perioperative indicators

Indicator	Minimum	Maximum	Mean ± SD
Operative time (min)	55	110	78.5 ± 15.2
Intraoperative blood loss (mL)	25	75	45.8 ± 12.3
Hospital stay (days)	2	8	4.2 ± 1.5
Early ambulation time (h)	3	12	6.2 ± 1.8

3.3. Trends in low back pain scores and JOA scores

The mean preoperative low back pain VAS score was 7.2 ± 1.4, decreasing to 2.8 ± 1.1 at 1 week after surgery, further decreasing to 1.9 ± 0.8 at 1 month after surgery, and stabilizing at 1.5 ± 0.6 at 3 months after surgery. Differences at each time point compared with preoperative values were statistically significant ($P < 0.001$), indicating that UBE surgery can effectively relieve low back pain. The mean preoperative lower limb pain VAS score was 6.8 ± 1.6, decreasing to 2.5 ± 1.0 at 1 week after surgery, 1.7 ± 0.7 at 1 month after surgery, and 1.2 ± 0.5 at 3 months after surgery, also showing good improvement.

The mean preoperative JOA functional score was 14.3 ± 2.8, increasing to 21.6 ± 2.4 at 1 week after surgery, reaching 24.2 ± 2.1 at 1 month after surgery, and maintaining at 25.8 ± 1.9 at 3 months after surgery. The JOA improvement rate at 3 months after surgery was 78.5 ± 12.6%. The excellent rate (improvement rate ≥75%) was 60.0%, the good rate (improvement rate 50–74%) was 31.4%, and the total effective rate was 91.4%. Neurogenic intermittent claudication was significantly alleviated, and the walking distance at 3 months after surgery increased by more than 150% on average compared with preoperative values. See **Table 2**.

Table 2. Comparison of preoperative and postoperative VAS and JOA scores

Assessment indicator	Preoperative	1 week postoperative	1 month postoperative	3 months postoperative	*P* value
Low back pain VAS score	7.2 ± 1.4	2.8 ± 1.1	1.9 ± 0.8	1.5 ± 0.6	<0.001
Lower limb pain VAS score	6.8 ± 1.6	2.5 ± 1.0	1.7 ± 0.7	1.2 ± 0.5	<0.001
JOA functional score	14.3 ± 2.8	21.6 ± 2.4	24.2 ± 2.1	25.8 ± 1.9	<0.001
JOA improvement rate (%)	-	-	65.2 ± 15.3	78.5 ± 12.6	<0.001

3.4. Complications and readmission

Among the 35 patients, 4 (11.4%) developed minor postoperative complications, including local incisional hematoma in 2 cases, transient lower limb numbness in 1 case, and headache in 1 case. All recovered after conservative treatment. No severe complications such as dural tear, nerve root injury, or infection occurred. During the 3-month postoperative follow-up, no patient was readmitted because of symptom recurrence or

complications. All patients had good incision healing, and no chronic pain occurred. Postoperative imaging showed adequate spinal canal decompression and no evidence of vertebral instability. See **Table 3**.

Table 3. Statistics of complications

Complication type	Number of cases	Incidence (%)	Management	Recovery time
Incisional hematoma	2	5.7	Local compression dressing	3–5 days
Transient lower limb numbness	1	2.9	Neurotrophic treatment	1–2 weeks
Postoperative headache	1	2.9	Symptomatic treatment	2–3 days
Severe complications	0	0	-	-

3.5. Early functional recovery and ambulation time

Early postoperative functional recovery was good. Patients could get out of bed at a mean of 6.2 ± 1.8 h after surgery and could walk independently within 24 h after surgery. Rehabilitation exercises, such as lumbar dorsal muscle exercises and walking, were started on the second postoperative day. Activities of daily living were basically restored at 1 week after surgery, and light physical labor could be performed at 2 weeks after surgery [5]. Compared with traditional open surgery, UBE greatly shortens recovery time and improves patients' quality of life. See **Table 4**.

Table 4. Time points of early functional recovery

Functional recovery indicator	Time	Proportion of patients (%)
Bedside ambulation	6.2 ± 1.8 h	100
Independent walking	Within 24 h	94.3
Self-care in daily living	Within 1 week	91.4
Light physical labor	Within 2 weeks	85.7

4. Discussion

4.1. Exploration of the mechanism by which UBE improves neurogenic symptoms

UBE uses two lenses in coordination for decompression. The improvement of neurogenic symptoms is mainly attributed to multiple pathophysiological changes. This technique can enlarge the interlaminar space and remove the ligamentum flavum under minimally invasive conditions, relieving nerve root compression and restoring normal physiological space within the spinal canal [6]. After decompression, blood supply around the nerve roots increases markedly, ischemic and hypoxic conditions are rapidly improved, inflammatory mediators are reduced, and thereby nerve root edema and inflammatory responses are alleviated. The biportal design separates instruments from the endoscope, avoiding the mutual interference between instruments and the lens seen in traditional uniportal endoscopy. This provides the operator with more working space and a better field of view, ensuring thoroughness and safety of decompression.

The improvement of neurogenic intermittent claudication is closely related to effective enlargement of the spinal canal volume. UBE can precisely remove hyperplastic facet joints and part of the lamina, achieving adequate decompression while preserving spinal stability [7]. During surgery, the patient's neurological function is promptly observed to prevent iatrogenic nerve injury. At the same time, the posterior structures of the spinal canal are preserved, which is beneficial for spinal biomechanical stability and neurological recovery.

4.2. Comparison of this study's results with previous literature

The results of this study are basically consistent with recent relevant literature, but they show the unique advantages of UBE in certain indicators. A multicenter study reported by Xia *et al.* in 2023 showed that the JOA score improvement rate of UBE in treating lumbar spinal stenosis was 68.5%, whereas this study reached an improvement rate of 72.3%, indicating that UBE has a favorable effect on neurological recovery. In terms of surgical trauma control, the mean blood loss in this study was 45.8 mL, far less than the 180–250 mL associated with traditional open surgery, and similar to the 48.2 mL reported by Kim *et al.* in 2024 for UBE surgery, indicating the minimally invasive nature of this technique. In terms of operative time, the mean of 78.5 min in this study was basically consistent with the 82.4 min reported by Lee *et al.* in 2023 for single-segment UBE surgery, suggesting that the technique has become relatively mature and reproducible.

4.3. Limitations of the study and clinical implications

Although this study demonstrated that unilateral biportal endoscopy is effective in treating lumbar spinal stenosis, several shortcomings remain. On the one hand, this was a retrospective study with a small sample size of only 35 patients and no control group, which may affect the credibility of the results. On the other hand, the follow-up period was relatively short, making it difficult to adequately evaluate the long-term efficacy and potential problems of UBE. In particular, conclusions regarding improvement in neurogenic intermittent claudication require longer follow-up. In addition, there may be bias in patient inclusion criteria and surgical indication selection, and differences in surgeons' technical proficiency may affect the consistency of surgical outcomes [8].

Clinically, UBE offers a new treatment option for patients with lumbar spinal stenosis, and it is particularly suitable for older patients and older patients with multiple comorbidities. Moreover, UBE can achieve good decompression while reducing surgical injury and the incidence of postoperative complications, greatly shortening hospital stay and saving costs. However, UBE places high demands on physicians' endoscopic operating skills and requires specialized training and extensive practice [9]. Future research should focus on large-sample, multicenter randomized controlled trials, establish unified operating standards and criteria for selecting indications, and strengthen physician training to ensure the safety and effectiveness of this minimally invasive technique [10].

5. Conclusion

Unilateral biportal endoscopy is a new minimally invasive treatment method in spine surgery and has clear efficacy in treating lumbar spinal stenosis. Through a retrospective study of 35 patients, it was found that UBE can effectively alleviate neurogenic intermittent claudication caused by lumbar spinal stenosis. Postoperative low back pain VAS scores and JOA functional scores were significantly improved, and patients' quality of life was greatly enhanced. By taking advantage of precise operation under direct endoscopic vision and the biportal design, this technique achieves adequate decompression of the stenotic spinal canal while preserving spinal stability structures to the greatest extent. Its advantages of minimal surgical trauma, less blood loss, and rapid recovery allow patients to return to normal life sooner and save hospitalization time and costs. Given the intensifying aging of China's population and the yearly increase in the prevalence of lumbar spinal stenosis, UBE has good safety and efficacy for this disease and broad prospects and space for clinical application.

Disclosure statement

The authors declare no conflict of interest.

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