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Study on the Clinical Efficacy of Spinal Endoscopy in the Treatment of Lumbar Spinal Stenosis

Yongbo Xie, Shiwei Li, Yang Xu

Leshan Shizhong District Traditional Chinese Medicine Hospital, Leshan 614000, Sichuan, China

Abstract: Objective: To investigate the clinical efficacy of spinal endoscopy in the treatment of lumbar spinal stenosis. *Methods:* Eighty patients with lumbar spinal stenosis treated in our hospital from January 2024 to June 2025 were selected and randomly divided into two groups using a random number table. Patients treated with traditional open laminectomy were assigned to the control group, while those treated with spinal endoscopic decompression were assigned to the observation group. Clinical indicators were compared between the two groups. *Results:* Compared with the control group, the observation group demonstrated a higher rate of excellent and good treatment outcomes after treatment, shorter operation time, earlier postoperative ambulation, shorter hospital stay, less intraoperative blood loss, higher Japanese Orthopaedic Association scores, and lower Visual Analog Scale and Oswestry Disability Index scores ($P < 0.05$). The overall complication rate was lower in the observation group than in the control group ($P < 0.05$). *Conclusion:* Spinal endoscopy for the treatment of lumbar spinal stenosis offers advantages such as minimal surgical trauma, less intraoperative bleeding, rapid postoperative recovery, and fewer complications. It effectively improves lumbar spine function, alleviates pain, and enhances clinical efficacy, making it worthy of clinical promotion and application.

Keywords: Lumbar spinal stenosis; Spinal endoscopy; Decompression; Lumbar spine function

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1. Introduction

Lumbar spinal stenosis is a common degenerative orthopedic disease primarily caused by abnormalities in the bony-fibrous structure of the lumbar spinal canal, leading to canal stenosis that compresses the dura mater and nerve roots, resulting in symptoms such as lumbosacral pain, lower extremity radiating pain, and intermittent claudication. In severe cases, it can cause decreased lower extremity muscle strength and dysfunction of urination and defecation, affecting patients' quality of life [1]. This condition is more prevalent in middle-aged and elderly individuals, and its incidence has been increasing annually with the aging population and changes in lifestyle. The clinical treatment of lumbar spinal stenosis focuses on relieving nerve compression and restoring lumbar spine function, with options divided into conservative treatment and surgical treatment [2]. Conservative treatment is suitable for patients with mild symptoms but has limited

long-term efficacy, with approximately 30% of patients ultimately requiring surgical intervention. Traditional open laminectomy can achieve nerve decompression but is associated with significant surgical trauma, substantial intraoperative bleeding, slow postoperative recovery, and a high risk of damaging the posterior spinal muscle-ligament complex, increasing the likelihood of postoperative spinal instability and chronic low back pain [3]. In recent years, spinal endoscopy technology has rapidly advanced, offering advantages such as minimal trauma, clear visualization, high precision, and rapid recovery. It has been widely applied in the treatment of lumbar spinal stenosis [4,5], but targeted research on its long-term clinical efficacy and safety remains to be supplemented. Based on this, this study further explores the efficacy of spinal endoscopy, with details as follows.

2. Materials and methods

2.1. General information

Eighty patients with lumbar spinal stenosis treated in our hospital from January 2024 to June 2025 were selected and randomly divided into two groups using a random number table. The control group (40 cases) consisted of 23 males and 17 females, with an average age of 42.35 ± 7.68 years (range: 20–67 years), an average disease duration of 7.23 ± 2.15 months, and stenosis segments as follows: L3–L4 in 11 cases, L4–L5 in 20 cases, and L5–S1 in 9 cases. The observation group (40 cases) consisted of 22 males and 18 females, with an average age of 43.12 ± 7.85 years (range: 21–68 years), an average disease duration of 7.56 ± 2.31 months, and stenosis segments as follows: L3–L4 in 10 cases, L4–L5 in 21 cases, and L5–S1 in 9 cases. The baseline data between the two groups showed minimal differences ($P > 0.05$).

Inclusion criteria: (1) Poor response to conservative treatment for more than 3 months; (2) Presence of clear symptoms such as lumbosacral pain, lower extremity radiating pain, and intermittent claudication affecting daily life; (3) Lumbar MRI showing a spinal canal anteroposterior diameter ≤12 mm and clear nerve compression; (4) Informed consent from patients and their families to voluntarily participate in this study and cooperate with follow-up.

Exclusion criteria: (1) Patients with congenital spinal stenosis, spinal tuberculosis, spinal tumors, or spinal deformities; (2) Patients requiring fusion and internal fixation due to severe lumbar spondylolisthesis or lumbar instability; (3) Patients with coagulation disorders, severe cardiovascular and cerebrovascular diseases, or liver and kidney dysfunction, which are contraindications for surgery; (4) Patients with a history of lumbar surgery; (5) Patients with mental illnesses who cannot cooperate with treatment and follow-up; (6) Patients with lower extremity vascular diseases or neurological disorders that affect symptom assessment.

2.2. Treatment methods

2.2.1. Control group

Traditional open laminectomy: The patient was placed in the prone position under general anesthesia, with a pillow placed under the abdomen to adjust the lumbar spine to a flexed position. An 8–12 cm incision was made at the center of the affected segment, and the tissues were dissected layer by layer until the affected segment's laminae, facet joints, and spinous processes were fully exposed. The degree of spinal canal stenosis was assessed, and a complete or partial laminectomy was performed. Prolapsed intervertebral disc tissue, hyperplastic bone, and ligamentum flavum were removed to relieve compression, including compression of the nerve roots and dura mater, and to improve nerve root mobility. Intraoperative hemostasis was thoroughly

performed, a drainage tube was placed, and the incision was sutured. Postoperative treatment included routine measures such as dehydration and anti-infection therapy. Patients were instructed to remain in bed for 4–6 weeks.

2.2.2. Observation group

Spinal endoscopic decompression was performed as follows: The patient was placed in the prone position under general anesthesia, with the abdomen adjusted and a pillow placed. The affected segment was identified using imaging equipment, and the operative site was marked. A longitudinal incision (2.0–2.5 cm) was made at the marked location, and the tissues were dissected layer by layer until the paravertebral muscles were reached. Soft tissues were dilated with the aid of a dilator to establish a large-channel spinal endoscopic operative corridor. The endoscope was placed into the corridor, and the imaging system was connected to clearly visualize the lesion site. Surgical instruments, including radiofrequency electrodes, nucleus pulposus forceps, and osteotomes, were placed through the large channel to treat hyperplastic tissue and partial laminae and medial facet joint margins, thereby relieving compression on the squeezed nerve roots and achieving comprehensive decompression. During the procedure, continuous irrigation with physiological saline was used to maintain a clear surgical field, achieve thorough hemostasis, and prevent damage to the nerve roots and dura mater. After completing the surgical procedure, the instruments were organized, and the incision was sutured. Postoperatively, nutritional nerve and anti-infection medications were administered based on the patient's condition.

2.3. Observation indicators

(1) Clinical efficacy: Excellent was defined as the complete disappearance of clinical symptoms (lower extremity radiating pain, lumbosacral pain, etc.), normal lumbar spine function, and the ability to engage in normal daily life and work; good was defined as significant improvement in clinical symptoms, nearly normal lumbar spine function, occasional mild pain without affecting daily life; fair was defined as alleviation of clinical symptoms, slight improvement in lumbar spine function, with significant pain; poor was defined as no alleviation of clinical symptoms and no improvement in lumbar spine function. The excellent and good rate was calculated as (excellent + good)/total number of cases × 100%.

(2) Surgical indicators (operation time, intraoperative blood loss, postoperative ambulation time) and hospital stay.

(3) Japanese Orthopaedic Association (JOA), Visual Analog Scale (VAS), and Oswestry Disability Index (ODI) scores were observed. The JOA score has a total of 29 points, with a positive correlation between the score and lumbar spine function. The VAS score has a total of 10 points, with 10 indicating severe pain. The ODI score has a total of 100 points, with a higher score indicating more severe dysfunction.

(4) Complication occurrence: Postoperative incision infection, nerve root injury, dural tear, spinal instability, and worsening of lower extremity numbness were recorded.

2.4. Statistical methods

SPSS 26.0 software was used to process the experimental data. Measurement data, including surgical indicators, hospital stay, JOA, VAS, and ODI scores, were expressed as mean ± standard deviation (SD) and compared using the t-test. Count data, including clinical efficacy and complication rate, were compared using the chi-square test. A significant difference between the two groups was defined as $P < 0.05$.

3. Results

3.1. Comparison of clinical efficacy

In terms of clinical efficacy, the observation group demonstrated a higher rate than the control group ($P < 0.05$), as shown in **Table 1**.

Table 1. Comparison of clinical efficacy [*n* (%)]

Group	Number of cases	Excellent	Good	Fair	Poor	Excellent & good rate
Control group	40	15	15	7	3	30 (75.00)
Observation group	40	22	15	2	1	37 (92.50)
χ^2						4.501
P						0.034

3.2. Comparison of surgical-related indicators

The observation group had shorter operation time, earlier postoperative ambulation time, and shorter hospital stay compared to the control group, along with less intraoperative blood loss ($P < 0.05$), as shown in **Table 2**.

Table 2. Comparison of surgical-related indicators and hospital stay (mean ± SD)

Group	Number of cases	Operation time (min)	Intraoperative blood loss (ml)	Postoperative ambulation time (h)	Hospital stay (days)
Control group	40	98.76 ± 12.35	185.42 ± 32.67	72.35 ± 10.42	10.87 ± 2.15
Observation group	40	65.43 ± 10.28	45.78 ± 15.36	28.67 ± 8.53	5.62 ± 1.34
t		13.119	24.464	20.515	13.106
P		0.000	0.000	0.000	0.000

3.3. Comparison of JOA, VAS, and ODI scores

In terms of JOA scores, the comparison revealed that the observation group had higher scores after treatment, while VAS and ODI scores were lower ($P < 0.05$), as shown in **Table 3**.

Table 3. Comparison of JOA, VAS, and ODI scores (mean ± SD, points)

Group	Number of cases	JOA score		VAS score		ODI score	
		Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Control group	40	12.35 ± 2.18	21.57 ± 2.46	7.65 ± 1.23	3.25 ± 1.08	68.75 ± 7.82	38.45 ± 6.53
Observation group	40	12.42 ± 2.23	25.78 ± 2.53	7.72 ± 1.25	1.87 ± 1.03	69.23 ± 7.85	22.36 ± 6.42
t		0.142	7.545	0.252	5.848	0.274	11.113
P		0.888	<0.001	0.801	<0.001	0.785	<0.001

3.4. Comparison of complication rates

In terms of the overall complication rate, the observation group had a lower rate than the control group ($P < 0.05$), as shown in **Table 4**.

Table 4. Comparison of complication rates [*n* (%)]

Group	Number of cases	Incision infection	Nerve root injury	Dural tear	Spinal instability	Worsening of lower limb numbness	Total incidence (%)
Control group	40	2	2	1	3	1	9 (22.50)
Observation group	40	1	1	0	0	0	2 (5.00)
χ^2							5.165
P							0.023

4. Discussion

The pathological basis of lumbar spinal stenosis (LSS) is the degeneration and hyperplasia of the osseous-fibrous structures within the lumbar spinal canal, leading to canal stenosis, compression of the dural sac and nerve roots, and a series of neurological dysfunction symptoms [6]. The disease has a protracted course, and conservative treatment can only temporarily alleviate symptoms without fundamentally relieving nerve compression. For patients with severe symptoms and ineffective conservative treatment, surgical intervention is the preferred option. The core of treatment is to thoroughly relieve nerve compression, restore the normal volume of the lumbar spinal canal, while maximally protecting the stability of the spinal structure and reducing the occurrence of complications [7].

Traditional open laminectomy is a classic surgical approach for treating LSS. It achieves nerve decompression by extensively stripping the paraspinal muscles and resecting the laminae and hyperplastic tissues. Although it has a long history of clinical application and provides definite decompression effects, it has significant limitations. This procedure involves a large surgical incision, causing substantial damage to the paraspinal muscles, ligaments, and osseous structures of the spine, with considerable intraoperative bleeding, a prolonged postoperative recovery period, and a high risk of complications such as spinal instability and chronic low back pain, which affect postoperative rehabilitation and quality of life [8]. Spinal endoscopy, a minimally invasive treatment technique developed in recent years, such as large-channel spinal endoscopy, has gradually replaced traditional open surgery as the preferred minimally invasive approach for clinical treatment of LSS due to its advantages of minimal trauma, clear visualization, and precise manipulation. By establishing a large channel, this technique avoids extensive stripping of the paraspinal muscles, allowing precise removal of hyperplastic tissues and relief of nerve compression under clear visualization, while maximally protecting the posterior spinal muscle-ligament complex, reducing the risk of postoperative complications, and promoting rapid patient recovery [9].

In this study, the observation group had shorter operative time, postoperative ambulation time, and hospital stay, as well as less intraoperative bleeding, primarily due to the minimally invasive nature of spinal endoscopy. Traditional open surgery requires extensive stripping of the paraspinal muscles to expose the affected segments, resulting in significant surgical trauma, prolonged operative time, substantial intraoperative bleeding, and the need for prolonged bed rest postoperatively, which prolongs the hospital stay. In contrast, spinal endoscopic surgery only requires two small incisions without extensive muscle stripping. The endoscope provides a magnified and clear surgical field, enabling precise localization of the pathological tissues and rapid completion of decompression, reducing intraoperative bleeding and surgical trauma. Patients can ambulate early postoperatively, shortening

the hospital stay and accelerating rehabilitation. Additionally, spinal endoscopic surgery causes minimal damage to the osseous structures and ligaments of the spine, avoiding extensive resection of the laminae and preserving the normal anatomical structure of the spine, thereby minimizing disruption to spinal stability and laying the foundation for rapid postoperative recovery. In this trial, the observation group showed a significant increase in the JOA score and a marked decrease in the VAS and ODI scores after surgical treatment, with differences compared to the control group. This indicates that spinal endoscopic treatment can more effectively improve lumbar function, alleviate pain, and reduce functional impairment in patients. The reasons mainly include two aspects: First, spinal endoscopic surgery provides more precise and thorough decompression. The endoscope clearly displays the compressed nerve roots and surrounding pathological tissues, enabling precise removal of hyperplastic bone, ligamentum flavum, and herniated intervertebral disc tissues, thoroughly relieving nerve compression, restoring normal blood supply to the nerve roots, and alleviating symptoms such as lower extremity radiating pain and numbness, thereby improving lumbar function. Second, spinal endoscopic surgery causes minimal trauma and less postoperative pain, allowing patients to initiate rehabilitation training early, including lumbar-back muscle functional exercises and lower extremity mobility training, which helps restore lumbar-back muscle strength, maintain lumbar stability, further improve lumbar function, and reduce functional impairment. Traditional open surgery, due to its significant trauma and obvious postoperative pain, delays the initiation of rehabilitation training and results in slower recovery of lumbar-back muscle function, leading to inferior improvement in lumbar function compared to spinal endoscopic surgery [10].

In this study, the observation group had a lower overall complication rate and a higher rate of excellent and good treatment outcomes compared to the control group, primarily related to the operational characteristics of spinal endoscopic surgery. Traditional open surgery, due to its significant trauma and extensive intraoperative exposure, is prone to complications such as wound infection, dural tear, and nerve root injury, with a high incidence of postoperative spinal instability, affecting clinical efficacy. In contrast, spinal endoscopic surgery involves small incisions, making intraoperative aseptic techniques easier to control and effectively reducing the incidence of wound infection. The clear endoscopic visualization allows precise avoidance of nerve roots and the dural sac, reducing the occurrence of complications such as nerve root injury and dural tear. Additionally, this surgery causes minimal damage to the spinal structure, preserving spinal stability and reducing the incidence of postoperative spinal instability. Furthermore, spinal endoscopic surgery promotes rapid postoperative recovery, enabling early patient ambulation and reducing complications such as lower extremity venous thrombosis and pulmonary infection caused by prolonged bed rest, further improving the rate of excellent and good clinical outcomes.

It should be noted that spinal endoscopic surgery requires high technical proficiency from the operating surgeon, who must be skilled in spinal anatomy and endoscopic manipulation techniques to ensure thorough decompression and avoid complications such as nerve injury and incomplete decompression due to improper operation. Additionally, postoperative rehabilitation guidance should be strengthened, and patients should be urged to perform rehabilitation training in a standardized manner, avoiding premature weight-bearing and reducing symptom recurrence.

5. Conclusion

In conclusion, spinal endoscopic treatment for LSS offers advantages such as minimal surgical trauma, less intraoperative bleeding, rapid postoperative recovery, and fewer complications. It effectively relieves nerve

compression, improves lumbar function, alleviates pain, and enhances clinical efficacy, aligning with the concept of clinical minimally invasive treatment and warranting widespread clinical application.

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Disclosure statement

The authors declare no conflict of interest.

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