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Application of Unilateral Double-Channel Endoscopic Lamina Fenestration Decompression in Lumbar Spinal Stenosis

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Abstract: *Objective:* This paper aims to observe and explore the application effect of unilateral double-channel endoscopic lamina fenestration decompression in the clinical treatment of patients with lumbar spinal stenosis. *Methods:* The study period is from January 2020 to December 2022, 60 patients with lumbar spinal stenosis were recruited and divided into the control group (traditional interlaminar fenestration) and the study group (unilateral double-channel endoscopic lamina fenestration decompression) according to the method of coin tossing, with 30 cases in each group. The operation time, perioperative blood loss, incision diameter, total hospitalization time, postoperative complications, Japanese Orthopedic Association (JOA), Numerical Rating Scale (NRS) pain score, and excellent rate of lumbar recovery were compared. *Results:* The operation time of the study group was longer than that of the control group, the amount of perioperative blood loss was lower than that of the control group, the incision diameter was smaller than that of the control group, and the total hospitalization time was shorter than that of the control group ($P < 0.05$). Postoperative complications such as dural tear, cerebrospinal fluid leakage, infection, and paravertebral muscle injury in the study group were less than those in the control group ($P < 0.05$). The JOA score of the study group was higher than that of the control group, and the NRS score was lower than that of the control group 6 months after operation ($P < 0.05$). The operation effect was evaluated according to the modified MacNab standard 6 months after operation, and the excellent rate of lumbar spine recovery in the study group was higher than that in the control group ($P < 0.05$). *Conclusion:* Unilateral double-channel endoscopic fenestration decompression of the lamina has a definite application effect, it can significantly reduce postoperative complications of lumbar spinal stenosis, and promote the recovery of lumbar spine function. It has the advantages of mild pain, high safety, less bleeding, small incision, and other advantages, which can be recommended in the treatment of lumbar spinal stenosis.

Keywords: Lumbar spinal stenosis; Unilateral dual-channel endoscopy; Decompressive laminectomy; Lumbar function; Pain

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1. Introduction

Lumbar spinal stenosis is a degenerative spinal disease with a risk of disability. It is common in the elderly, and can cause intermittent claudication and low back pain in patients. Surgical intervention is often used when conservative drug treatment is not effective [1]. However, the paravertebral muscles need to be stripped during conventional open resection, which can easily damage the spinal structure and lead to a decrease in the stability of the lumbar spine [2]. Therefore, in order to make up for the shortcomings of traditional open surgery, clinical medicine has begun to explore minimally invasive spinal surgery treatment options, especially as endoscopic technology is becoming more and more advanced, the decompression of the lamina fenestration based on unilateral dual-channel endoscopic technology is relatively developed. Its advantages of practicability, flexible operation, safety and efficiency, wide operative field, minimally invasive, and less complications have gradually attracted the attention of clinical orthopedic surgeons [3]. Therefore, this study selected 60 patients with lumbar spinal stenosis to observe and explore the application effect of unilateral dual-channel endoscopic lamina fenestration decompression, hoping to provide evidence-based support for promoting the health of patients.

2. Materials and methods

2.1. General information

From January 2020 to December 2022, 60 patients with lumbar spinal stenosis were recruited, and they were divided into the control group (n = 30) and the study group (n = 30) according to the method of coin tossing. The ratio of male to female in the control group was 16:14, the age range was 37–75 years old, with an average of 55.58 $\pm$ 7.89 years old. Among them, there were 4 cases of L2–3 segment, 7 cases of L3–4 segment, 11 cases of L4-5 segment, 8 cases of L5–S1 segment. The ratio of male to female in the study group was 15:15, the age range was 38–76 years old, with an average of 55.61 $\pm$ 7.87 years old. Among them, there were 3 cases of L2–3 segment, 8 cases of L3–4 segment, 13 cases of L4–5 segment, 6 cases of L5–S1 segment. There was no difference in general data between the two groups ($P > 0.05$).

Inclusion criteria included patients with lumbar spinal stenosis confirmed by imaging examinations, patients with ineffective recovery for more than 12 weeks after conservative treatment, patients who can complete regular follow-up for 6 months after surgery, patients who have given informed consent to this study.

Exclusion criteria were patients with scoliosis, patients with spinal infection, patients with spinal tuberculosis, patients with spinal instability, patients with a history of lumbar spine surgery, patients with malignant tumors and intervertebral discitis, patients with mental illness, patients with hip and knee joints disease, patients with coagulation disorders.

2.2. Methods

In the control group, 30 patients with lumbar spinal stenosis underwent traditional interlaminar fenestration. After successful general anesthesia, the waist and abdomen were suspended in the air to open the interlaminar space. Under the guidance of a C-arm X-ray machine, the responsible intervertebral space was identified. The incision was centered on the tip of the lumbar spinous process (on the responsible intervertebral space), and the skin was cut 0.5–1.0cm beside the spinous process. The length of the incision was 5.0–8.0cm. Then along the fascia, incision was made on the erector spinae of the affected side near the spinous process, the attachment point of the ligamentum flavum on the lower edge of the upper lamina was peeled off, the upper lamina was taken out with forceps to expose the upper edge of the ligamentum flavum, and part of the articular process was osteotomized. The inner edge of the articular process was exposed, and then the inner edge of the outer side of the ligamentum flavum was taken out with forceps. After the ligamentum flavum was cut off, the upper edge of the inferior lamina was taken out with forceps.

In the study group, 30 patients with lumbar spinal stenosis underwent unilateral double-channel endoscopic lamina fenestration decompression. After successful general anesthesia, the entry points were clearly defined and marked by the C-arm X-ray machine. A positioning pin was placed in the center of the upper edge of the lower plate of the responsible intervertebral space. The double channel was established in the X-ray projection part of the upper and lower pedicle body surface on the same side of the responsible intervertebral space. The incision is 0.5–0.8cm long, and then the probe and light source were inserted through the observation channel, and the instruments were inserted through the operation channel. With the positioning needle as the center, the plasma knife head was used to create a cavity next to the spinous process, 1/2 of the upper and lower lamina was fully exposed, and part of the lamina and part of the articular process were resected (upper boundary: lower 1/3 of the upper cone and plate; lower boundary: lower cone 1/3 of the board; medial border: the root of the spinous process; lateral border: the connection between the inner edge of the upper and lower pedicles). The ligamentum flavum was also resected, the hyperplastic tissue behind the dural sac was cleaned up, the nerve root and dural sac were exposed, and the compression of the nerve roots and the degree of compression of the dural sac were identified, they were released one by one, the intervertebral disc was exposed, and the herniated disc tissue was removed, so that the dura mater and nerve root pulsated well. If the contralateral side is narrow, the bony structure along the root of the spinous process is removed, the ligamentum flavum is taken out with forceps, the contralateral dural sac is exposed, and the contralateral side is treated in the same decompression manner. Standardized hemostasis in the operation area was performed, the operation channel was evacuated, the incision was closed and covered with sterile dressing, and bandaged with pressure.

2.3. Observation indicators

The indicators below were observed for the two groups.

(1) Perioperative indicators including operation time, perioperative blood loss, incision diameter, and total hospitalization time.

(2) Postoperative complications including dural tear, cerebrospinal fluid (CSF) leak, infection, paravertebral muscle injury, etc.

(3) Lumbar function was evaluated by the Japanese Orthopedic Association Evaluation Score (JOA) [4] before operation and 6 months after operation, with a total score of 0–29 points. The better the lumbar function recovery, the higher the evaluation score.

(4) The Numerical Rating Scale (NRS) [5] was used to evaluate the degree of low back pain in patients before operation and 6 months after operation, with a total score of 0–10 points. The lighter the low back pain, the lower the evaluation score.

(5) Excellent rate of lumbar recovery was evaluated. According to the modified MacNab standard [6], the curative effect of the operation was evaluated 6 months after the operation, that is, the symptoms such as claudication, numbness and pain in the lower limbs, low back pain, and other symptoms are absent, and they could carry out normal activities and life, which was judged as "excellent." Those with relieved symptoms and can carry out basic activities and have little impact on daily life are judged as "good." Those whose symptoms are not relieved and cannot perform normal activities with daily life greatly affected are judged as "poor." Among them, the sum of the number of excellent and good cases is the percentage of the total number of cases, which is the excellent and good rate.

2.4. Statistical processing of data

SPSS22.0 software was used to statistically observe the indicators, and the postoperative complications and lumbar spine recovery rate of the two groups of patients were described in the form of [n (%)] and the difference between the two groups was tested by x^2. Perioperative period indicators, JOA score, NRS score, and other measurement data are described in the form of mean ± standard deviation (SD), and the data difference between groups is tested by t test. When the test result $P < 0.05$, the difference is statistically significant.

3. Results

3.1. Comparison of perioperative indicators

Compared with the control group, the operation time of the study group was slightly longer, but the perioperative blood loss was less, the diameter of the incision was smaller, and the total hospitalization time was shorter. There was a significant difference between the two groups ($P < 0.05$). Perioperative indicators are shown in **Table 1**.

Table 1. Comparison of perioperative indicators between the two groups (mean ± SD)

Group	Operation time (min)	Perioperative blood loss (ml)	Cutting diameter (mm)	Total hospital stay (day)
Study group (n = 30)	72.78 ± 5.96	46.88 ± 5.26	17.65 ± 1.25	7.12 ± 1.38
Control group (n = 30)	55.92 ± 6.04	60.33 ± 5.29	68.74 ± 12.33	9.08 ± 2.24
t	6.756	4.327	9.088	5.124
P	<0.05	<0.05	<0.05	<0.05

3.2. Comparison of postoperative complications

Compared with the control group, the study group had fewer postoperative complications, and the results of the two groups were significantly different ($P < 0.05$). This can be seen in **Table 2**.

Table 2. Comparison of postoperative complications between the two groups [n (%)]

Group	Dural tear	CSF leak	Infection	Paravertebral muscle injury	Total incidence
Study group (n = 30)	1 (3.33)	0	1 (3.33)	2 (6.67)	4 (13.33)
Control group (n = 30)	3 (10.00)	2 (6.67)	5 (16.67)	2 (6.67)	12 (40.00)
x^2	-	-	-	-	6.043
P	-	-	-	-	<0.05

3.3. Comparison of JOA score and NRS score

Before operation, there was no difference in JOA score and NRS score between the two groups. Compared at 6 months after operation, the JOA score of the study group was higher than that of the control group, and the NRS score of the study group was lower than that of the control group ($P < 0.05$), as shown in **Table 3**.

Table 3. Comparison of JOA score and NRS index between the two groups (mean ± SD)

Group	JOA score		NRS score	
	Preoperative	6 months after operation	Preoperative	6 months after operation
Study group (n = 30)	18.44 ± 2.75	24.33 ± 1.95	5.15 ± 0.74	1.35 ± 0.52
Control group (n = 30)	18.45 ± 2.79	20.21 ± 1.91	5.12 ± 0.75	2.36 ± 0.96
t	0.412	7.534	0.586	4.125
P	>0.05	<0.05	>0.05	<0.05

3.4. Comparison of the excellent rate of lumbar spine recovery

Based on **Table 4**, the excellent rate of lumbar recovery in the study group 6 months after operation was higher than that in the control group ($P < 0.05$).

Table 4. Comparison of good and good rates of lumbar recovery between the two groups [n (%)]

Group	Excellent	Good	Poor	Excellent rate
Study group (n = 30)	20 (66.67)	7 (23.33)	3 (10.00)	27 (90.00)
Control group (n = 30)	16 (53.33)	5 (16.67)	9 (30.00)	21 (70.00)
x^2	-	-	-	5.130
P	-	-	-	<0.05

4. Discussion

Patients with lumbar spinal stenosis are significantly impacted by the disease, in terms of daily life and work. If conservative intervention fails, surgical treatment is required as soon as possible to prevent the disease from worsening and progressing [7]. Unilateral dual-channel endoscopic fenestration decompression of the lamina is a new type of surgery developed under the concept of modern clinical minimally invasive treatment. It mainly provides corresponding interventions through the establishment of operating channels and observation channels. The dual-channel surgical field is wide and do not interfere with each other [8]. At the same time, the endoscope used in the operation is similar to the arthroscope, and can be applied to each other, which reduces the equipment cost to the greatest extent, and effectively solves the problems of high requirements for surgical equipment, narrow operative field, and limited decompression [9]. In this study, the operation time of the study group was longer than that of the control group, the amount of perioperative blood loss was lower than that of the control group, the incision diameter was smaller than that of the control group, and the total hospitalization time was shorter than that of the control group ($P < 0.05$). The reason may be that unilateral dual-channel endoscopic fenestration decompression of the lamina requires high precision, thus it takes a relatively long time of operation [10]. During the operation, according to the patient's treatment needs, the scope of the endoscopic field of view and the direction of observation are reasonably adjusted, and the whole process of visual decompression operation is performed without operating blind spots. Therefore, unnecessary damage is avoided to a certain extent, the amount of bleeding is reduced, and it is beneficial for patients to recover quickly after surgery ensuring shorter hospital stay [11]. At the same time, 13.33% of postoperative complications such as dural tear, cerebrospinal fluid leakage, infection, and paraspinal muscle injury in the study group were less than 40.00% in the control group ($P < 0.05$). The reason may be that operation under direct vision of the endoscope, full and comprehensive decompression through multi-angle and dual channels, coupled with a wide field of vision, minimizes the trauma to the human body and avoids the occurrence of related complications [12]. Lastly, the JOA score of the study group was higher than that of the control group, and the NRS score was lower than that of the control group 6 months after operation ($P < 0.05$). Since the fenestration and decompression of the lamina under the unilateral dual-channel endoscope has a small opening, there is no need to stretch or peel off the paraspinal muscles during the operation, thus it can reduce the degree of muscle damage and the pain of the patient. Plus, it is beneficial for the patient to get out of bed early after the operation, which accelerates the recovery of lumbar spine function [13]. The operation effect was evaluated according to the modified MacNab standard 6 months after operation, and the excellent and good rate of lumbar spine recovery in the study group (90.00%) was higher than that in the control group (70.00%) ($P < 0.05$). It shows that unilateral double-channel endoscopic lamina fenestration decompression has a reliable therapeutic effect. Chen *et al.* [14] observed and discussed the treatment effect of unilateral dual-channel endoscopic spinal canal decompression in 13 patients with lumbar spinal stenosis, and the excellent and good rate of the operation was as high as 92.31%. Tuo *et al.* [15] observed and compared the surgical efficacy of 47 patients with lumbar spinal stenosis. The results showed that the excellent and good rate of unilateral dual-channel endoscopic treatment was 90.91%, which was higher than that of traditional intervertebral disc endoscopic treatment (88.00%).

In conclusion, unilateral dual-channel endoscopic fenestration decompression surgery has a definite curative effect as well as significant advantages for patients with lumbar intervertebral stenosis. It can reduce postoperative complications, improve lumbar function, with the advantages of less pain, less bleeding, and smaller incisions, which is worthy of wide application in clinical practice.

Disclosure statement

The author declares no conflict of interest.

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