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# Efficacy of percutaneous transforaminal endoscopic discectomy unilateral and bilateral approach for bilateral decompression in treatment of degenerative lumbar spinal stenosis and their effects on quality of life

Running title: Surgical treatment of degenerative lumbar spinal stenosis

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## **Abstract:**

This study aimed to explore the efficacy of percutaneous transforaminal endoscopic discectomy (PTED) unilateral and bilateral approach for bilateral decompression in the treatment of degenerative lumbar spinal stenosis (DLSS) and their effects on quality of life. Altogether 119 patients with DLSS admitted to our hospital from May 2012 to February 2014 were enrolled in this study. Patients in Group A (62 cases) were treated with PTED bilateral approach for bilateral decompression, while those in Group B (57 cases) were treated with PTED unilateral approach for bilateral decompression. The therapeutic effect and incidence of complications in the two groups were observed. Visual Analogue Scale (VAS) was used to assess the pain degree of the lower limbs. Oswestry Disability Index (ODI) was used to assess the improvement of neurological function. 36-Item Short Form Health Survey (SF-36) developed by the Institute of Medicine was used to assess the quality of life. There were no significant differences between Group A and Group B in operative time, intraoperative blood loss, hospitalization time, the

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effective rate of treatment, and the incidence of complications ( $P>0.05$ ). The recovery time of lumbar function in Group A was significantly shorter than that in Group B ( $P<0.01$ ). VAS and ODI scores at 1, 3, and 6 months after operation in Group A were significantly lower than those in Group B ( $P<0.05$ ). The scores of general health (GH), bodily pain (BP), social function (SF), vitality (VT), and mental health (MH) at 6 months after operation in Group A were significantly higher than those in Group B ( $P<0.05$ ). In conclusion, PTED bilateral approach for bilateral decompression was effective in the treatment of patients with DLSS. It can promote the recovery of their lumbar function and neurological function, and improve their quality of life.

**Keywords:** percutaneous transforaminal endoscopic discectomy; approach; decompression; lumbar degenerative disease; lumbar spinal stenosis

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## Introduction

Degenerative lumbar spinal stenosis (DLSS) refers to the pathological degeneration of the bone and fibrous soft tissue of lumbar spinal canal, which includes joint hyperplasia and herniated disk. The disease results in nerve root and dural sac compression, causing patients to experience lower limb pain and intermittent claudication (1). DLSS is a common health issue for the elderly and the most common indication for people aged over 60 years who have undergone spinal surgery, with an incidence of about 47% in adults with lower limb pain and numbness (2). Non-surgical treatment such as physiotherapy cannot treat patients with DLSS, so surgery is the preferred treatment. Decompression, which is the most common one, decompresses spinal cord or spinal nerve by removing the surrounding bone and soft tissue from the spinal canal (3). However, traditional fenestration decompression and decompressive laminectomy lead to huge trauma and are easy to cause spinal instability. Moreover, postoperative scars which need long recovery time may cause nerve adhesion. Therefore, the two surgeries are not suitable for weak elderly patients with many basic diseases (4).

With the development of microsurgical techniques in recent years, lumbar degenerative diseases are treated by ladder-like therapeutic schemes, not fixation or fusion surgery (5). Percutaneous transforaminal endoscopic discectomy (PTED) is a minimally invasive surgical technique which has been gradually applied to the treatment of lumbar degenerative diseases. Patients treated with it have a little bleeding, timely relief of symptoms, and a little interference in posterior muscles and ligaments (6). PTED unilateral approach for bilateral decompression is effective in the treatment of lumbar degenerative diseases in a short time, causing a few postoperative complications (7). Ahn and others' study described the effectiveness of posterolateral endoscopic lumbar intervertebral foramen for patients with DLSS. During the

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13-month follow-up, the total effective rate has a satisfactory of 83% (8). However, there are currently few studies on the efficacy of PTED bilateral approach for bilateral decompression in the treatment of DLSS and its effects on quality of life.

In this study, patients with DLSS were treated with PTED bilateral approach for bilateral decompression, to discuss its therapeutic effects on the disease and its effects on quality of life.

## **1 Materials and methods**

### **1.1 General information**

A total of 119 patients with DLSS admitted to our hospital from May 2012 to February 2014 were enrolled in this study. Patients in Group A (62 cases) were treated with PTED bilateral approach for bilateral decompression, while those in Group B (57 cases) were treated with PTED unilateral approach for bilateral decompression. In Group A, there were 28 males and 34 females, aged 48-73 years, with an average age of (58.3±8.6) years, a course of disease of 1.6-15.3 years, and an average course of disease of (4.9±1.5) years. In Group B, there were 27 males and 30 females, aged 46-71 years, with an average age of (57.8±8.2) years, a course of disease of 1.5-14.8 years, and an average course of disease of (4.7±1.6) years. This study was approved by the Ethics Committee of our hospital. The subjects were informed and they signed the fully informed consent form.

### **1.2 Inclusion and exclusion criteria**

Inclusion criteria were as follows: patients who were confirmed with DLSS by imaging, MRI, and CT (9) and who had bilateral stenosis within 1 segment; patients aged 46-73 years; patients with typical symptoms of nerve root and intermittent claudication, and with lower limb pain, weakness, and numbness; patients with complete clinical data; patients with unsatisfactory efficacy of 3-month conservative treatment; patients followed up for 3 years. Exclusion criteria were as follows: patients with spinal canal stenosis  $\geq 2$  segments; patients who were intolerable to this surgery; patients complicated with major organ dysfunction, lumbar spinal tuberculosis, spinal canal encroachment, spinal infection, fractures, coagulation disorders, malignant tumors, cauda equina syndrome, mental disorders, or chronic cardiac, pulmonary, and cerebral diseases; patients undergoing surgery for the second time.

### **1.3 Surgical methods**

Patients in the two groups were treated with PTED under the guidance of the percutaneous transforaminal endoscopic spine system (Beijing Tianqi Medical Technology Co., Ltd., China). The methods of PTED unilateral approach for bilateral decompression were as follows: the patients were placed in a prone position to open the posterior intervertebral space, and the side with serious symptoms was used as the approach. L4-L5 intervertebral space was located through normal perspective, and the puncture point was 10cm away from the right side of the intersection of the posterior

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intervertebral space and the posterior median line. Disinfection and draping were carried out in the operative area, and then 0.75% lidocaine was used for infiltration anesthesia at the puncture point. Under normal perspective, the puncture point was selected and the puncture needle was sent to the anterior inferior boarder of the superior articular process in L5 segment. Then, a guide wire was inserted and the skin was incised about 7mm. The subcutaneous tunnel was enlarged layer by layer and an operative channel was established. A trephine was used to cut out the ligamentum flavum and part of the bone at the superior articular lateral border of the L5 segment, to enlarge and expose the exiting nerve root of the intervertebral foramen and the lateral recess in the L4-L5 segment. After the aperture mirror was inserted into the working channel, the power drill equipment was used to remove the hyperosteo-geny of the articular process, and a pituitary rongeur was used to remove the herniated nucleus pulposus in the lateral recess and the surrounding ligamentum flavum, so as to decompress exiting and traversing nerve roots. Radiofrequency ablation technique was used for intradiscal electrothermal annuloplasty and intervertebral disc decompression. After showing significantly pulsatile nerve roots, the aperture mirror was gradually pushed along the contralateral direction through the ventral intervertebral space of the L4-L5 segment, to remove the nucleus pulposus tissue compressing the contralateral traversing nerve root, so as to relax it. The methods of PTED bilateral approach for bilateral decompression were as follows: the horizontal line and the posterior median line of the L4-L5 intervertebral space were located, and bilateral puncture points 10cm away from the left and right sides were respectively made. Disinfection and draping were carried out in the operative area. Bilateral puncture was performed by the same doctor, and the catheter and working channel were inserted (the steps were the same as those of unilateral approach). After the aperture mirror was inserted, the right nerve root was decompressed, which included hyperosteo-geny grinding, radiofrequency ablation, and nucleus pulposus removal. Then, the left nerve root was decompressed (the steps were the same as those of right nerve root). Finally, the intervertebral space of patients in the two groups was cleaned using normal saline, and the working channel was withdrawn. The patients' wound was sutured, disinfected, and dressed.

#### **1.4 Outcome measures**

Operative time, intraoperative blood loss, hospitalization time, the recovery time of lumbar function, and the incidence of complications in the two groups were observed. The complications mainly included dural sac rupture, intervertebral space infection, and incomplete decompression. After discharge, the patients were followed up by telephone once every 1 month and reexamined by outpatient services once every 6 months. The clinical efficacy in the two groups was assessed according to the modified MacNab criteria (10). See Table 1.

**Table I Evaluation criteria for efficacy**

Efficacy	
Markedly effective	The pain and numbness in waist and legs completely disappeared. Muscle strength level returned to normal, and leg elevation was $>70^\circ$ .
Effective	The pain and numbness in waist and legs were significantly relieved. Muscle strength level was grade IV, and leg elevation was $>30^\circ$ but $<70^\circ$ .
Invalid	The pain and numbness in waist and legs were not relieved or even worsened. Muscle strength level was grade I, and leg elevation was $<30^\circ$ .
(Markedly effective + effective cases) / total number of cases $\times 100\%$ = effective rate of treatment	

Visual Analogue Scale (VAS) (11) was used to assess the pain degree of the lower limbs before operation, and at 1, 3, and 6 months, and 3 years after operation. A 10mm VAS ruler was used, and the patients slid the marker needle to the position of the number (10 indicated severe pain and 0 indicated no pain). Oswestry Disability Index (ODI) (12) was used to assess the improvement of neurological function before operation, and at 1, 3, and 6 months, and 3 years after operation. It included intensity of pain, lifting, ability to care for oneself, ability to walk, ability to sit, sexual function, ability to stand, social life, sleep quality, and ability to travel. Each item was scored on a scale of 0-5 points; the higher the score was, the more severe the neurological dysfunction was. 36-Item Short Form Health Survey (SF-36) developed by the Institute of Medicine (13) was used to assess the quality of life before operation, and at 6 months and 3 years after operation, including general health (GH), bodily pain (BP), physical function (PF), role physical (RP), social function (SF), vitality (VT), mental health (MH), and role emotional (RE). Each dimension had 100 points; the higher the score was, the better the quality of life was.

### 1.5 Statistical methods

In this study, SPSS 22.0 (Beijing Strong-Vinda Information Technology Co., Ltd., China) was used for statistical analysis. GraphPad Prism 8 (SOFTHEAD Inc., Shenzhen, China) was used to plot figures. Measurement data were expressed by mean  $\pm$  standard deviation ( $\bar{x} \pm SD$ ), and independent samples t test was used for the comparison of the data between groups. Count data were expressed by the number of cases/percentage (n/%), and chi-square test was used for the comparison of the data between groups, which was analyzed by chi-square test with continuity correction when the theoretical frequency in the test was less than 5. Repeated measures analysis of variance (ANOVA) was used for the comparison of the data between multiple time points, and LSD-t test was used for pairwise comparison within groups between different time points. When  $P < 0.05$ , the difference was statistically significant.

## 2 Results

### 2.1 Comparison of general information

There were no significant differences between Group A and Group B in terms of gender, age, body mass index (BMI), course of disease, diabetes, hypertension, hyperlipidemia, lesion segment, history of smoking, history of drinking, place of residence, educational level, sports, aspartate aminotransferase (AST), alanine aminotransferase (ALT), systolic blood pressure (SBP), and diastolic blood pressure (DBP) ( $P>0.05$ ). See Table 2.

**Table II Comparison of general information [n(%)]/( $\bar{x}\pm SD$ )**

Categories	Group A (n=62)	Group B (n=57)	t/ $\chi^2$ value	P value
Gender			0.058	0.809
Male	28 (45.16)	27(47.37)		
Female	34(54.84)	30(52.63)		
Age (Years)	58.3 $\pm$ 8.6	57.8 $\pm$ 8.2	0.324	0.746
BMI(kg/m <sup>2</sup> )	23.49 $\pm$ 2.74	23.87 $\pm$ 2.53	0.784	0.435
Course of disease (Years)	4.9 $\pm$ 1.5	4.7 $\pm$ 1.6	0.704	0.483
Diabetes			0.208	0.649
Yes	7(11.29)	5(8.77)		
No	55(88.71)	52(91.23)		
Hypertension			0.214	0.643
Yes	5(8.06)	6(10.53)		
No	57(91.94)	51(89.47)		
Hyperlipidemia			0.038	0.846
Yes	9(14.52)	9(15.79)		
No	53(85.48)	48(84.21)		
Lesion segment			1.376	0.503
L3-4	6(9.68)	3(5.26)		
L4-5	39(62.90)	41(71.93)		
L5-S1	17(27.42)	13(22.81)		
History of smoking			0.346	0.556
Yes	25(40.32)	20(35.09)		
No	37(59.68)	37(64.91)		
History of drinking			0.428	0.513
Yes	30(48.39)	31(54.39)		
No	32(51.61)	26(45.61)		
Place of residence			0.145	0.703

City	46(74.19)	44(77.19)		
Countryside	16(25.81)	13(22.81)		
Educational level			0.074	0.964
Junior high school and below	9(9.68)	9(15.79)		
Senior high school	20(62.90)	19(33.33)		
College and above	33(27.42)	29(50.88)		
Sports			0.138	0.711
Often	26(41.94)	22(38.60)		
Occasionally	36(58.06)	35(61.40)		
AST (U/L)	22.39±13.58	21.25±12.07	0.482	0.630
ALT (U/L)	30.15±14.32	29.46±14.56	0.260	0.795
SBP (mmHg)	119.58±12.08	122.07±12.76	1.093	0.276
DBP (mmHg)	67.62±10.49	66.48±12.28	0.546	0.586

**2.2 Comparison of operative time, intraoperative blood loss, hospitalization time, and recovery time of lumbar function**

There were no significant differences between Group A and Group B in terms of operative time, intraoperative blood loss, and hospitalization time (P>0.05). The recovery time of lumbar function in Group A was significantly shorter than that in Group B (P<0.01). See Table 3.

**Table III Comparison of operative time, intraoperative blood loss, hospitalization time, and recovery time of lumbar function (  $\bar{x}\pm SD$  )**

Categories	Group A (n=62)	Group B (n=57)	t value	P value
Operative time (min)	91.27±6.92	89.46±7.49	1.370	0.173
Intraoperative blood loss (mL)	62.01±8.25	60.48±8.66	0.987	0.326
Hospitalization time (d)	10.58±2.69	10.13±2.73	0.905	0.367
Recovery time of lumbar function (d)	84.59±11.25	91.25±12.27	3.089	0.002

**2.3 Comparison of effective rate of treatment**

After operation, Group A had 22 markedly effective cases, 34 effective cases, and 6 invalid cases, with an effective rate of 90.32%, while Group B had 20 markedly effective cases, 25 effective cases, and 12 invalid cases, with an effective rate of 78.95%. There was no significant difference in the effective rate of treatment between Group A and Group B (P>0.05). See Table 4.

**Table IV Comparison of effective rate of treatment [n(%)]**

Categories	n	Markedly effective	Effective	Invalid	Effective rate (%)
Group A	62	22(35.48)	34(54.84)	6(9.68)	90.32
Group B	57	20(35.09)	25(43.86)	12(21.05)	78.95
$\chi^2$ value	-	-	-	-	2.993
P value	-	-	-	-	0.084

#### 2.4 Comparison of incidence of postoperative complications

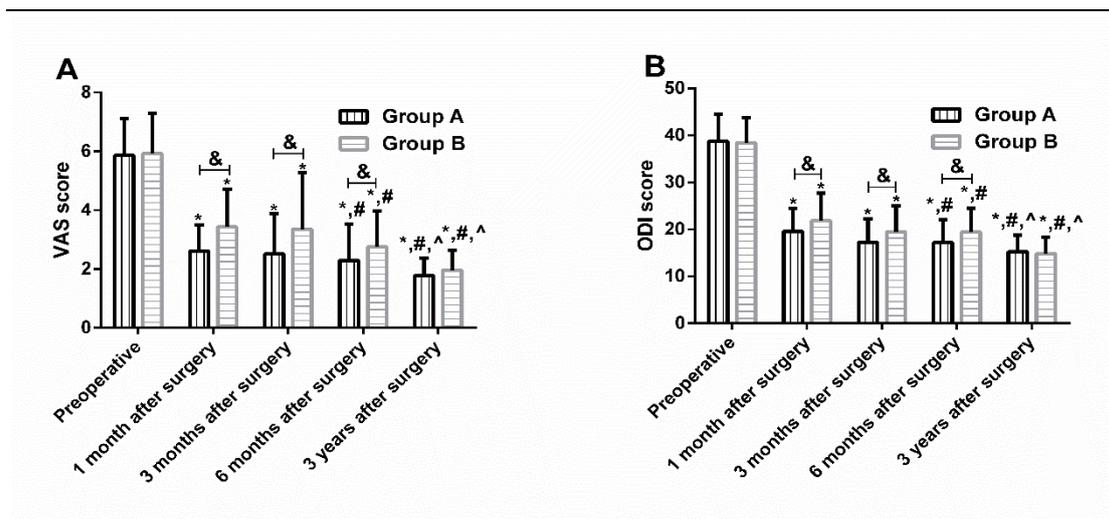
After operation, Group A had 1 case (1.61%) of dural sac rupture and 1 case (1.61%) of intervertebral space infection, with an incidence of complications of 3.23%, while Group B had 2 cases (3.51%) of dural sac rupture and 4 cases (1.75%) of incomplete decompression, with an incidence of complications of 5.26%. There was no significant difference in the incidence of complications between Group A and Group B ( $P>0.05$ ). See Table 5.

**Table V Comparison of incidence of postoperative complications [n(%)]**

Categories	n	Dural sac Rupture	Intervertebral space infection	Incomplete decompression	Incidence (%)
Group A	62	1(1.61)	1(1.61)	0(0.00)	3.23
Group B	57	2(3.51)	0(0.00)	1(1.75)	5.26
$\chi^2$ value	-	0.005	0.002	0.002	0.009
P value	-	0.941	0.966	0.966	0.924

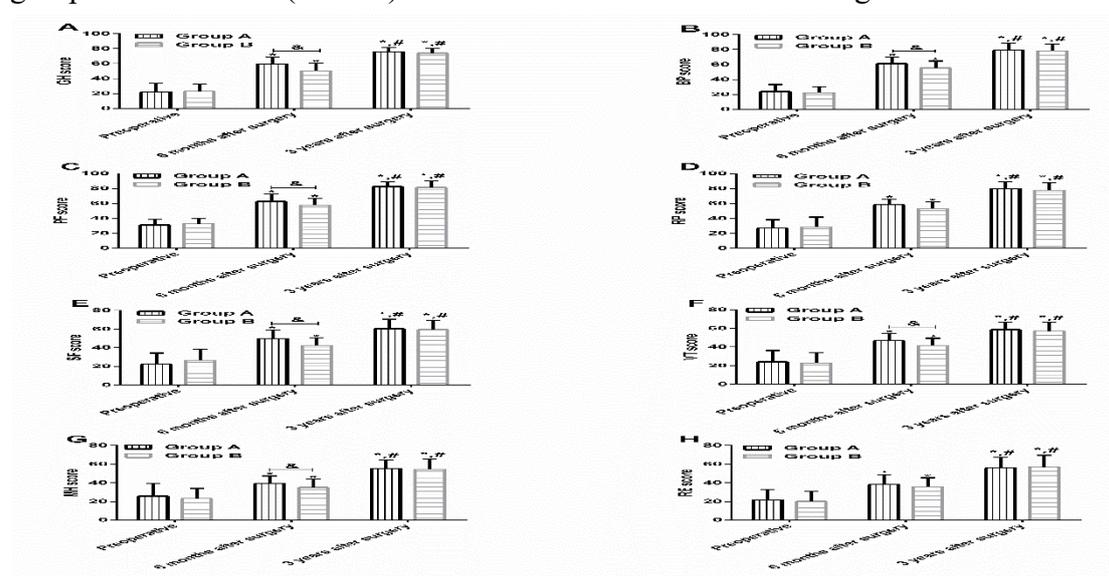
#### 2.5 Comparison of VAS and ODI scores before and after operation

According to repeated measures ANOVA, there were statistically significant differences in VAS and ODI scores between different time points. VAS and ODI scores at 1, 3, and 6 months, and 3 years after operation in the two groups were significantly lower than those before operation ( $P<0.05$ ). The scores at 6 months after operation in the two groups were significantly lower than those before operation, and at 1 and 3 months after operation ( $P<0.05$ ). The scores at 3 years after operation in the two groups were significantly lower than those at 1, 3, and 6 months after operation ( $P<0.05$ ). The scores at 1, 3, and 6 months after operation in Group A were significantly lower than those in Group B ( $P<0.05$ ). There were no significant differences between the two groups in the scores before operation and at 3 years after operation ( $P>0.05$ ). See Figure 1.



### 2.6 Comparison of quality of life before and after operation

There were no significant differences between Group A and Group B in the scores of GH, BP, PF, RP, SF, VT, MH, and RE before operation and at 3 years after operation ( $P>0.05$ ). The scores at 6 months and 3 years after operation in the two groups were significantly higher than those before operation ( $P<0.05$ ). The scores at 3 years after operation in the two groups were significantly higher than those at 6 months after operation ( $P<0.05$ ). The scores of GH, BP, PF, SF, VT, and MH at 6 months after operation in Group A were significantly higher than those in Group B ( $P<0.05$ ), while there were no significant differences in the scores of RP and RE between the two groups ( $P>0.05$ ). See Figure 2.



### 3 Discussion

If not treated in time, DLSS which mostly occurs in the elderly seriously affects patients' quality of life as it progresses. Patients with serious condition even cannot take care of themselves (14, 15). Clinically, the disease is treated by surgery which

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decompresses the lumbar spine, but traditional surgical methods may cause huge trauma. In addition, the elderly patients usually have some basic diseases, so the therapeutic effect of surgery is unsatisfactory (16).

With the development of microsurgical techniques, PTED has become a representative minimally invasive spinal surgery for lumbar intervertebral disc protrusion (17). The significant progress in current technologies has promoted endoscopic spinal surgery to shift from the treatment of lumbar intervertebral disc protrusion to DLSS. PTED causes less damage to the posterior structures of patients with DLSS than conventional posterior open surgery (18). Previous studies have proved that PTED unilateral approach for bilateral decompression has a better therapeutic effect. In a study by Palmer et al., 17 patients with DLSS who were treated with this method had reasonable operative time, minimum blood loss, and better therapeutic effects (19). In a study by Haufe et al., this method showed a good therapeutic effect on the treatment of refractory lateral recess stenosis. During the 42-month follow-up, both the ODI scores of 59% of the patients and the VAS scores of 66% were improved by at least 75% (20). In this study, during the operation, the working channel was laid flat as much as possible, so as to facilitate access to the ventral posterior longitudinal ligament and the ventral lateral recess. If there was L5-S1 spinal canal stenosis, the abduction angle of the working channel should be placed at about 35° to avoid the obstruction of L5 transverse process and high crista iliaca. Under the normal perspective, an abrasion drill was used to treat the osteophyma of the articular process, a clamp was used to remove hypertrophic ligamentum flavum and joint capsules, and radiofrequency was finally used to remove residual ligament atrophy or annulus fibrosus, so as to further reduce nerve root compression. In this study, there were no significant differences between Group A and Group B with respect to operative time, intraoperative blood loss, hospitalization time, and the effective rate of treatment, but the recovery time of lumbar function in Group A was significantly shorter than that in Group B. This shows that the therapeutic effect of unilateral approach for bilateral decompression is the same as that of bilateral approach on patients with DLSS, but the patients treated with bilateral approach have shorter recovery time of lumbar function. Additionally, VAS and ODI scores at 1, 3, and 6 months, and 3 years after operation in Group A and Group B were significantly lower than those before operation, but the scores at 1, 3, and 6 months after operation in Group A were significantly lower than those in Group B. This indicates that bilateral approach for bilateral decompression has a better short-term therapeutic effect on patients with DLSS, relieves their pain, and improves their postoperative neurological function. A previous study has shown that DLSS is mainly caused by the sharp changes of intervertebral disc and bilateral facet joints. Lumbar intervertebral foramen stenosis and lateral recesses, most of which are bilateral, are usually seen on imaging (21). Therefore, bilateral decompression can relieve nerve compression, and then promote the recovery of lumbar function and neurological function. According to

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Ahn et al., PTED under local anesthesia was effective for treating lumbar intervertebral foramen stenosis. The mean VAS score of leg pain decreased from 8.36 points at baseline to 3.36 points at 6 weeks after operation, to 2.03 points at 1 year after operation, and to 1.97 points at 2 years after operation. The mean ODI score decreased from 65.8 points at baseline to 31.6 points at 6 weeks after operation, to 19.7 points at 1 year after operation, and to 19.3 points at 2 years after operation (22). This was similar to our findings. According to the long-term follow-up in this study, the VAS and ODI scores at 3 years after operation of patients treated with unilateral approach were consistent with those of patients treated with bilateral approach, and the long-term efficacy of the two methods was also consistent.

PTED is considered as an effective alternative to open discectomy (23, 24). However, with the increasing use of endoscopic techniques in spinal surgery, related complications have occurred, including postoperative dysesthesia, dural laceration, hematoma, infection, and visceral injury (25). In this study, there were 3 cases of dural sac rupture in the two groups. This may be because the nerve root and dural sac had adhered to the surroundings when patients with DLSS were treated with PTED. Therefore, after the aperture mirror was passed through the narrow intervertebral space and dural sac, the separation of dural sac may increase the risk of dural sac rupture (26). There was 1 case of intervertebral space infection in the two groups, so powerful antibiotics were used to avoid infection spread for 7 days, and then the patients were improved. There was 1 case of incomplete decompression. This is possibly because the exposed space of the contralateral side is limited during unilateral approach for bilateral decompression. As a result, only the contralateral ligament is released, and the enlargement of the lateral recess and lateral intervertebral foramen are ignored, which leads to incomplete decompression (27). Surgical or non-surgical treatment only alleviates the symptoms and body functions of patients with DLSS, but cannot prevent the development of degeneration (28). In a study by Peng et al., PELD can relieve the patients' postoperative back pain and lower limb symptoms, and shorten their hospitalization time and recovery time, thus improving their quality of life (29). In another study by Peng et al., its therapeutic effect is closely related to patients' quality of life (30). Therefore, it is pivotal for the improvement of the therapeutic effect to improve the short- and long-term quality of life of patients with DLSS (31). In this study, the quality of life at 6 months and 3 years after operation was significantly improved; the improvement was more significant at 6 months after operation for patients treated with bilateral approach for bilateral decompression, but there was no significant difference in the quality of life at 3 years after operation between the two groups. This shows that both unilateral and bilateral approach can improve the patients' quality of life, but patients treated with bilateral approach have better quality of life in a short time.

This study confirms the definite efficacy of PTED unilateral and bilateral approach for bilateral decompression in the treatment of DLSS, but it still has limitations. The

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long-term incidence of postoperative complications and the patients' quality of life at 5 years after operation were not observed. These deficiencies need to be supplemented in future studies.

In summary, effective in the treatment of patients with DLSS, PTED bilateral approach for bilateral decompression can promote the recovery of their lumbar function and neurological function, and improve their quality of life.

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### **Availability of data and materials**

The datasets used and/or analyzed during the present study are available from the corresponding author on reasonable request.

### **Authors' contributions**

XIC, HL, XUC and HC led the conception and design of this study. XIC, XUC, FZ and CW were responsible for the data collection and analysis. HL, HC and FZ were in charge of interpreting the data and drafting the manuscript. XIC and HL made revision from critical perspective for important intellectual content. The final version was read and adopted by all the authors.

### **Ethics approval and consent to participate**

The study was approved by the Ethics Committee of Ganzhou People's Hospital. Signed written informed consents were obtained from the patients and/or guardians.

### **Consent for publication**

Not applicable.

### **Competing interests**

The authors declare that they have no competing interests.

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### Figure legends

**Figure 1 VAS and ODI scores before and after operation.** (A) VAS scores at 1, 3, and 6 months after operation in Group A were significantly lower than those in Group B ( $P < 0.05$ ). There were no significant differences between the two groups in the scores before and at 3 years after operation ( $P > 0.05$ ). (B) ODI scores at 1, 3, and 6 months after operation in Group A were significantly lower than those in Group B ( $P < 0.05$ ). There were no significant differences between the two groups in the scores before and at 3 years after operation ( $P > 0.05$ ). Note: \* indicates  $P < 0.05$  compared with that before operation. # indicates  $P < 0.05$  compared with that at 1 and 3 months after operation. ^ indicates  $P < 0.05$  compared with that at 6 months after operation. & indicates  $P < 0.05$ .

**Figure 2 Comparison of quality of life before and after operation.** (A) GH score at 6 months after operation in Group A was significantly higher than that in Group B ( $P < 0.05$ ). (B) BP score at 6 months after operation in Group A was significantly higher than that in Group B ( $P < 0.05$ ). (C) PF score at 6 months after operation in Group A was significantly higher than that in Group B ( $P < 0.05$ ). (D) There was no significant difference in RP score at 6 months after operation between Group A and Group B ( $P > 0.05$ ). (E) SF score at 6 months after operation in Group A was significantly higher than that in Group B ( $P < 0.05$ ). (F) VT score at 6 months after operation in Group A was significantly higher than that in Group B ( $P < 0.05$ ). (G) MH score at 6 months after operation in Group A was significantly higher than that in Group B ( $P < 0.05$ ). (H) There was no significant difference in RE score at 6 months after operation between Group A and Group B ( $P > 0.05$ ). Note: \* indicates  $P < 0.05$  compared with that before operation. # indicates  $P < 0.05$  compared with that at 6 months after operation. & indicates  $P < 0.05$ .