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RESEARCH

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Comparison of clinical efficacy between Percutaneous Endoscopic Large channels nerve decompression through Translaminar approach and Percutaneous Endoscopy Conventional channels nerve decompression through Transforaminal approach for the treatment of degenerative L4/5 spinal stenosis: a retrospective study

Junlin Liu[1†], Qingquan Kong[1,2*], Junsong Ma[1], Pin Feng[1] and Bin Zhang[1]

Abstract

Objecytive Percutaneous endoscopic surgery via the interlaminar approach and transforaminal approach are commonly used for the treatment of degenerative lumbar spinal stenosis, and in order to compare the clinical efficacy of Percutaneous Endoscopic Large channel Translaminar approach (PEL-TL) and Percutaneous Endoscopy Conventional channels Transforaminal approach (PEC-TF) in the treatment of degenerative L4/5 spinal stenosis.

Method A retrospective analysis was conducted on 124 patients who underwent percutaneous endoscopic single segment unilateral decompression surgery for degenerative L4/5 spinal stenosis in our hospital from January 2020 to January 2023. They were divided into PEL-TL group and PEC-TF group according to different surgical methods. Recording general information of two groups of patients, including age, gender, course of disease, and length of hospital stay. Recording the surgical time, C-arm fluoroscopy frequency, incidence and type of complications for two groups of patients. CT was used to measure the Lateral Recess Angle (LRA), and MRI was used to measure the Dural Sac Cross sectional Area (DSCA) to evaluate the degree of lateral recess stenosis and compare the neurological decompression between the two groups. Using the White Panjabi scoring system (WP) to evaluate local stability before and 3 months after surgery. Recording the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) for

[†]First author: Junlin Liu.

*Correspondence:
Qingquan Kong
kqqspine@126.com

Full list of author information is available at the end of the article

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preoperative and postoperative hip and lower limb pain in two groups of patients. Evaluateing the efficacy using the modified Macnab criteria one year after surgery.

Results There was no statistically significant difference in general information between the two groups of patients ($P>0.05$). The surgery time in the PEL-TL group was shorter than that in the PEC-TF group ($P<0.05$). The number of C-arm fluoroscopy in the PEL-TL group was significantly lower than that in the PEC-TF group ($P<0.05$). There was no statistically significant difference in the incidence of complications between the two groups of patients (11.1% in the PEL-TL group and 14.3% in the PEC-TF group) ($P>0.05$). The postoperative recurrence rate of PEL-TL is lower than that of PEC-TF ($P<0.05$). All enrolled patients were followed up regularly for 1 year. There was no significant difference in preoperative LRA and DSCA between the two groups of patients ($P>0.05$). After 1 year of surgery, LRA and DSCA in both groups were significantly larger than before ($P<0.05$). There was no statistically significant difference in postoperative DSCA between the two groups, but LRA in the PEL-TL group was more significantly larger than that in the PEC-TF group ($P<0.05$). There was no statistically significant difference in preoperative and postoperative WP between the two groups of patients, and there was no significant difference in WP in two groups. The ODI scores and the VAS scores of buttock and lower limb pain at each follow-up time point after surgery in both groups of patients showed significant improvement compared to before surgery. There was no statistically significant difference in functional scores between the two groups at each follow-up time point ($p>0.05$). One year after surgery, the efficacy was evaluated using the modified Macnab criteria. Among them, in the PEL-TL group, 36 cases were excellent and 14 cases were good, with an excellent and good rate of 92.6%. In the PEC-TF group, 48 cases were excellent and 16 cases were good, with an excellent and good rate of 91.4%. There was no statistically significant difference between the two groups ($p>0.05$).

Conclusion Both surgical methods can achieve satisfactory clinical efficacy in treating degenerative lumbar 4/5 spinal stenosis. PEL-TL has fewer C-arm fluoroscopy times, wider decompression range, shorter surgical time, and lower recurrence rate during surgery, while PEC-TF can be routinely performed under local anesthesia to reduce anesthesia risk.

Keywords Percutaneous endoscopy, Interlaminar, Transforaminal, Lumbar stenosis

Introduction

The incidence rate of degenerative lumbar spinal stenosis (DLSS) gradually increases with aging [1]. Patients who fail to receive conservative treatment and whose symptoms seriously affect their life and work or have neurological dysfunction need surgery. For patients with non discogenic lower back pain or without the need to rebuild lumbar stability, neurodecompression is the ideal surgical plan [2]. Compared to current minimally invasive endoscopic decompression, traditional open decompression has disadvantages such as high cost, large intraoperative bleeding, long surgical time, and high incidence of complicationss [3]. With the continuous development of endoscopic surgery technology, various endoscopic decompression schemes have been used to treat DLSS [4–5]. Endoscopic decompression through the intervertebral foramen is a good choice for treating degenerative L4/5 spinal stenosis, which has advantages such as minimal trauma, high safety, and low incidence of complications [6]. Endoscopic decompression through the interlaminar approach can also be applied to L4/5 spinal stenosis, but due to the narrower gap between the L4/5 lamina compared to the L5/S1, a grinding drill or vertebral plate rongeur is needed during surgery to remove some bone structures, which can significantly reduce surgical efficiency [7]. Therefore, it is not considered the preferred surgical method. In recent years, with the continuous improvement of instruments, percutaneous coaxial large channel endoscopic systems have gradually been applied to DLSS [8–9]. Due to the expansion of endoscopic size, it allows for the use of larger surgical instruments and provides a clearer surgical field, which improves its surgical efficiency. It has been widely used in L4/5 DLSS [10]. Our team started applying different spinal endoscopic surgical techniques to L4/5 DLSS in January 2020 and has accumulated some application experience. A retrospective analysis is conducted on the clinical data of L4/5 DLSS patients treated with PEL-TL and PEC-TF surgery from January 2020 to January 2023, and the clinical efficacy of the two surgical methods is compared.

Patients and methods

The 124 enrolled patients underwent percutaneous endoscopic single segment unilateral decompression surgery in our hospital from January 2020 to January 2023 due to degenerative L4/5 spinal stenosis. They were divided into PEL-TL group and PEC-TF group according to different surgical methods.

Recording general information of two groups of patients, including age, gender, course of disease, and length of hospital stay. Recording the surgical time and intraoperative C-arm fluoroscopy frequency for two groups of patients. Calculating the incidence and types of complications in two groups of patients. Using the IC-PACS imaging system to measure the preoperative and 1-year postoperative LRA (LRA measurement method: using a CT cross-section, select the plane at the entrance of the pedicle as the measurement plane, measure the angle between the posterior edge tangent of the vertebral body and the inner edge tangent of the pedicle) on the symptomatic side of the L4/5 under CT, and evaluate the degree of lateral recess decompression and nerve dilation using DSCA before and 1 year after surgery under MRI. The White Panjabi score was used to evaluate preoperative and 3 m-postoperative lumbar spine stability [11], and the scoring system identified lumbar instability as having a total score of 5 or greater. All imaging data were recorded by one radiologist and one spine surgeon, respectively. Recording the VAS scores of leg and hip pain for two groups of patients on the 1st day before surgery, the 3rd day after surgery, the 3rd month after surgery, and the 1st year after surgery, as well as the ODI scores on the 1st day before surgery, the 3rd month after surgery, and the 1st year after surgery [12]. At the last follow-up, the modified Macnab criteria were used to evaluate clinical efficacy. All follow-up data were recorded by one physician.

Inclusion criteria includes unilateral intermittent claudication, and imaging suggests DLSS and the narrow site is a lateral recess. The surgical segment is L4/5 and meet the indications for neurodecompression surgery. The conservative treatment lasting for 3 months resulted in unsatisfactory results and perform single-segment unilateral decompression using PEL-TL or PEC-TF surgery. Exclusion criteria includes revision surgery, and merge intervertebral disc protrusion, prolapse, and detachment. Discogenic lower back pain, segmental instability and lumbar spondylolisthesis. Serious illness that cannot tolerate surgery or has not received surgical treatment. Existence of neurological disorders or hip and knee joint disorders and missing follow-up information.

Surgical technique

PEL-TL

All patients were anesthetized using a combination of intravenous and inhalation anesthesia, with a prone position and abdominal suspension, while using 4 bags of 3-liter bags connected to the endoscope. Waterproof measures should be taken in the surgical area using waterproof cloth and transparent film. Inserting an endoscopic channel to identify anatomical sites such as the inner edge of the articular process, joint capsule, and spinous process root. Depending on the actual situation, and select a visual depth limiting ring saw, depth limiting bone knife, or large-sized vertebral plate rongeur to remove the lower articular process to the insertion point of the ligamentum flavum at the head end. Using laminectomy forceps to remove the ligamentum flavum parallel to the dura mater. Resection needs to be performed from the insertion point of the ligamentum flavum towards the tail end. Removing the bony structure outward to fully decompress the nerve root. The ventral side of the dural sac is thinned with blue forceps on the surface of the fibrous ring, and the radiofrequency ablation electrode is used for wrinkling and shaping. Decompression is required on the head side to the stop of the ligamentum flavum, on the tail side to the stop of the ligamentum flavum, on the inner side to the midline of the dural sac, and on the outer side to the outer edge of the nerve root. It is necessary to confirm under the microscope that the dural sac has reopened and the pulse is good.

PEC-TF

All patients will receive local anesthesia combined with intravenous anesthesia, with a prone position and abdominal suspension. Two bags and three liter bags will be connected to the endoscope, and waterproof measures will be taken in the surgical area using waterproof cloth and transparent film. Under the guidance of the C-arm, the puncture needle is inserted into the ventral side of the upper articular process, and local anesthesia is performed around the upper articular process using 0.5% lidocaine. Inserting a stepwise expansion tube and working channel, and after satisfying the fluoroscopy position, using a depth limited ring saw to complete the initial arthroplasty. The arget of arthroplasty is the superior articular process. Inserting an endoscopic channel to identify anatomical sites such as the base of the upper articular process and the upper edge of the pedicle. Depending on the actual situation, choose a circular saw, grinding drill, or vertebral plate rongeur to remove the bottom of the upper articular process to the insertion point of the ligamentum flavum at the tail end. Using a vertebral plate rongeur to remove the ligamentum flavum from its insertion point towards the head in a direction parallel to the dura mater, fully exposing the nerve root and dura mater sac. The ventral side of the dural sac is thinned with blue forceps on the surface of the fibrous ring, and the radiofrequency ablation electrode is used for wrinkling and shaping. Decompression is performed on the head side to the insertion point of the fibrous ring, and on the tail side to the insertion point of the ligamentum flavum. To the inside, the bony structure and ligamentum flavum need to be removed to the outer edge of the dural sac and the axilla of the nerve root. It is necessary to confirm under the microscope that the dural sac has reopened and the pulse is good.

Table 1 Comparation of the general results between two groups

Characteristics	PEL-TL ($n=54$)	PEC-TF ($n=70$)	t/ χ2	*P*
Age (years)	59.2 ± 11.2	58.3 ± 13.6	0.400^{t}	0.69
Sex M/F	25/29	32/38	0.004 $^{\chi2}$	0.95
Duration of symptoms (months)	11.5 ± 5.9	13.6 ± 6.7	1.882^{t}	0.062
Hospital stay (d)	5.2 ± 1.5	5.4 ± 1.6	0.851^{t}	0.396
Operating time (min)	45.6 ± 7.1	56.9 ± 7.5	8.550^{t}	< 0.001
Intraoperative fluoroscopy (t)	3.7 ± 1.1	10.8 ± 2.2	23.506^{t}	< 0.001

PEL-TL indicates Percutaneous Endoscopic Large channel Translaminar approach neurodecompression surgery; PEC-TF indicates Percutaneous Endoscopy Conventional channels Transforaminal approach neurodecompression surgery; n indicates the total number of patients.

Postoperative management
All patients were not placed with drainage tubes and underwent lumbar spine imaging examination on the same day after surgery, while walking under the protection of lumbar support. Discharge criteria includes imaging findings indicate satisfactory decompression range and the incision healed well and showed no signs of infection, and satisfactory therapeutic effect. Regular follow-up examinations will be conducted in 3 months and 1 year after discharge.

Statistical analysis
Statistical analysis was conducted using SPSS 20.0 software. For quantitative data that followed a normal distribution, the data are presented as mean ± standard deviation. Comparison between two groups using independent sample t-test. Categorical data are expressed as rates, and the chi-square test (χ2 test) was used for comparisons between groups. For ordinal data, the Mann-Whitney rank-sum test was employed. Repeated measures analysis of variance (ANOVA) was used to compare LRA, DSCA, VAS and ODI scores at multiple time points between the two groups. If the sphericity assumption was violated, the Greenhouse-Geisser correction was applied. Within-group comparisons at different time points were performed using the Bonferroni method. Between-group comparisons at the same time point were conducted using a multifactorial ANOVA. The level of significance for all tests was set at a two-sided α of 0.05.

Results
General results
A total of 124 patients were included in this study. Among them, there were 54 cases in the PEL-TL group, 25 males and 29 females, aged 59.2 ± 11.2 years, with a course of 11.5 ± 5.9 months and a hospital stay of 5.2 ± 1.5 days. There were 70 cases in the PEC-TF group, including 40 males and 30 females, aged 58.3 ± 13.6 years, with a course of 13.6 ± 6.7 months and a hospital stay of 5.4 ± 1.6 days [Table 1]. There was no statistically significant difference in general information such as age, gender, disease course, and length of hospital stay between the two groups of patients ($p > 0.05$) [Table 1]. Preoperative dynamic X-ray images did not indicate segmental instability; CT shows thickening of the responsible segment of the ligamentum flavum and bony or soft narrowing of the lateral recess area; MRI shows partial reduction in intervertebral disc signal, narrowing of lateral recess, and compression of nerves and dura mater. The surgery time in the PEL-TL group was shorter than that in the PEC-TF group ($p < 0.05$) [Table 1]. The number of C-arm fluoroscopy in the PEL-TL group was significantly lower than that in the PEC-TF group ($P < 0.05$)[Table 1].

Radiographic result
All enrolled patients were followed up regularly for 1 year. There was no significant difference in preoperative LRA and DSCA between the two groups of patients ($P > 0.05$). One year after surgery, LRA and DSCA in both groups were significantly larger than before ($P < 0.05$). There was no statistically significant difference in postoperative DSCA between the two groups. LRA in the PEL-TL group was more significantly larger than that in the PEC-TF group ($P < 0.05$) [Table 2]. There was no significant difference in WP between the two groups of patients at 3 months before and after surgery ($P > 0.05$) [Table 2].

Functional results
The ODI and VAS of hip pain and leg pain in the two groups of patients at different postoperative periods

Table 2 Comparation of the radiographic result between two groups

Group	*n*	LRA		DSCA		WP	
		Pre-op	Post 1y-op	Pre-op	Post 1y-op	Pre-op	Post 3 m-op
PEL-TL	54	34.7 ± 9.3	79.4 ± 3.4	74.6 ± 9.2	118.1 ± 7.3	2.5 ± 0.9	2.4 ± 1.1
PEC-TF	70	35.7 ± 8.5	71.2 ± 4.3	73.5 ± 9.6	119.1 ± 8.4	2.3 ± 1.1	2.3 ± 1.1
Statistic		time: F = 1998.976,$P < 0.001$ time*group: F = 26.606, $P < 0.001$ group: F = 16.789, $P < 0.001$		time: F=,1516.727 $P < 0.001$ time*group: F = 0.849, $P = 0.36$ group: F = 0.012, $P = 0.91$		time: F=,0.002 $P = 0.97$ time*group: F = 0.140, $P = 0.71$ group: F = 1.236, $P = 0.27$	

LRA indicates Lateral Recess Angle; DSCA indicates Dural Sac Cross sectional Area; WP indicates White Panjabi scoring syste; pre-op indicates preoperative; post-op indicates postoperative. The time effect of LRA of PEL-TL and PEC-TF are $p < 0.001$, respectively. The Group effect of LRA of pre-op and post 1y-op are $p = 0.52$ and $p < 0.001$, respectively.

Table 3 Comparation of the VAS and ODI between two groups

Group	VAS-hip				VAS-leg				ODI		
	Pre-op	Post 3d-op	Post 3 m-op	Post 1y-op	Pre-op	Post 3d-op	Post 3 m-op	Post 1y-op	Pre-op	Post 3 m-op	Post 1y-op
PEL-TL	5.2 ± 1.2	0.9 ± 0.8	0.6 ± 0.6	0.5 ± 0.7	5.1 ± 1.4	1.0 ± 0.8	0.5 ± 0.5	0.5 ± 0.5	59.3 ± 5.8	10.1 ± 2.6	9.9 ± 2.7
PEC-TF	5.2 ± 1.0	1.0 ± 0.9	0.7 ± 0.7	0.6 ± 0.6	4.8 ± 1.5	1.0 ± 0.9	0.5 ± 0.6	0.5 ± 0.6	59.0 ± 5.1	10.0 ± 2.6	9.9 ± 2.8
Statistic	time: F = 692.907, $P < 0.001$ time*group: F = 0.828, $P = 0.481$ group: F = 2.936, $P = 0.09$				time: F = 341.389, $P < 0.001$ time*group: F = 0.454, $P = 0.72$ group: F = 0.439, $P = 0.51$				time: F = 4023.260, $P < 0.001$ time*group: F = 0.093, $P = 0.91$ group: F = 0.062, $P = 0.80$		

VAS indicates Visual Analog Scale; ODI indicates Oswestry Disability Index;

Table 4 Comparation of the Macnab between two groups

MacNab		PEL-TL	PEC-TF	Z	P
Post-1y	Excellent	36	48	0.135	0.89
	good	14	16		
	acceptable	4	4		
	poor	0	2		
	EG rate	92.6%	91.4%		

EG indicates excellent and good.

Table 5 Comparation of the complication rate between two groups

Characteristics	PEL-TL	PEC-TF	χ2	P
Numbness of lower limbs	2	1	4.98	0.03
Pain due to nerve edema	1	0	0.273	0.60
Recrudescence	1	9		
Recrudescence Rate (%)	1.9%	12.9%		
Postoperative delirium	2	0		
Dural sac tear	0	0		
Infect 感染	0	0		
Complication Rate (%)	11.1%	14.3%		

were significantly improved compared to before surgery ($P < 0.05$). There was no statistically significant difference in ODI and VAS of hip pain and leg pain between the two groups at each follow-up time point ($p > 0.05$) [Table 3]. One year after surgery, the improved Macnab criteria were used to evaluate clinical efficacy. Among them, the PEL-TL group had 36 cases of excellent and 14 cases of good, with an excellent and good rate of 92.6%. The PEC-TF group had 48 cases of excellent and 16 cases of good, with an excellent and good rate of 91.4%. There was no statistically significant difference between the two groups ($p > 0.05$) [Table 4].

Complications

Two cases in the PEL-TL group experienced lower limb numbness after surgery, while one case in the PEC-TF group experienced lower limb numbness, both of which recovered within two weeks after surgery. One patient in the PEL-TL group experienced neuroedema pain after surgery, which was relieved within one week after surgery. In addition, there was 1 case of recurrence in the PEL-TL group and 9 cases in the PEC-TF group, respectively. Among them, the PEL-TL group did not undergo revision surgery and improved after conservative treatment, while 2 cases underwent revision surgery in the PEC-TF group. The postoperative recurrence rate in the PEL-TL group was lower than that in the PEC-TF group (1.9% in the PEL-TL group vs. 12.9% in the PEC-TF group) [Table 5]. Two cases of postoperative delirium occurred in the PEL-TL group, both of which recovered 2 days after surgery. There was no statistically significant difference in the incidence of complications between the two groups of patients (11.1% in the PEL-TL group and 14.3% in the PEC-TF group) ($P > 0.05$) [Table 5].

Typical cases

Figure 1, Fig. 2.

Discussion

Endoscopic treatment of DLSS

Degenerative lumbar spinal stenosis with non-surgical treatment ineffective, severe symptoms affecting daily life and work, and accompanying neurological dysfunction requires surgery [13]. Patients with non segmental instability and discogenic lower back pain are more suitable for neurodecompression surgery [14]. Unlike lumbar disc herniation, the focus of decompression for lumbar spinal stenosis is not limited to the intervertebral space, especially in cases without combined disc herniation. During surgery, efforts should be made to protect the fibrous ring and avoid entering the intervertebral disc, which may increase the risk of postoperative disc re herniation [15]. The focus of decompression for lumbar spinal stenosis is to expand the space for nerve activity, fully remove the bony structures around the nerves and soft tissues such as the ligamentum flavum [16]. Based on the Thessys technique using intervertebral foramen shaping reported by Thomas in 2002 [17], with the strong promotion of numerous minimally invasive spinal surgeons and the rapid development of endoscopic tools, PEC-TF surgery has been widely used in the treatment of DLSS [18–19]. In 1988, Young first proposed minimally invasive neurodecompression surgery through the interlaminar approach in the presence of air medium [20]. This technique can achieve target nerve tissue decompression while maintaining the structural stability of the articular process and posterior ligament as much as possible. In recent years, with the development of endoscopic technology, under the intervention of aqueous media, the

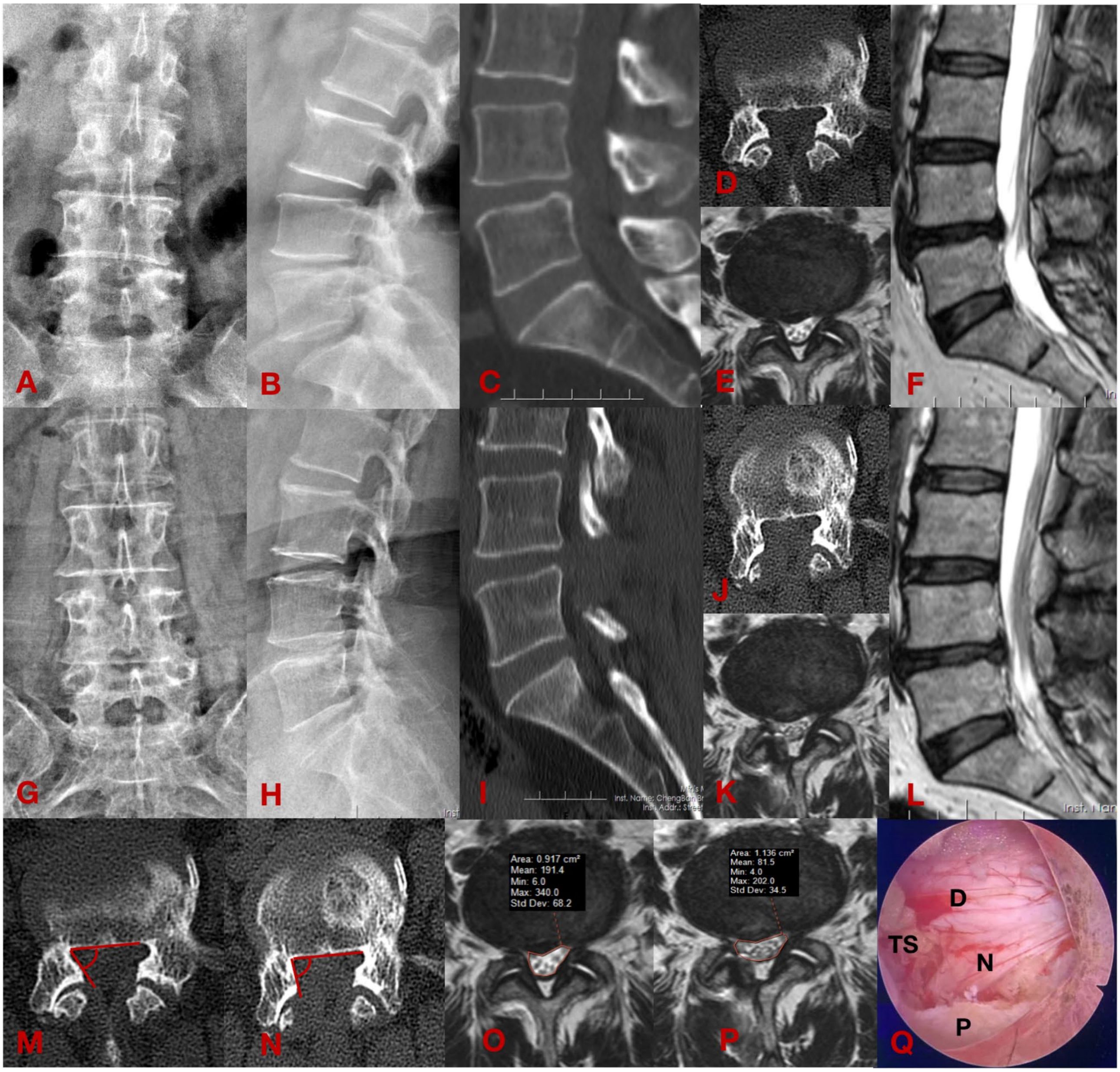

Fig. 1 Patients in the PEL-TL group, with L4/5 spinal canal stenosis, underwent unilateral decompression through a unilateral approach. **A-F** is a preoperative imaging examination, which showed stenosis of the L4/5 spinal canal, located in the right lateral recess and intervertebral disc degeneration; **G-L** represents postoperative imaging examination, indicating satisfactory decompression range; **M,N** represents the measurement of preoperative and postoperative LRA under CT, and the postoperative LRA increases compared to before surgery; **O,P** represents the preoperative and postoperative DSCA changes measured under MRI, with postoperative DSCA increasing compared to preoperative; **Q** represents the nerve image after intraoperative endoscopic decompression, **D** represents the dural sac, **N** represents the nerve root, **P** represents the pedicle, and TS represents the tail side

surgical field under endoscopy is clearer and the operation is more accurate. However, conventional endoscopic operations have smaller space and lower efficiency [10]. The diameter of the percutaneous coaxial large channel working channel is relatively large, and the instruments are similar to open surgery. At the same time, it can be matched with larger endoscopic bone knives and circular saws, which greatly improves the surgical efficiency of PEL-TL and makes the treatment of degenerative L4/5 spinal stenosis through the interlaminar approach gradually become an alternative surgical option for more surgeons.

Comparison of effectiveness between PEL-TL and PEC-TF

Analyzing from the perspective of clinical efficacy. In a retrospective study of 50 enrolled cases, Park concluded that endoscopic nerve decompression through the interlaminar approach can achieve definite clinical efficacy

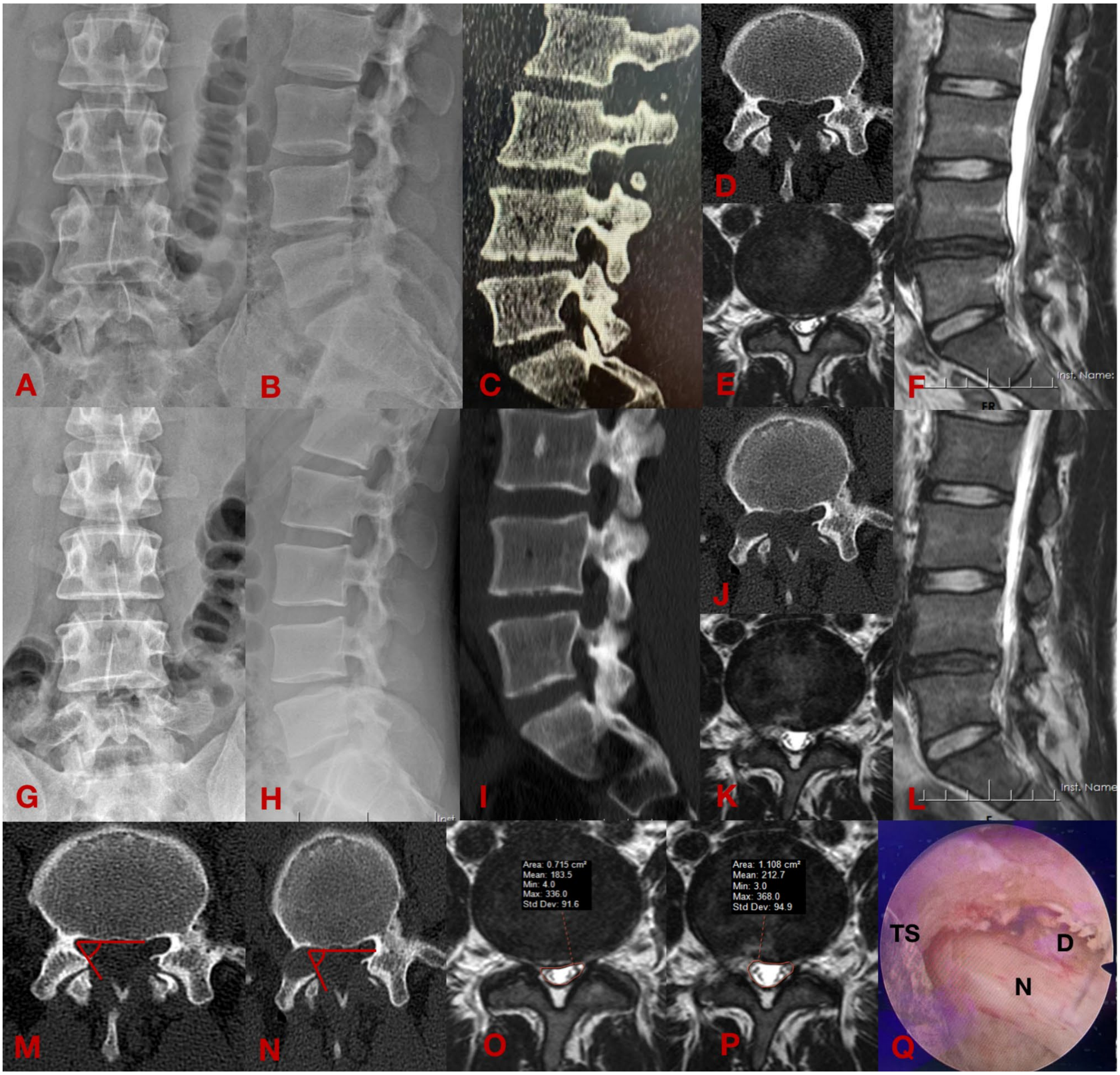

Fig. 2 Patients in the PEL-TF group, with L4/5 spinal canal stenosis, underwent unilateral decompression through a unilateral approach. **A-F** is a preoperative imaging examination, which showed stenosis of the L4/5 spinal canal, located in the right lateral recess and intervertebral disc degeneration; **G-L** represents postoperative imaging examination, indicating satisfactory decompression range; **M,N** represents the measurement of preoperative and postoperative LRA under CT, and the postoperative LRA increases compared to before surgery; **O,P** represents the preoperative and postoperative DSCA changes measured under MRI, with postoperative DSCA increasing compared to preoperative; **Q** represents the nerve image after intraoperative endoscopic decompression, **D** represents the dural sac, **N** represents the nerve root, and TS represents the tail side

[21]. In a randomized controlled trial conducted by Komp, after a 2-year follow-up, it was found that the clinical efficacy of endoscopic nerve decompression through the interlaminar approach was satisfactory [22]. Li and Zhang also achieved satisfactory clinical efficacy in their respective retrospective studies of endoscopic decompression through the intervertebral foramen for the treatment of lumbar spinal stenosis [23–24]. The above studies indicate that the intervertebral and foraminal approaches can achieve satisfactory therapeutic effects in the treatment of degenerative lumbar spinal stenosis, which is similar to the results of this study. In this experiment, the VAS score of leg and hip pain and ODI score of the two groups of patients were significantly improved compared to before surgery, and there was no significant difference between the two groups, which further demonstrates that the two surgeries have similar therapeutic effects in treating DLSS.

From the perspective of decompression range, there is currently no unified understanding of endoscopic nerve decompression range. The decompression instruments used in PEC-TF surgery mainly include endoscopic ring saws, grinding drills, and conventional models of laminectomy Punc. Arthroplasty and multiple endoscopic procedures can quickly and effectively expand the decompression range and shorten the surgical time [25]. PEC-TF can easily decompress the main nerve compression areas of DLSS, including the intervertebral space and lateral recess area. There was no statistically significant difference in postoperative DSCA between the two groups of patients, and there was no difference in the degree of early postoperative dural sac retraction. This indicates that both surgical methods can fully complete the decompression of the main nerve compression area. In this experiment, the expansion of postoperative LRA in the PEL-TL group was more significant than that in the PEC-TF group. This is because compared to PEC-TF, the large-sized laminectomy Punch used under PEL-TL endoscopy can routinely perform dorsal decompression at the head side nerve root insertion point, while simultaneously reducing pressure along the inner edge of the pedicle towards the tail end to the middle of the pedicle, fully removing the dorsal bone structure of the nerve root to complete the full range of nerve root decompression, and obtaining a larger range of bone side recess decompression.

Analyzing from the perspective of surgical time. As the channel diameter increases, PEL-TL allows conventional surgical instruments to perform endoscopic operations, greatly improving surgical efficiency [10]. In this experiment, the surgical time of PEL-TL was shorter than that of PEC-TF, thanks to the combined use of large-sized vertebral lamina rongeur, large-sized endoscopic ring saw, and endoscopic bone knife. By biting off the vertebral lamina to the insertion point of the ligamentum flavum, the dorsal ligamentum flavum can be quickly removed to complete decompression.

Comparison of safety between PEL-TL and PEC-TF

Analyzing from the perspective of radiation dose. The steps that PEC-TF requires fluoroscopy assistance include puncture anesthesia, channel placement, and arthroplasty. The steps that PEL-TL requires fluoroscopy assistance include puncture and channel placement. In this experiment, PEL-TL had significantly lower surgical X-ray fluoroscopy times compared to PEC-TF. Clarifying the formation site and depth of the circular saw is the reason why PEL-TF surgery has more X-ray fluoroscopy times. Our team had an average of 15 X-ray fluoroscopy sessions during the early stages of PEL-TF surgery. PEL-TL does not require external arthroplasty, resulting in a significant reduction in the number of X-ray fluoroscopy times. An increase in the number of X-rays fluoroscopy will increase radiation exposure measurement for medical personnel and there are still certain risks when performing surgery for a long time. Therefore, good protection is crucial for medical personnel during PEC-TF.

Analyzing from the perspective of complications. All patients in this trial did not damage the fibrous ring or enter the intervertebral space to remove the nucleus pulposus during surgery, which can effectively reduce the incidence of postoperative disc re-herniation [26]. Although there was no statistically significant difference in the incidence of complications between the two groups of patients in this experiment. It is worth noting that according to the statistical results, we found that there were more recrudescence rate in the PEC-TF group after surgery compared to the PEL-TL group. We believe this is mainly due to two reasons. Firstly, PEC-TF adopts arthroplasty and removing the bony structure on the ventral side of the upper articular processm, and some patients may have residual cortical bone, so under stress, the bony structure will continue to grow outward, further compressing the nerves [Figure 3] [27]. Furthermore, although both surgical procedures can achieve satisfactory results in the short term, PEL-TL has a larger range of bony lateral recess after surgery compared to PEC-TF. During the continuous degeneration of the intervertebral disc, even if there is disc herniation, PEL-TL can have a larger buffer space than PEC-TF, reducing the recurrence rate of nerve compression symptoms.

Analyze from the perspective of anesthesia methods. Due to the increase in endoscopic diameter of PEL-TL from 3.75 mm in conventional endoscopy to the current 7.1 mm, occasional use of a lingual channel to protect nerves during surgery may cause discomfort and even uncontrollable physical agitation in patients. This increases the risk of nerve damage and reduces the patient's medical experience, so all of our PEL-TL use a combination of intravenous and inhalation anesthesia. PEC-TF can be performed under local anesthesia due to its use of intervertebral foramen approach, which causes relatively less nerve stimulation. In this experiment, two patients in the PEL-TL group experienced postoperative delirium, both of whom were of advanced age. This also indicates that compared to PEL-TL, the anesthesia risk of PEC-TF is lower. In addition, PEL-TF surgery uses local anesthesia combined with intravenous anesthesia, especially for patients with severe lateral recess stenosis, which can improve patient discomfort through stronger sedative and analgesic drugs.

Conclusion

Both surgical methods can achieve satisfactory clinical outcomes in the treatment of degenerative L4/5 spinal stenosis. PEL-TL has fewer X-ray fluoroscopy times,

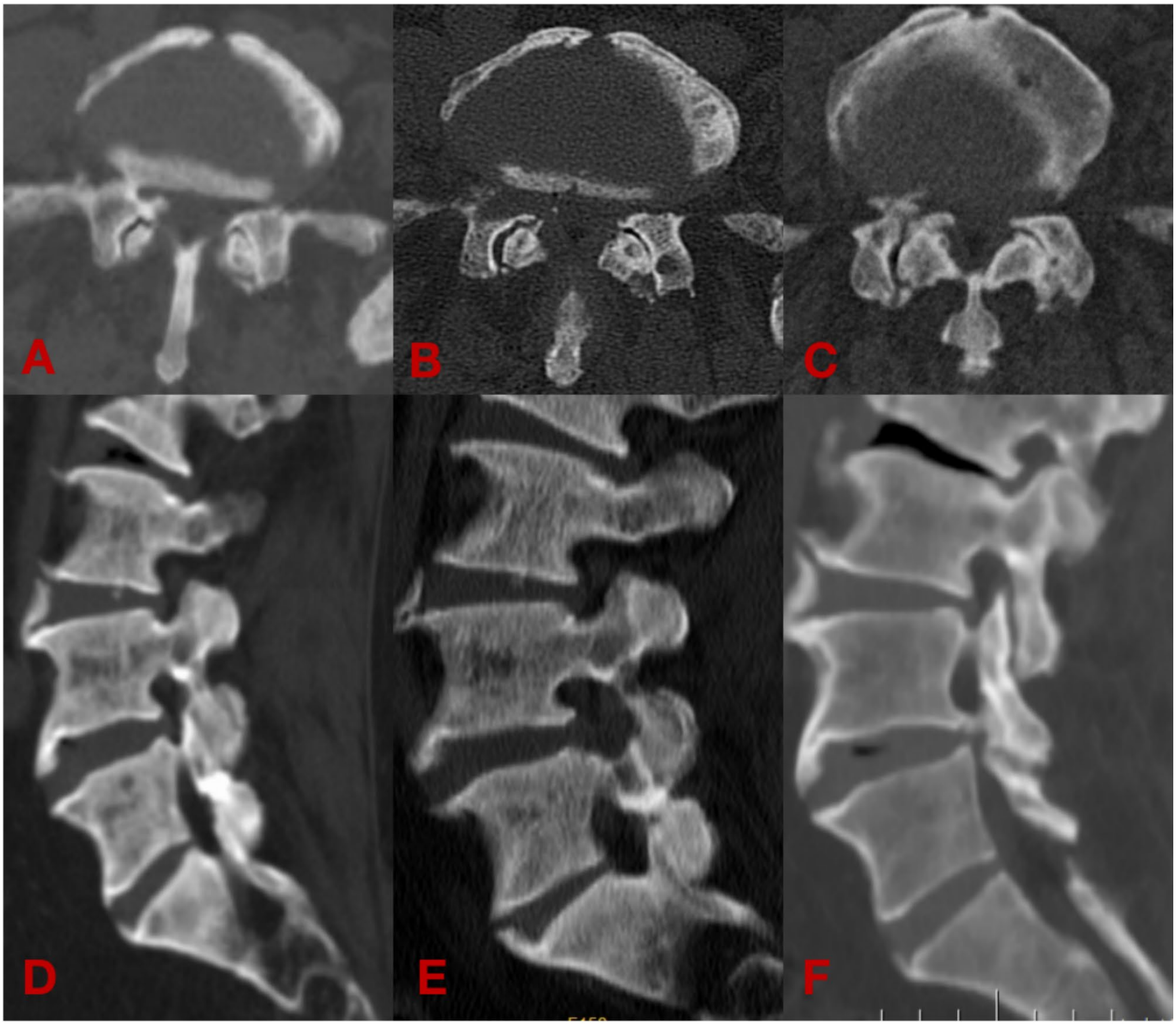

Fig. 3 Typical cases of postoperative recurrence in PEC-TF. **A**, **D** is a preoperative CT scan of PEC-TF, showing narrowing of the bony lateral recess on the right side of the L4/5 and osteophyte hyperplasia; **B,E** is a CT scan 2 days after PEC-TF surgery, which shows satisfactory decompression range in the L4/5 side recess area and significant enlargement of the bony side recess; **C,F** is a 2-year CT scan after PEC-TF surgery, which shows osteophyte hyperplasia and stenosis in the right side of the L4/5 recess, and the degree of stenosis is more severe than before surgery

wider decompression range, shorter surgical time, and lower recurrence rate, while PEC-TF can be routinely performed under local anesthesia to reduce anesthesia risk. However, this trial is a retrospective study with a small number of enrolled cases, which has certain limitations. We hope that the results of this study can lay a foundation for future randomized controlled trials and continue to explore the advantages and disadvantages of various endoscopic surgical methods.

Abbreviations

PEL-TL	Percutaneous Endoscopic Large channel Translaminar approach
PEC-TF	Percutaneous Endoscopy Conventional channels Transforaminal approach
LRA	Lateral Recess Angle
DSCA	Dural Sac Cross sectional Area
WP	White Panjabi
VAS	Visual Analog Scale
ODI	Oswestry Disability Index
DLSS	Degenerative lumbar spinal stenosis

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JL is responsible for writing articles and sorting out ideas, QK is responsible for operation implementation and experimental planning, PF and BZ are responsible for data analysis, JM are responsible for data collection.

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Data availability
The datasets analysed in this article are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study is approved by the Ethics Committee of West China Hospital of Sichuan University (2024-69). All participants provided informed written consent. All methods were performed in accordance with the relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Chengdu Office Hospital of the People's Government of the Xizang Autonomous Region, Chengdu, China
[2]Spinal Surgery Department, West China Hospital of Sichuan University, Chengdu, China

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