

# Micro-endoscopic discectomy versus percutaneous endoscopic surgery for lumbar disk herniation

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## Abstract

**Objective:** This study was performed to compare the effectiveness and safety of percutaneous endoscopic lumbar discectomy (PELD) versus micro-endoscopic discectomy (MED) in the treatment of patients with lumbar disk herniation.

**Methods:** In total, 216 patients treated for lumbar disk herniation in our center from January 2016 to July 2017 were prospectively divided into two groups according to the treatment received. One group was treated with PELD and the other group was treated with MED. The surgical duration, intraoperative blood loss, total hospital stay, visual analog scale (VAS) pain score, and Oswestry disability index (ODI) score before and after the surgery were compared between the groups.

**Results:** The surgical duration was significantly longer in the PELD than MED group. The intraoperative blood loss volume was significantly larger in the MED than PELD group. The total hospital stay was significantly longer in the MED than PELD group. The decline in the VAS pain score and increase in the ODI score after surgery were not significantly different between the two groups.

**Conclusions:** Although PELD is associated with a longer surgical duration than MED, it should still be considered superior to MED because of less intraoperative hemorrhage and a significantly shorter hospitalization time.

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## Keywords

Percutaneous endoscopic lumbar discectomy, micro-endoscopic discectomy, lumbar disk herniation, prospective cohort study, visual analog scale, Oswestry disability index

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## Background

Low back pain is a common phenomenon among the middle-aged and elderly population. Up to 50% of the population has experienced at least one episode of low back pain, and it is the most common symptom requiring treatment in spine clinics. Lumbar disk herniation is one of the most common causes of low back pain with or without numbness, weakness, and pain in the lower extremities. Although most affected patients achieve satisfactory alleviation of pain by pharmaceutical treatment, physical therapy, and rehabilitation exercises, some severe cases still require surgical intervention.<sup>1-3</sup>

With the development of minimally invasive surgical techniques in spinal care, endoscopic surgery has gained increasing popularity in the treatment of lumbar disk herniation.<sup>4-6</sup> Now that the equipment and trained surgeons for both micro-endoscopic discectomy (MED) and percutaneous endoscopic lumbar discectomy (PELD) are available in many spinal centers, some surgeons may encounter a dilemma in choosing between these two surgical approaches. The current study was performed to compare the efficacy and safety of those two approaches.<sup>7-9</sup>

## Methods

All procedures were approved by the ethics committee of the Sixth Affiliated Hospital of Xinjiang Medical University. All patients provided written informed consent to

undergo the treatment and participate in the study. The surgical method was decided by the patients themselves after the surgeons explained the advantages and disadvantages of PELD and MED. The patients were prospectively divided into the PELD and MED groups according to the surgical procedure they chose to undergo.

### *Inclusion and exclusion criteria*

The inclusion criteria were as follows: age of 18 to 70 years; diagnosis confirmed by magnetic resonance imaging (MRI) and computed tomography and at least 1 month of conservative treatment with no satisfactory results; no previous surgical treatment at the same level of disk protrusion; no heart, liver, or lung conditions that may prevent surgical treatment; and agreement to undergo either PELD or MED and attend follow-up visits at the outpatient clinic.

The exclusion criteria were as follows: age of <18 years or >70 years; severe low back pain but no significant pathological change on MRI or computed tomography; a history of surgical treatment; severe heart, liver, or lung conditions that may prevent surgical treatment; and refusal or inability to accept surgical treatment and/or postoperative follow-up visits.

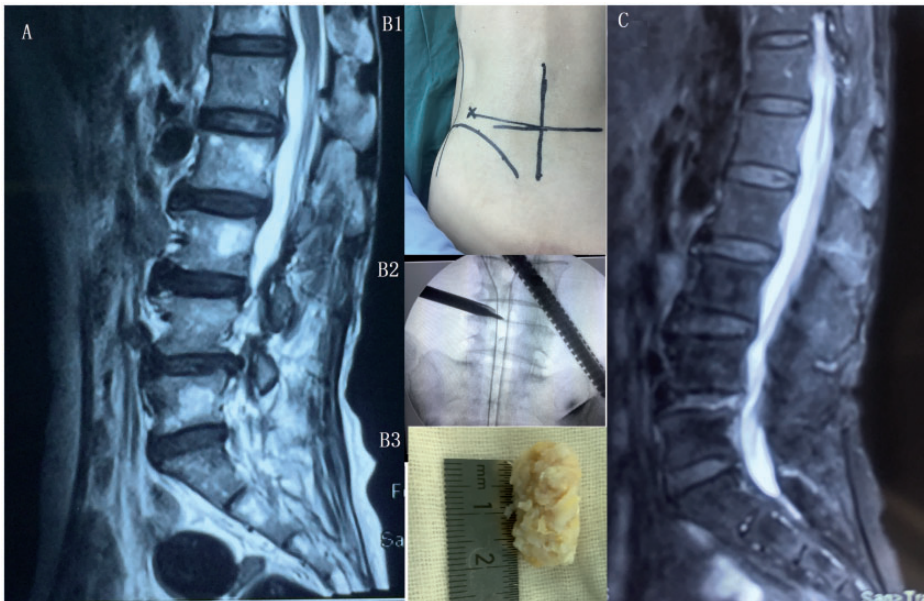
### *Surgical procedures*

PELD was carried out under regional anesthesia using the Panoview Plus discoscope (Richard Wolf GmbH, Knittlingen, Germany). The patient was placed in the

prone position. The position and angle of the needle was determined by intraoperative X-ray examination. The puncture needle was placed on the lower lip of the superior articular process of the inferior vertebral body. After administration of regional anesthesia with 0.5% lidocaine, the puncture needle was inserted through the intervertebral foramen into the intervertebral disk, and discography and a pain induction experiment were performed to determine the correct surgical segment. Upon confirmation of this segment, a 1-cm incision was made and percutaneous tissue expansion pipelines were applied to expand the soft tissue. A trepan was used to remove the lateral margin of the superior articular process of the inferior vertebral body and expand the narrow intervertebral foramen. An 8-mm tunnel was inserted into the incision to establish a working tunnel. A foramenoscope was then placed in the working

tunnel, and the outstanding intervertebral disk and nucleus pulposus were extracted using different nucleus pulposus forceps. The operative field was washed with 3000 mL of physiological saline containing 240,000 units of gentamicin. The epidural space was exposed and checked for fragments if the disk was cranially or caudally sequestered. Partial pediclectomy was carried out to create more space for manipulation when the migrated disk was blocked by a pedicle. After the extraction, 5 mg of beta-methasone dipropionate and 2 mg of beta-methasone sodium phosphate were injected into the working tunnel, and the incision was sutured (Figure 1).

MED was carried out under continuous epidural anesthesia using the METRx MED system (Medtronic Sofamor Danek Inc., Memphis, TN, USA). The patient was placed in the prone position with the abdomen suspended to reduce pressure.



**Figure 1.** Images from a patient who underwent percutaneous endoscopic lumbar discectomy. (a) Preoperative sagittal magnetic resonance imaging, (b1) intraoperative patient positioning, (b2) intraoperative fluoroscopy, (b3) intervertebral disk that was removed, and (c) postoperative sagittal magnetic resonance imaging.

A guide pin was inserted 1.5 cm from the spinous process on the side of surgery, and intraoperative C-arm fluoroscopy was used to confirm the correct surgical site. A 1.6-cm longitudinal incision was made while centering the pin, and dilators with different diameters were inserted toward the interlaminar spaces. A 16-mm-diameter tubular retractor was inserted into the soft tissue tunnel, bordering the inferior edge of the upper lamina and the medial edge of the inferior articular process. An endoscope was inserted into the working tunnel, a nucleus pulposus forceps was used to clean the residual soft tissue, and bipolar coagulation was used to stop the hemorrhage. After exposure of the inferior edge of the lamina, ligamentum flavum, and medial edge of the inferior articular process, a curette was used to strip the ligamentum flavum from the lamina and a laminectomy rongeur was used to remove part of the lamina and ligamentum flavum to expose the dura and nerve roots. A nerve root retractor was used to protect the nerve root while exposing the intervertebral disk and removing the extruded and loose disk material. The epidural space was exposed and checked for fragments if the disk was cranially or caudally sequestered. Partial pediculectomy was carried out to create more space for manipulation when the migrated disk was blocked by a pedicle. After the extraction, 5 mg of betamethasone dipropionate and 2 mg of betamethasone sodium phosphate were applied regionally to alleviate swelling. A drainage tube was placed over the lamina, and the incision was closed in layers.

### **Postoperative treatment**

Postoperative pain was treated with oral application of dihydrocodeine tartrate (Lutan Pharmaceutical Co. Ltd., Weihai, Shandong, China) or muscular injection of lornoxicam (San Lian Pharmaceutical

Co. Ltd., Harbin, Heilongjiang, China). Drainage tubes were removed after the drainage fluid reached <20 mL, which normally occurred 48 hours postoperatively. Hormones were not administered postoperatively. The patients were typically discharged 3 to 4 days after removal of the drainage tubes if no adverse surgery-related complications had occurred.

### **Outcome assessment**

The surgical duration, intraoperative blood loss, intraoperative fluoroscopic exposure, and total hospital stay were recorded during hospitalization. Back and leg visual analog scale (VAS) pain scores<sup>10</sup> and Oswestry disability index (ODI) scores<sup>11</sup> were recorded preoperatively, 1 month postoperatively, and at the last follow-up. All assessment parameters were compared between the two groups.

### **Statistical analysis**

All statistical analyses were carried out by SPSS 22.0 software (IBM Corp., Armonk, NY, USA). The differences in the results were compared between the two groups by an independent-sample t-test. Differences were considered statistically significant when the P value was <0.05.

### **Results**

From January 2016 to July 2017, 216 patients (120 women, 96 men; age range, 21 to 65 years; mean age,  $37.5 \pm 13.6$  years) underwent surgical treatment for lumbar disk herniation in our center. Among these patients, 82 underwent PELD and 134 underwent MED. There were no significant differences in age, sex, disease duration, or surgical segment between the two groups (Table 1).

All surgeries were carried out according to the original surgical plan, and no conversions to open surgery were required.

Two patients in the PELD group and one patient in the MED group developed a dural tear. Nerve root injury occurred in three patients in the PELD group and one patient in the MED group. Transient post-operative dysesthesia was reported by three patients in the PELD group and eight patients in the MED group. Two patients in the MED group had poor wound healing due to superficial fat necrosis, but no bacteria were found in cultures; therefore, no antibiotics were administered. All of these complications were managed conservatively.

**Table 1.** Comparison of demographic characteristics between the PELD and MED groups.

	PELD	MED	P
Sex			
Male	38	58	0.66
Female	44	76	
Age, years	38.2 ± 9.2	36.3 ± 8.6	0.47
Involved segment			
L2/3 or L3/4	6	11	0.78
L4/5	63	98	
L5/S1	13	25	
Disease duration, months	6.8 ± 3.2	7.4 ± 2.6	0.25
VAS score			
Back	7.8 ± 1.7	7.4 ± 1.9	0.63
Leg	7.1 ± 2.0	6.6 ± 1.4	0.41
ODI score	81.5 ± 13.8	76.3 ± 15.3	0.18

Data are presented as number of patients or mean ± standard deviation.

PELD, percutaneous endoscopic lumbar discectomy; MED, micro-endoscopic discectomy; VAS, visual analog scale; ODI, Oswestry disability index.

Twelve patients in the MED group developed hemorrhage of >200 mL from the internal vertebral plexus, but none of them required a blood transfusion. One patient experienced symptoms of L5 nerve root injury, but the symptoms disappeared within 3 months postoperatively.

The surgical duration was significantly longer in the PELD than MED group ( $P < 0.05$ ), the intraoperative blood loss was significantly larger in the MED than PELD group ( $P < 0.05$ ), and the total hospital stay was significantly longer in the MED than PELD group ( $P < 0.05$ ) (Table 2). However, the decrease in the VAS pain scores and increase in the ODI scores after the surgery were not significantly different between the two groups. The mean number of intraoperative fluoroscopic examinations was significantly higher in the PELD group ( $11.3 \pm 4.1$ ) than in the MED group ( $1.7 \pm 0.5$ ;  $P < 0.05$ ) (Table 3).

## Discussion

Since Foley and Smith<sup>12</sup> first reported the application of MED to the treatment of lumbar disk herniation in 1997, MED has been applied in increasingly more spine centers. MED combines the traditional posterior interlaminar fenestration technique and modern endoscopic surgery, making it possible for the spine surgeon to achieve adequate decompression by a small incision. In our patient series, the 16-mm-diameter working tunnel was large enough to insert

**Table 2.** Comparison of operative parameters between the PELD and MED groups.

Approach	Time (min)	Fluoroscopy (times)	Hemorrhage (ml)	Postoperative bed stay (days)	Total hospital stay (days)
PELD	64 ± 8.6	9.7 ± 3.6	15 ± 6.9	1.2 ± 0.7	4.5 ± 1.6
MED	85 ± 10.6	4.5 ± 2.5	137 ± 22.6	2.8 ± 1.4	7.3 ± 3.0
P value	<0.01	<0.01	<0.01	<0.01	<0.01

Data are presented as mean ± standard deviation.

PELD, percutaneous endoscopic lumbar discectomy; MED, micro-endoscopic discectomy.

**Table 3.** Comparison of VAS back and leg scores and ODI scores between the PELD and MED groups.

Approach	VAS score (lower back pain)		VAS score (leg pain)		ODI score	
	1 mo	Last f/u	1 mo	Last f/u	1 mo	Last f/u
PELD	1.8 ± 0.3	2.0 ± 0.8	1.6 ± 0.7	2.1 ± 0.8	32.7 ± 6.7	27.3 ± 5.4
MED	2.3 ± 0.5	2.6 ± 0.9	1.9 ± 1.1	2.5 ± 1.2	28.6 ± 7.2	25.5 ± 6.3
P value	0.32	0.65	0.48	0.41	0.33	0.58

Data are presented as mean ± standard deviation.

PELD, percutaneous endoscopic lumbar discectomy; MED, micro-endoscopic discectomy; VAS, visual analog scale; ODI, Oswestry disability index; 1 mo, 1 month postoperatively; f/u, follow-up.

both the endoscope and surgical instruments. The endoscope provides an enlarged operative field and decreases the risk of injury to the nerves and vessels during decompression. Additionally, because MED involves limited destruction of the soft tissue and bony structures, the stability of the spine can be preserved. In a case series by Wu et al.,<sup>13</sup> 624 (76%) of 873 patients achieved complete alleviation of low back pain, and 112 (14%) patients reported marked alleviation of low back pain.

The PELD approach can achieve direct extraction of the diseased intervertebral disk by a working tunnel with a diameter of 7.5 mm. As one of the newest minimally invasive surgical techniques, PELD has been applied by many authors with satisfactory results.<sup>14-16</sup> Because of its advantages in safety, efficacy, and minimal invasiveness, it is being accepted by an increasing number of spine care centers.

Although the patients in the current study were not randomly allocated to different groups, their baseline characteristics were similar, which could have minimized the potential patient selection bias. After the surgery, significant differences in several parameters were present between the two groups. For example, the surgical duration was significantly longer in the PELD than MED group (85 ± 10.6 vs. 64 ± 8.6 min, respectively;  $P < 0.01$ ). The intraoperative blood loss volume was significantly larger in the MED than PELD group

(137 ± 22.6 vs. 15 ± 6.9 mL, respectively;  $P < 0.01$ ). In the authors' hospital, patients are typically discharged 3 to 4 days after removal of the drainage tubes if no adverse surgery-related complications have occurred, and patients who have undergone open procedures typically stay in the hospital for 11 to 14 days. In the current case series, the total hospital stay was significantly longer in the MED group (7.3 ± 3.0 days) than in the PELD group (4.5 ± 1.6 days,  $P < 0.01$ ). Postoperative pain has a direct effect on the patients' mobilization ability and quality of life. Most patients experienced pain alleviation after the surgery, and the decline in the VAS pain scores and increase in the ODI scores after the surgery were not significantly different between the two groups. The intraoperative fluoroscopic exposure was significantly greater in the PELD than MED group (9.7 ± 3.6 vs. 4.5 ± 2.5 times, respectively;  $P < 0.01$ ), which may have affected the surgeons' preference of the type of surgical intervention.

PELD was carried out using regional anesthesia, which is much safer than MED. Because the patient is awake during the whole procedure, it is easier to avoid injuring the nerve root. The incision is significantly smaller with PELD, and it better preserves the integrity of the soft tissue and bony structure, making PELD preferable for maintaining spinal stability. However, the learning curve of PELD is steeper, and both the surgeon and patient

are subjected to a large amount of harmful radiation exposure.

The current study has certain limitations. The fact that the treatment was chosen by the patients may have had some effect on the outcome assessments such as the VAS and ODI scores. However, we tried to eliminate this potential bias by blinding the data collection and analysis process. The patients in the current study were only followed up for 6 months to 2 years, which made it impossible to compare the long-term results of the two approaches. Further follow-up studies could remedy this shortcoming. Moreover, because of its limited availability and high price, postoperative MRI was performed only when the patient reported either no significant alleviation or aggravation of pain after the surgery; this could have led to insufficient data with which to support the conclusion of the study. However, because only the surgical duration, intraoperative hemorrhage, and total hospitalization were significantly different between the two groups, the lack of MRI may not have affected the final conclusion of the study.

## Conclusions

Although PELD has a longer surgical duration than MED, it should still be considered superior to MED because it involves less intraoperative hemorrhage and a significantly shorter hospitalization time.

## Availability of data and material

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

## Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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