

The effect of paraspinal muscle-splitting microscopic-assisted discectomy versus percutaneous endoscopic lumbar discectomy on patients in the treatment of far-lateral lumbar disc herniation

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Research article

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Abstract

Background Minimally invasive surgery includes percutaneous endoscopic lumbar discectomy and the microscopic tubular technique. This study aimed to compare the two techniques and evaluate the outcome of the procedure. **Methods** We retrospectively analyzed patients with far-lateral lumbar disc herniation (FLLDH) from June 2015 to October 2018. Twenty-six patients underwent paraspinal muscle-splitting microscopic-assisted discectomy (MD), and 30 underwent percutaneous endoscopic lumbar discectomy (PELD) surgery. Data included the duration of the operation, duration of intraoperative radiation exposure and average hospitalization. Pre- and postoperative pain scores and neurological functions were recorded using visual analogue scale (VAS) score and Oswestry disability index (ODI). **Results** A total of 56 patients remained in the study over the 12–24 months. The mean operating time was 65.83 ± 16.64 min in the PELD group, the mean duration of radiation exposure was 2.87 ± 1.19 min and average hospitalization was 3.43 days. The mean operating time was 44.96 ± 16.87 min in the MD group, the mean duration of radiation exposure was 0.78 ± 0.32 min and average hospitalization was 4.12 days. All patients in both groups showed significant improvement of VAS and ODI scores after surgery and until final follow-up. **Conclusion** Both techniques are minimally invasive, effective, and safe for treating far-lateral lumbar disc herniation in selected patients. Compared with the PELD technique, the MD procedure affords a wider field of vision during operation, shorter operation time, fewer postoperative complications, and a shorter learning curve.

Background

Far-lateral lumbar disc herniation (FLLDH) is a rare disease that accounts for 2–12% of all lumbar disc herniation syndromes; it was first described by Abdullah in 1974^[1]. With increased awareness of the disease, experts have paid increasing attention to the diagnosis and treatment of FLLDH. The resulting nerve root syndrome is characterized by intense pain, often accompanied by motor or sensory disturbances. The diagnostic probability of FLLDH increases with the use of computed tomography (CT) and magnetic resonance imaging (MRI) scans. Although awareness of its existence has improved, the best treatment remains controversial^[2]. Surgical treatment is a challenge for spine surgeons as the FLLDH is difficult to access due to the adjacent bone structures such as articular processes. Traditional treatments for FLLDH include midline incisions, extensive subperiosteal exposures, and partial excision of the articular processes and laminae^[3]. However, these inevitably affect the stability of the lumbar spinal segment and eventually lead to refractory low back pain. Unlike in Europe, the gold standard in East Asia for the treatment of lumbar disc herniation is endoscopic surgery. Advances in various technologies (including the “inside-out technique”^[4]), have made endoscopy easy to perform surgery on the lumbar and cervical spine, using extraforaminal-targeted fragmentectomy techniques^[2]. However, the high number of intraoperative punctures increased exposure of patients and surgeons to radiation^[5]. The introduction of paraspinal muscle splitting has also shown good therapeutic effects on FLLDH. Percutaneous endoscopic and transmuscular techniques through tubular retractors can avoid extensive facet joint resections to maintain biomechanical stability and reduce postoperative low back pain

complications by minimizing access-related soft tissue trauma^[6]. Nevertheless, a comparison of these two minimally invasive surgical approaches has not been reported. The purpose of our research is to compare the two most popular minimally invasive procedures at the moment, which is the safest and most effective method for treating the FLLDH.

Materials And Methods

We retrospectively analyzed fifty-six patients who were treated from July 2015 to October 2018. Fifty-six patients underwent surgery, twenty-six of whom underwent paraspinal muscle-splitting microscopic-assisted discectomy (MD). There were five women and twenty-one men with ages ranging from 20 to 82 years (mean: 38.4 ± 13.98 years). Nine patients underwent surgery at the L5-S1 level, eleven underwent surgery at the L4-5 level, and six patients underwent surgery at the L3-4 level. Thirty patients underwent percutaneous endoscopic lumbar discectomy (PELD) surgery, ten women and twenty male men, with ages ranging from 27 to 77 years (mean: 47.4 ± 9.38 years). A total of twelve patients underwent surgery at the L5-S1 level, fifteen patients underwent surgery at the L4-5 level, and three patients underwent surgery at the L3-4 level (**Table 1**). They were treated using the PELD technique by a single surgeon team. The operation time, duration of intraoperative radiation exposure and average hospitalizations were recorded, the postoperative leg and back visual analogue scale (VAS) and Oswestry disability index (ODI) scores were recorded and followed up at 3, 12 and 24 months postoperatively.

Inclusion and exclusion criteria

The inclusion criteria were as follows: X-ray imaging without lumbar instability; MRI or CT imaging clearly indicating far-lateral lumbar disc herniation; patients not receiving other minimally invasive treatments; presence of more symptoms of unilateral lower radicular symptoms such as pain, numbness, or abnormal sensation; and inefficacy of conservative treatment (lying on bed traction, physiotherapy) for at least 6 weeks. Exclusion criteria were as follows: chronic low back pain; substantial intervertebral foramen stenosis; degenerative lumbar instability spondylolisthesis more than grade I or scoliosis of more than 20°; and spinal instability and scoliosis causing loss of foraminal height. In short, patients did not need to undergo fusion surgery^[7].

Surgical technique

PELD group

The patient was placed in the prone position, and surgery was performed under local anesthesia and intravenous sedation. We marked the midline and the height of the iliac crest from the preoperative assessment of axial MRI scan calculating the skin entry point, making appropriate adjustments according to the patient's body shape and weight; this may be 5 cm to 8 cm, lidocaine was injected for local anesthesia. We inserted an 18-G needle into the skin entrance. The angle between the needle and the sagittal plane depended on the segment and position of the disc herniation. In our experience, placing the needle tip in the upper corner of the caudal vertebral body (Fig. 2b) can reduce the compression of the

exiting nerve root located cranially. An approximately 7-mm incision was made and dilators were used to expand the soft tissue gradually along the guidewire. Working cannulas were then placed on the surface of the disc space. Some soft tissue covering the disc was first seen under endoscopy. Using a flexible bipolar radio frequency probe, we cleared the soft tissue to expose the exit nerve root. We used endoscopic grasping forceps to search for and grasp the tail of the nucleus pulposus and gently pull it. This was usually sufficient to remove the protruding nucleus (Fig. 3a). Finally, exploration was performed along the entire exit nerve root.

MD group

The procedure was performed under tracheal anesthesia, and the patient was placed in the prone position. We located the lesion segment and made an approximately 3–4 cm incision at 2–3 cm next to the midline (Fig. 2d). After cutting the fascia of the lower back, we used blunt finger dissection to separate the paraspinal muscles from the Wiltse gap. We then added soft tissue expanders in sequence, inserted a 14-mm working channel (Fig. 2c), confirmed its position by intraoperative X-ray, and fixed it on the operating table. The surgical microscope was used to complete the subsequent steps. The angle between the lower border of the transverse process and the outside of the isthmus area was an important anatomical landmark. The intertransverse process ligament was removed, and care was taken to expose and protect the nerve roots and ganglia. We minimized ganglion surgery to prevent abnormal postoperative abnormal. After the herniated disc was removed (Fig. 3b), the nerve root was completely decompressed, the fascia was closed, and the skin was sutured.

Follow-up

The follow-up examinations were conducted on the day after the operation (54 patients) and at 3, 12, and 24 months. Two patients in the MD group were followed up at 12 months. We started data recording and follow-up from the subsequent day; 6-month, 12-month, and 24-month data were collected in the outpatient clinic. The ODI and VAS scores were recorded for back and leg pain.

Statistical analysis

Data analysis was performed using SPSS 16.0 (IBM Corporation, Armonk, NY, USA). Significant differences were evaluated using a one-way analysis of variance with a post hoc Bonferroni correction. Differences were considered significant when $P < 0.05$.

Results

A total of 56 patients remained followed up over the 12–24 months. In the PELD group, the mean operating time was 65.83 ± 16.64 min (Fig. 1a), which was longer than that of the MD group (44.96 ± 16.87 min). Because our patients were hospitalized before surgery and underwent different anesthesia protocols, average hospitalization length in the PELD group was 82.32 ± 14.88 hours, less than that of the MD group (98.64 ± 15.65 hours). The mean duration of radiation exposure was 2.87 ± 1.19 min, due to

intraoperative puncture was required to ensure safety and correct position, which was longer than that of the MD group (0.78 ± 0.32 min). In the PELD group, there were two patients with postoperative transient dysesthesia and one underwent reoperation seven months after surgery. Only one patient had postoperative transient dysesthesia in the MD group. All patients received rehabilitation and nerve stimulation treatment, Symptoms resolved in less than 12 weeks. Because in PELD surgery there was continuous irrigation and no drainage remained postoperatively, we could not accurately compare the amount of bleeding. There were no severe complications such as epidural hematoma, nerve root injury, or intervertebral disc infection. Figures 1c and 1d show the VAS pain scores, and Fig. 1b shows the ODI scores. These results demonstrated significant improvement in the pain and ODI scores ($p < 0.001$). Patients still had low back pain at the follow-up at 3 months ($p > 0.05$) after surgery. Both two groups had significant relief at the follow-up after 12 months ($p < 0.05$). Overall, clinical results were significantly better than they were preoperatively.

Discussion

The first anatomical description of extreme lateral protrusions dates back to 1944, and with the development of spinal surgery, their clinical application has received increasing attention^[1, 8]. Because the dorsal root ganglia is accompanied by motor and sensory components, low back pain can be accompanied by severe nerve root pain. Most FLLDH occur at the L3-4 or L4-5 level; therefore, most patients have substantial thigh symptoms^[9, 10]. Straight leg elevation tests are negative, and symptoms of scoliosis are exacerbated; this helps to distinguish FLLDHs from other common disc herniations. In recent years, various surgical methods emerged to treat FLLDH^[3, 6, 11]. These surgical methods have changed over the years, including traditional open surgery, surgery using an operating microscope, microsurgery through a tubular channel, and percutaneous endoscopic surgery.

There are several reports of FLLDH managed using PELD^[12]. Using endoscopic technology, the working sleeve is first inserted into the intervertebral foramen to identify the nerve root, and then the working sleeve is retracted along the nerve root to locate the protruding intervertebral disc. One group reported their experience with transforaminal endoscope technology for the treatment of distant lateral and foraminal protrusions, a total of 47 patients^[13]. Their technique was similar to the Yeung technique^[14], with the selected entry point being 8 to 12 cm from the midline. They advocated first removing the central disc and the final step was removal of the extraforaminal disc. In China, many surgeons use various methods to treat FLLDH using the in-outside method, which contradicts the currently accepted principle of removing only protruding discs and loose fragments located in the posterior annulus. Furthermore, this technique extends the operation time, and removal of the central disc increases the possibility of loss of long-term intervertebral disc height. For FLLDH, the protrusion disc is often located in the anterior medial aspect of the exiting nerve root, occupying part of the space of the intervertebral foramen, and causing "soft stenosis" in the intervertebral foramen. When the working sleeve is set through the narrow intervertebral foramen into the intervertebral disc, it squeezes the soft intervertebral disc nucleus tissue, leading to more severe compression of the exit nerve root. Because of the presence of dorsal root

ganglion (DRG), severe pain often occurs. We made appropriate adjustments and improvements to the puncture approach. The intervertebral disc nucleus pulposus protruding outside the intervertebral foramen tends to shift to the cranial and lateral side, and the exiting nerve root is squeezed toward the “outer side”; however, the “inside and below” space is relatively abundant, and this is the ideal position to place the puncture needle and the working sleeve slightly below the protrusion, which is beneficial to remove the protruding nucleus pulposus tissue (properly rotating the working cannula) and reduce the nerve roots injury and irritate to DRG. The puncture target was placed at the intersection of the slightly inner side of the protruding position and the upper endplate of the caudal vertebra, meaning that the lateral position of the puncture needle was located at the posterior horn of the caudal vertebral body and the anteroposterior position was located at the outer edge of the midpoint of the pedicle (Fig. 2a, b). Many studies have emphasized the need to educate and protect everyone in the room during fluoroscopy^[15, 16], the mean duration of radiation exposure was 2.87 ± 1.19 min in our PELD group, it is believed that surgeon and patients need to limit their radiation exposure.

There are minimally invasive surgical treatments for FLLDH, including microendoscopic decompression of the endoscopic to minimize the damage to facet joints, muscles and ligaments^[17]. Less muscle trauma and fewer osteotomies reduce lumbar back pain and adjacent disc degeneration, reducing lumbar instability and fusion^[18]. Furthermore, trans-tubular microsurgery helps reduce hospital stay and promotes rapid recovery; our average hospitalization was 98.64 ± 15.65 hours, longer than PELD group due to intratracheal anesthesia. Compared to conventional paramedian muscle splitting, it has the advantage of using a sequential dilator and finally a tubular retractor, which makes procedures in obese patients as fast and simple as those of thin people^[19]. In our department, the surgeon separates paraspinal muscles with their fingers. They became familiar with using microscopes, reducing operation time. Choi et al. used the percutaneous endoscopic “targeted fragmentectomy” technique to treat 41 cases of FLLDH; two patients developed relapse symptoms after early symptoms improved (4.8%)^[2], three patients (7.3%) developed dysesthesia in the leg, one patient (2%) had persistent lower extremity pain after surgery and had microdiscectomy revision via paraspinal approach. In the MD group, intratracheal anesthesia helped the patient cooperate, the intraoperative vision was clear, and there was less nerve stimulation, which reduced the risk of lower limb numbness and recurrence after surgery. Nevertheless, regardless of surgical method, to achieve adequate decompression, a certain number of bone resections and treatment of nerve roots and dorsal root ganglia are sometimes required. This may cause paresthesia, reflex sympathetic dystrophy, or chronic back pain in some patients at 3-month follow-up.

Nellensteijnin reported 214 cases of FLLDH treated with transforaminal endoscopy; the median recurrence rate was 2.6%, the median complication rate was 5.1%, and the median was 8.0%^[20]. Porchet reported long-term prognosis in 202 patients with FLLDH; they used a 5–7-cm midline incision and transmuscular approach^[21]. The authors reported that the probability of postoperative complications was 5%. However, only three patients (1.5%) had complications that were directly related to the surgical procedure. According to Macnab's criteria, the results of surgical treatment were excellent or good, and

the average VAS of radical leg pain before surgery to final follow-up was 8.5 to 2.2^[22]. The incidence of reoperation was significantly lower than that of percutaneous endoscope. A study by Yoon found that, compared with lumbar discectomy, postoperative VAS and ODI scores following tubular microsurgery were significantly better than those of percutaneous endoscopic surgery^[23]. The follow-up data were basically the same. There are several limitations in this study. First, it was a single-centre study, and therefore may be subject to selection bias. For this reason, we instituted strict inclusion and exclusion criteria. Second, our sample size was small and it was a short-term follow-up. Multi-centre studies and large samples, long-term clinical follow-up are needed to validate our findings.

Conclusions

The paraspinal muscle-splitting microscopic-assisted discectomy and PELD technique are minimally invasive, effective, and safe for treating FLLDH in selected patients. Compared with PELD technique, MD has a wider field of vision during operation, shorter operation time, less radiation exposure. Average hospitalization was longer than PELD group due to different anesthesia methods.

Abbreviations

PELD
percutaneous endoscopic lumbar discectomy
VAS
Visual Analog Scale
ODI
Oswestry Disability Index
MD
Microscopic-assisted discectomy
FLLDH
far-lateral lumbar disc herniation
CT
Computed tomography
MRI
Magnetic resonance imaging

Declarations

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Competing interests

The authors declare that they have no competing interests.

Conflicts of interest

The authors confirm that they have no conflicts of interest.

Availability of data and materials

Corresponding author Hong -guang Xu can be contacted to request the raw data.

Consent for publication

Not applicable

Ethics approval and consent to participate

All procedures were in accordance with the ethical standards of the committees responsible for human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008. Informed consent was obtained from all patients before being included in the study.

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Authors' contributions

L Kong designs and writes manuscripts all of the manuscript. X Chen is responsible for the follow-up data collection and statistics .Y Huang and WZ Zhang, HG Xu modified the paper and put forward some positive ideas, such as the overall framework and the limitation of the study, and made the final edition. All authors participated in every revision and improvement of the manuscript. Absolutely, we declare all authors have read and approved the manuscript.

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Table

Tab 1. Demographic parameters of the patients

Baseline characteristic	(PELD)	(MD)
Number of patients	30	26
Gender	M (20) / F (10)	M (21) / F (5)
Age (years; median IQR)	47.4± 9.38	38.4±13.98
Postoperative severe complication, n (%)	0	0
Temporary dysesthesia	2 (6.7%)	1(3.8%)
Severe back pain	0	0
Average hospitalization(day)	3.43	4.12
Operation time (min)	65.83±16.64	44.96 ±16.87
radiation exposure(min)	2.87±1.19	0.78 ±0.32
Revision	L4/5 1(3.3%)	0
L5/S1	15 (50.0%)	11 (42.3%)
L3/4	12 (24.0%)	9 (34.6%)
	3 (6.0%)	6(23.1%)

Figures

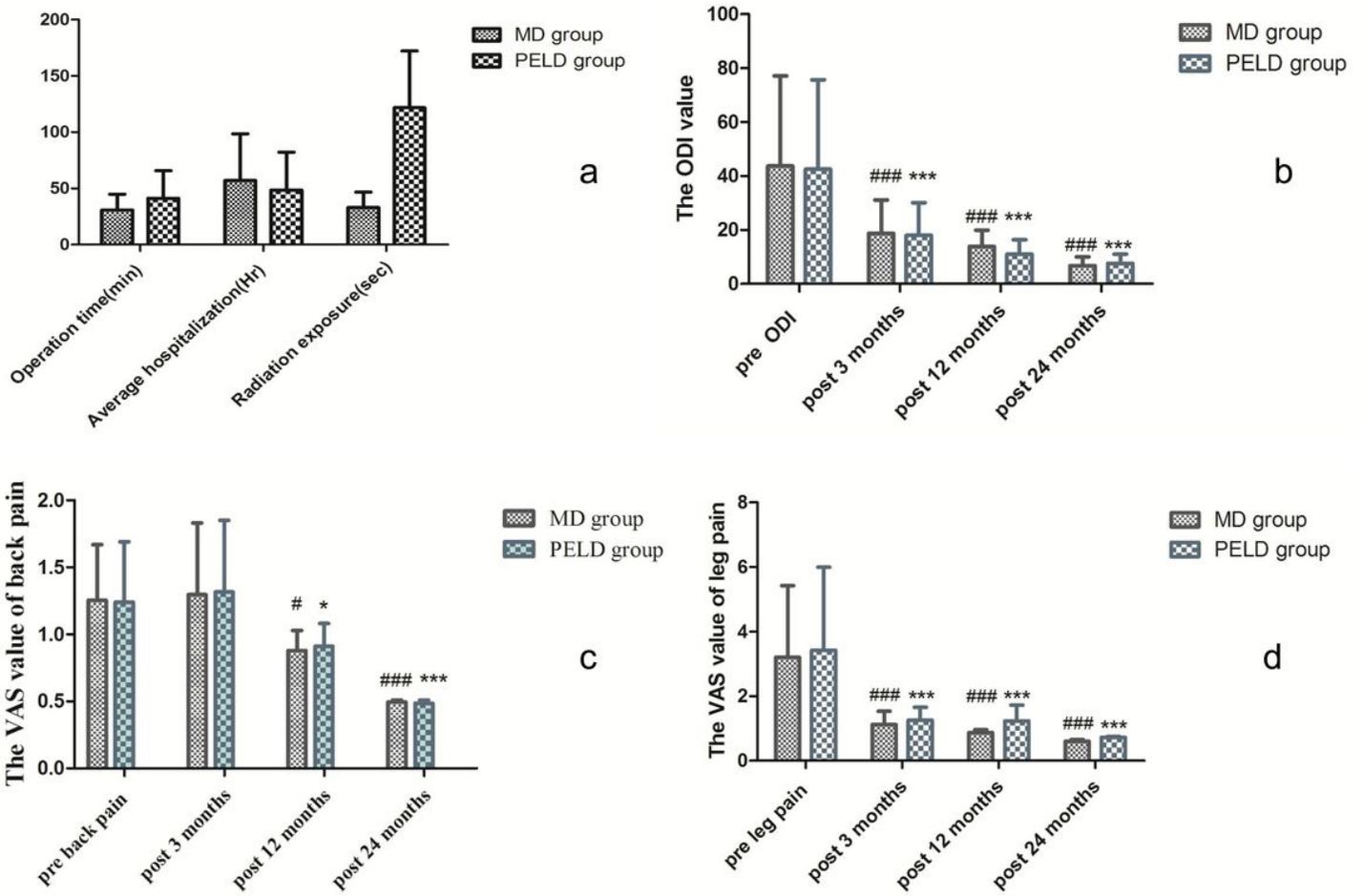


Figure 1

a The average operation time and hospital stay in both groups. c and d The preoperative and postoperative leg and back pain VAS scores. The results demonstrated significant improvement in the leg pain ($p < 0.001$). The patients still had low back pain at the follow-up at 3 months ($p > 0.05$) after surgery. Both groups had a significant relief at the follow-up after 12 months ($p < 0.05$). b The preoperative and postoperative ODI scores, where the results demonstrated significant improvement in ODI scores ($p < 0.001$).

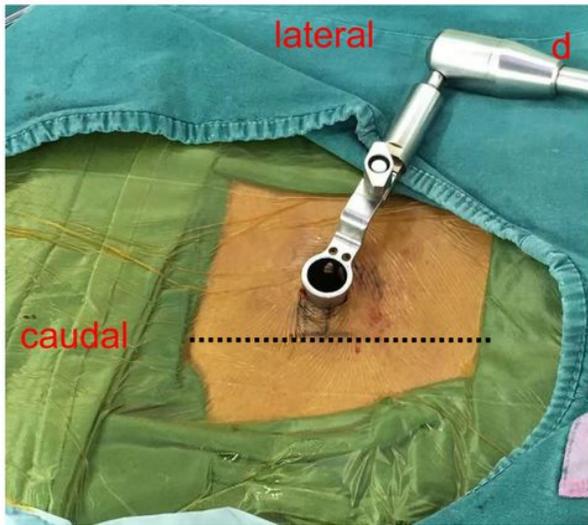
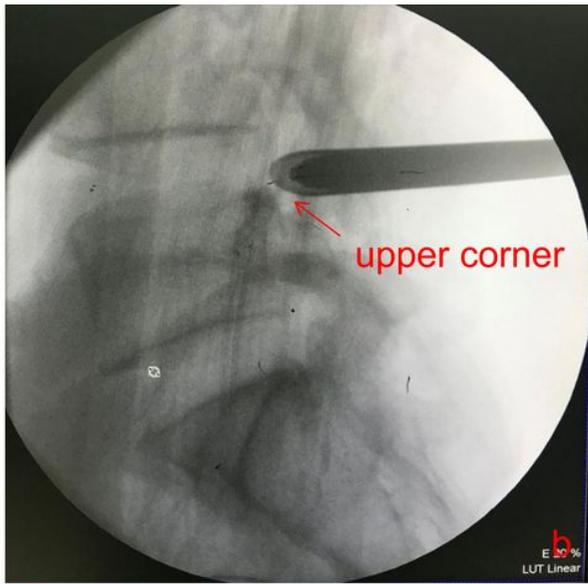
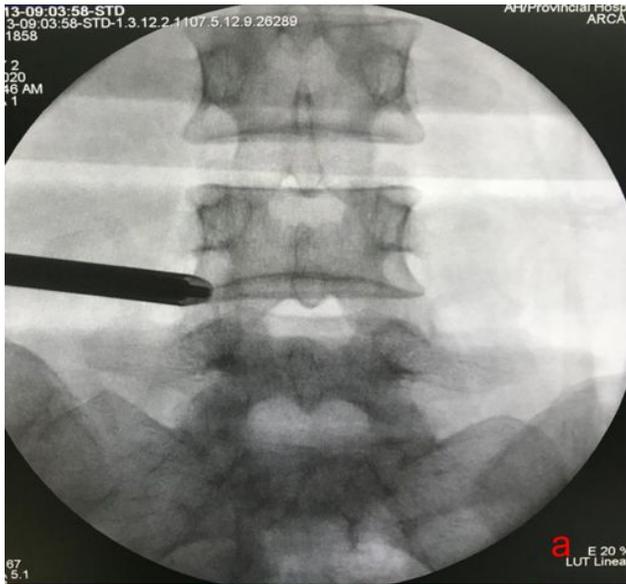


Figure 2

a The PELD technique. b The MD technique.

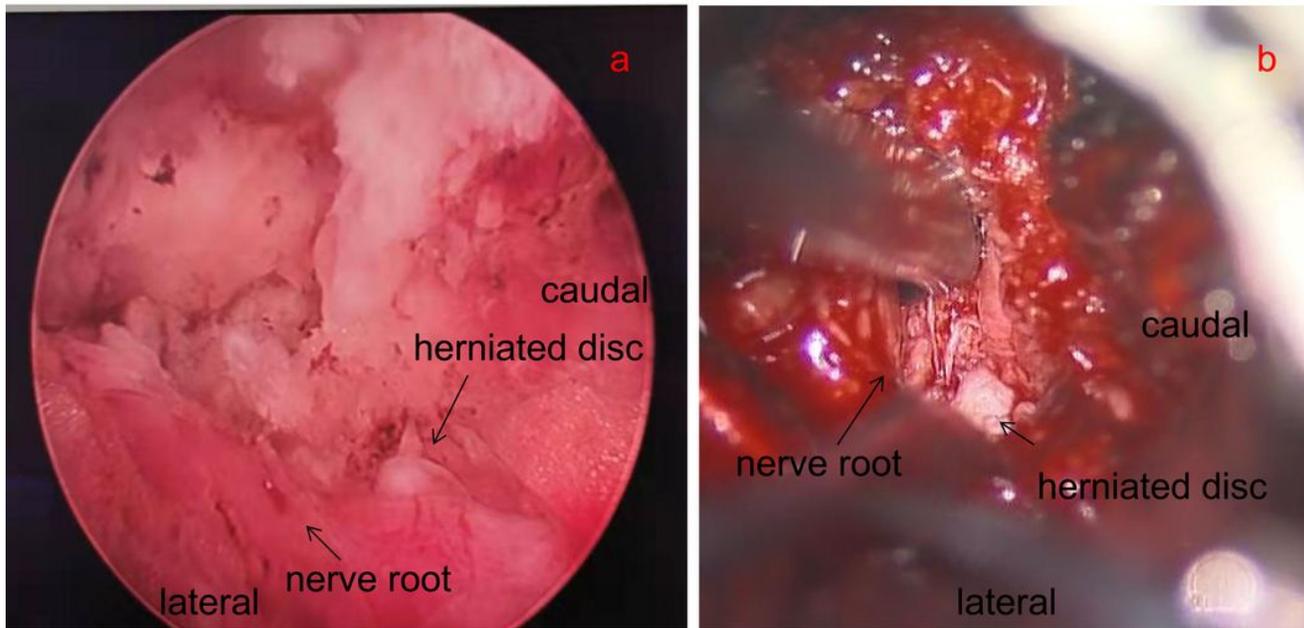


Figure 3

a Anatomy under the endoscope in PELD group. b Anatomy under the microscope in MD group.

Supplementary Files

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