Retrospective Study

Pain Variability of Tissues Under Endoscope in Percutaneous Endoscopic Lumbar Discectomy and Its Significance: A Retrospective Study

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Background: Percutaneous endoscopic lumbar discectomy (PELD), as a representative minimally invasive spine surgery technique for lumbar disc herniation (LDH), has been standardized. In PELD, tissues such as ligamentum flavum, dural sac, nerve root, posterior longitudinal ligament, annulus fibrosus, and endplate were exposed, removed, and decompressed. However, during PELD, whether there is pain or not in the tissues under endoscope in LDH patients has never been thoroughly discussed in the previous research.

Objectives: The purpose of the study is to evaluate tissue pain variability during PELD as for the treatment of LDH, to provide references and guideline for the operation, and to give humanistic care for patients.

Study Design: A retrospective analysis.

Setting: All data were collected from Shandong Provincial Hospital Affiliated to Shandong First Medical University.

Methods: From January 2008 to December 2020, 3,600 patients with LDH were enrolled in this retrospective study. All patients suffered from low back and leg pain because of LDH and underwent PELD. The pain of these tissues under endoscope was assessed according to the Visual Analog Scale (VAS) scores for the back and legs (VAS-B and VAS-L, respectively).

Results: For VAS-B, the tissues were ranked from the highest VAS scores to the lowest in the following order: posterior longitudinal ligament; next, dural sac/nerve root; then, endplate/annulus fibrosus/ligamentum flavum. For VAS-L, they were in the following order: dural sac/nerve root; next, posterior longitudinal ligament; then, endplate/annulus fibrosus/ligamentum flavum.

Limitations: Retrospective nature of data collection.

Conclusions: Tissues, such as ligamentum flavum, dural sac, nerve root, posterior longitudinal ligament, annulus fibrosus, and endplate, have different kinds of pain in PELD for LDH.

Key words: Percutaneous endoscopic lumbar discectomy, visual analog scale, lumbar disc herniation, pain

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Lumbar disc herniation (LDH) is a kind of disease with a series of clinical manifestations (1) caused by degeneration of intervertebral disc tissue (2) because of various reasons (3), which results in compression of the dural sac or nerve root in the posterior spinal canal. With the aging of the population, the incidence of this disease is increasing, severely affecting patients' quality of life. In recent years, percutaneous endoscopic lumbar discectomy (PELD) (4) has the advantages of small incision, less tissue trauma, less bleeding, fast recovery, early movement, fewer complications, relatively low operation cost, and marked reduction of wound infection rate as compared with the traditional open surgery when facing diseases of LDH or stenosis of the lumbar spinal canal, etc. (5-8). Additionally, with the development of intervertebral foraminoplasty (9), patients with almost all types of LDH could be cured by PELD. In the treatment of disc herniation, more and more patients tended to choose PELD first.

During the PELD surgery, we found that the patients would feel disproportionate pain when the tissues were exposed and removed. At present, the relevant research on pain differences has not been reported. In this study, we applied the Visual Analog Scale (VAS) scores for pain sensation in LDH patients during intraoperative tissue processing of the PELD surgery. This study will give us relevant references on the amount of local anesthesia, help us better identify different tissues, optimize the pain management of patients, and strengthen humanistic care.

Methods

Patients

From January 2008 to December 2020, we performed PELD on 3,600 patients. All patients in this study underwent PELD for LDH (Fig. 1), which was performed by the same surgeon in the past 12 years. PELD was performed under local anesthesia. Furthermore, 0.5% lidocaine in 10 mL, 0.25% ropivacaine in 4 mL, and 0.9% normal saline in 16 mL were mixed and administered to prevent related pain. The mixed narcotic drug, 15 to 20 mL, was injected layer-by-layer into the skin, subcutaneous tissue, fasciae, muscle, and the lumbar facet joint. The mixed narcotic drug would be added intraoperatively, if necessary.

Inclusion and Exclusion Criteria

This study was approved by our institutional review board. The study included patients who underwent transforaminal percutaneous endoscopic lumbar discectomy (TF-PELD) in our hospital and who were diagnosed with symptomatic disc herniation at one level with no prior or subsequent surgery at any other spinal level. The exclusion criteria included patients undergoing multiple levels of discectomy or concomitant surgery, in addition to PELD performed at the same or different levels; patients with stenosis, infection, fractures, or tumors were also excluded.

Data Collection

One surgeon performed TF-PELD for all enrolled patients. When tissues, such as ligamentum flavum, dural sac, nerve root, posterior longitudinal ligament, annulus fibrosus, and endplate, were exposed, removed, and decompressed, the pains were clinically assessed with the VAS scores for the back (VAS-B) and legs (VAS-L) with the other surgeon on standby. (Figs. 2,3)

Statistical Analyses

Statistical analyses were performed using SPSS for Windows (version 14.0; SPSS, Inc., Chicago, IL). Depending on the variables, comparison between groups was analyzed using independent samples t test. The result was considered statistically significant if the probability value was less than 0.05.

Surgical Technique

The following techniques have been described in previous publications (10,11).

TF-PELD was performed under local anesthesia with the patient in a prone position on a radiographic table (10). The index level was identified under fluoroscopy and labeled. An 18-gauge spinal needle was inserted laterally from the midline to a distance premeasured on magnetic resonance imaging (MRI) preoperatively. Fluoroscopic verification confirmed that, on the lateral view, the needle tip was at the level of the posterior disc space and, on the anterior-posterior (AP) view, the needle tip was located at the ipsilateral mid-pedicular line. Epidural anesthesia was administered followed by entering the disc space and injecting a radioopaque dye (Telebrix, Gluerbet, Aulnay-sous-Bois, France). The annulus was then penetrated and discography was done with an indigo carmine (Indigo Carmine, indigotindisulfonate sodium injection) and a normal saline mix. A guidewire was inserted into the cannula, and a stab incision was made on the skin to pass sequential serial dilators ending with an obturator that entered intra-

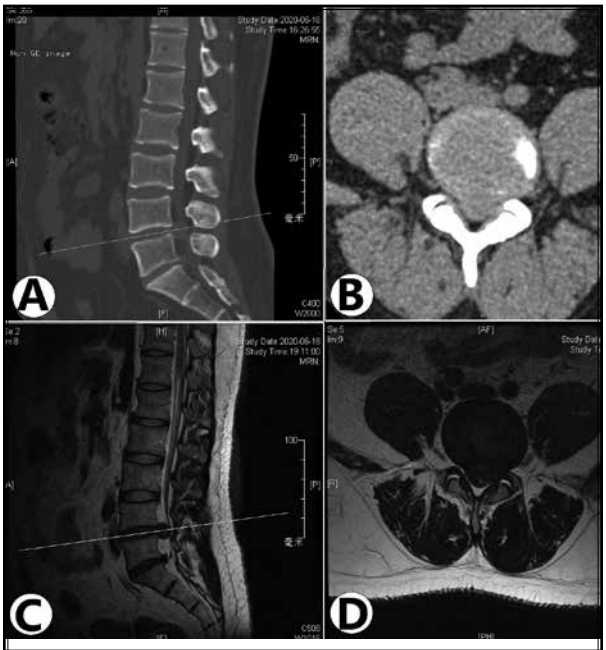

Fig. 1. *CT and MR imaging of a patient with LDH.*

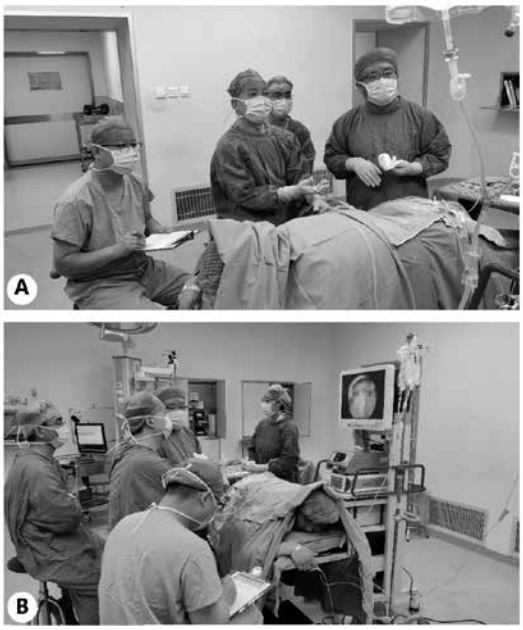

Fig. 2. *One patient is having the TF-PELD surgery. A: One surgeon is performing TF-PELD; B: The other surgeon assesses pain with VAS for VAS-B and VAS-L on standby.*

discally. A multichannel endoscope was then inserted (YESS [Yeung Endoscopic Spine System], Richard Wolf GmbH, Knittlingen, Germany), and a discectomy was performed first by releasing the intraannular disc attachments to the sequestered disc. The herniated fragment was then removed within the spinal canal with forceps slowly while gradually retrieving the working channel and endoscope (Fig. 4). A Holmium-YAG side-firing laser was used to vaporize disc fragments that were not removed by the forceps, and a radiofrequency bipolar coagulator was used to coagulate bleeding vessels. Decompression was confirmed visually (11).

Results

A total of 3,600 patients with LDH were admitted to Shandong Provincial Hospital from January 1, 2008 to December 31, 2020. They were treated with TF-PELD. The age of patients ranged from 13 to 63 years and most of them were young. All patients presented symptoms and confirmatory signs of lumbar radiculopathy that were consistent with the symptomatic disc level and findings of imaging studies. The segments, disc location, disc type, disc size, and migration of LDH among 3,600 patients were recorded in Table 1.

With regard to VAS-B, we found that the most intense pain came from the posterior longitudinal

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Date:

Name: Gender: Age:

Segment: Side: OP method:

Herniation: Central
Paramedian
Extreme lateral

Tissues	VAS-B (0-10)	VAS-L (0-10)
Ligamentum flavum		
Dural sac		
Nerve root		
Posterior longitudinal ligament		
Fiber annulus		
Endplate		

Fig. 3. *Questionnaires used for the VAS scores for patients who have undergone TF-PELD.*

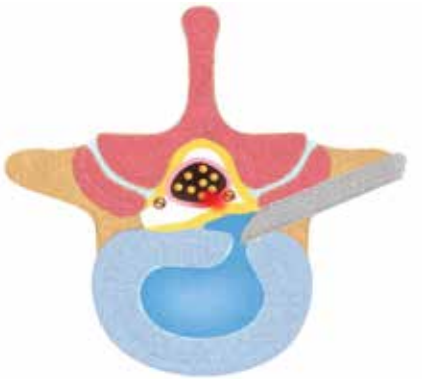

Fig. 4. *Cross-section representation of TF-PELD during disc extraction.*

Table 1. *Characteristics of the included patients.*

Item		Average (± SD)
Total Number		3,600
Gender	Male	1,818
	Female	1,782
Segments	L1-2	19
	L2-3	200
	L3-4	599
	L4-5	1,457
	L5-S1	1,363
OP Method	TF-PELD	3,600
Side	Left	1,790
	Right	1,810
Age (years)	< 30 years	1,299
	30-40 years	2,056
	40-50 years	150
	>50 years	95
Disc Location	Central	1,556
	Paracentral	987
	Foraminal	835
	Extreme Lateral	222
Disc Type	Shoulder	1,823
	Axillary	1,777
Disc Size	≥50% Canal Compromise	799
	< 50% Canal Compromise	2,801
Migration	Up-Migrated	722
	Down-Migrated	1,201
	Low-Grade	954
	High-Grade	723

Abbreviations: OP, operative; TF-PELD, transforaminal percutaneous endoscopic lumbar discectomy.

ligament; next, the nerve root/dural sac; then, the endplate, ligamentum flavum, and annulus fibrosus in that order (P = 0.003). VAS-B in the posterior longitudinal ligament and dural sac/nerve root is 5.37 ± 1.7 and 4.83 ± 0.4, respectively, significantly higher than those of the other tissues. With regard to VAS-L, we found that the most intense pain came from the nerve root/dural sac; next, the posterior longitudinal ligament; then, the endplate, ligamentum flavum, and annulus fibrosus in that order (P = 0.001). VAS-B in the dural sac/nerve root and posterior longitudinal ligament is 7.54 ± 1.4 and 4.88 ±1.2, respectively, significantly higher than other tissues (Table 2).

Discussion

In PELD, the typical anatomic landmarks under endoscope in the image's azimuth, from 12 to 6, are the ligamentum flavum, dural sac/nerve root, posterior longitudinal ligament, annulus fibrosus/disc, and endplate in counterclockwise order (Figs. 5,6).

There's been a great deal of research on pain in terms of different tissues under endoscope. Many scholars believed that vertebral endplate changes seemed to be strongly associated with active low-back symptoms and segmental instability, thus reflecting a state of active degeneration and biomechanical instability of the lumbar spine (12-17). On the contrary, Kovacs et al (18) considered vertebral endplate changes were not associated with chronic low back pain. Ashton et al (19) provided further evidence that the facet capsule, not the ligamentum flavum, had substantial innervation by sensory and autonomic nerve fibers and had a structural basis for pain perception. Many studies have indicated that pressure and chemical irritation of nociceptive nerves (22,25) depended on degenerated discs exciting sensory neural elements, especially in the posterior longitudinal ligament and possibly also in the peripheral parts of the anulus fibrosus (20), while the disc itself, at least if not penetrated by vascular granular tissue, was painless and neuroanatomically lacked a structural basis for pain perception (20-25).

From January 2008 to December 2020, 3,600 patients with LDH were enrolled to receive PELD in our hospital. We found that different tissues have different kinds of pain. The most severe back pain usually came from the posterior longitudinal ligament, with the VAS scores of 3-4. The most severe leg pain tends to be from the dural sac/nerve root, with the VAS scores of 5-6. The VAS scores of other tissues (ligamentum flavum, annulus fibrosus/disc, and endplate) were not significantly different.

Table 2. *Tissues pain assessed by VAS-B and VAS-L in PELD.*

Tissues	VAS-B (x ± s, n = 3,600)	VAS-L (x ± s, n = 3,600)
Ligamentum Flavum	1.31 ± 0.2	1.22 ± 0.1
Dural Sac/Nerve Root	4.83 ± 0.4*	7.54 ± 1.4*
Posterior Longitudinal Ligament	5.37 ± 1.7*	4.88 ± 1.2*
Annulus Fibrosus	1.49 ± 0.6	1.71 ± 0.8
Endplate	1.70 ± 1.3	1.43 ± 1.0
P Value	0.003	0.001

Abbreviations: VAS-B, visual analog pain scale of the back; VAS-L, visual analog pain scale of the leg.
*$P < 0.05$, the comparison between groups is statistically significant.

This study is of great clinical significance. First, we can determine the amount of local anesthesia based on the pain differences of tissues under endoscope. When the needle reaches around the dural sac/nerve root and posterior longitudinal ligament, we can appropriately increase the dosage of local anesthetic drugs to reduce the patient's pain during the operation. Second, surgeons can preliminarily judge the nature of the tissues according to the patient's intraoperative VAS scores in order to reduce nerve injury, dural sac tear, and other surgical complications. And last, patients can be informed of the predicted pain before surgery, which can reduce patients' panic, anxiety and other negative emotions, and improve the surgical fluency.

Despite the strengths, several limitations could not be avoided in the present investigation. First, all patients come from different cultural backgrounds and have different understandings of the VAS scores, which may have a certain impact on the study results. Second, the pain variability among different tissues under endoscope in this study were defined by the VAS scores, and they were short of anatomic or even molecular evidence. Next, we will conduct pathological and molecular biology studies on different tissues under endoscope, such as the amount of nerve fibers and substance P.

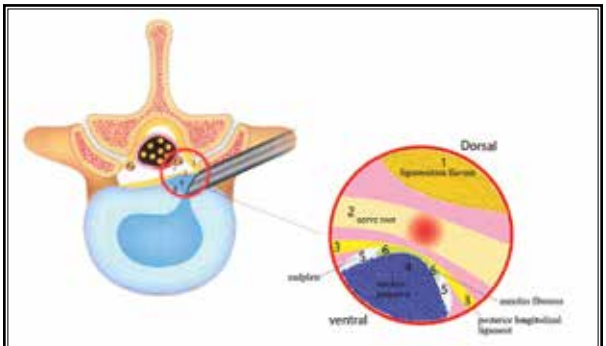

Fig. 5. *Concise schematic diagram of tissues seen under endoscope in the TF-PELD surgery.*

Fig. 6. *Tissues seen under endoscope in the TF-PELD surgery.*

Conclusions

When tissues such as ligamentum flavum, dural sac, nerve root, posterior longitudinal ligament, annulus fibrosus, and endplate are exposed, removed, and decompressed in the PELD surgery, patients will experience different kinds of pain, of which the dural sac/nerve root and longitudinal ligament are particularly obvious.

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