Percutaneous Endoscopic Lumbar Discectomy for Far Lateral L5/S1 Disc Herniation With High Iliac Crest

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Research article

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Abstract

Background: To investigate the effect of percutaneous endoscopic lumbar discectomy (PELD) via a modified posterolateral approach on far lateral lumbar disc herniation (FLLDH) at L5/S1 level with high iliac crest.

Methods: This retrospective study recruited the patients diagnosed of FLLDH at L5/S1 level with high iliac crest and accepted PELD in our hospital from March 2016 to November 2019. The visual analogue scale (VAS), Oswestry disability index (ODI), and modified Japanese Orthopaedic Association (M-JOA) scores were recorded before and after surgery. The fractional anisotropy (FA) values were recorded before and after operation. The incision length, operation duration, intraoperative blood loss, hospital stay and complications were observed. The excellent and good rate was calculated at final follow-up.

Results: A total of 17 patients, including 10 males and 7 females, were screened and enrolled in this study. The mean incision length, operation duration, blood loss and hospital stays were 0.74 ± 0.058 cm, 55.64 ± 8.635 minutes, 27.42 ± 4.936 ml, and 3.74 ± 1.052 days, respectively. The postoperative VAS scores decreased, the ODI and M-JOA scores, and FA values of nerve root at affected side increased significantly ($p < 0.05$), compared with those at pre-operation, but no difference was observed among the postoperative scores ($p > 0.05$). The complications rate was 5.88% (1/17) and overall excellent and good rate was 94.12% (16/17) at the final follow-up.

Conclusions: PELD via a modified posterolateral approach was an effective, minimally invasive and safe technique for FLLDH at L5/S1 level with high iliac crest.

Background

Far lateral lumbar disc herniation (FLLDH), also called extraforaminal lumbar disc herniation, is a special type of lumbar disc herniations (LDHs) and firstly described by Abdullah in 1974 [1]. It consists of foraminal and extraforaminal LDHs, and accounts for 0.7%~11.7% of all LDHs [2, 3]. The pathogenesis of FLLDH is different from that of intraspinal central or paracentral disc herniations. It compresses the dura and traversing nerve root, producing directly mechanical compression and/or inflammatory stimulation to the nerve root and causing severe radiation pain in the corresponding nerve-dominant area on the lower extremity [4]. FLLDH usually was irresponsible to completely conservative treatments and needed surgical interventions [5]. Surgical techniques had ranged from a conventional posterior laminectomy to minimally invasive approaches, of which percutaneous endoscopic lumbar discectomy (PELD) was employed widely and achieved good clinical effects [6–10]. Of FLLDHs, approximately 43% occurred at L5/S1 [11] and PELD via the conventional transforaminal route was challenging, especially in the patients with a high iliac crest, a hypertrophic fifth transverse process, and prominent sacral ala [12]. Some researchers introduced a transiliac approach to manage LDH at L5/S1 level, and it could directly create a working channel near the target site [13, 14]. However, the transiliac approach required a relatively long operative duration, and could cause fracture of the ilium and severe and uncontrollable

bleeding. Herein, in this study, we performed PELD via a modified posterolateral approach to treat FLLDH patients at L5/S1 with high iliac crest and observed their clinical efficacy.

Methods

Subjects

Medical records of the patients diagnosed of FLLDH and accepted PELD in our hospital from March 2016 to November 2019 were collected. Inclusion criteria were as follows: (1) patients complaining about lower extremity or/and low back pain; (2) positive Lasegue sign; (3) isolated FLLDH at L5/S1 confirmed on magnetic resonance imaging (MRI) and diffusion tensor imaging (DTI); (4) patients with high iliac crest defined by Choi et al. [14] as the iliac crest was above the middle of L5 pedicle in lateral radiography (Fig. 1) ; (5) symptoms corresponding to radiological findings; (6) failure to at least 3-month conservative treatments. The exclusion criteria included: (1) patients with severe organ dysfunctions or hemorrhagic tendency; (2) vertebral infection or tumor; (3) spinal operation history at the same segment; (4) lumbar spondylolisthesis more than grade II or obvious lumbar instability; (5) severe lumbar spinal stenosis. In accordance with the above inclusion and exclusion criteria, a total of 17 patients were enrolled in this study, which was approved by the Ethics Committee of the First Affiliated Hospital of Nanjing Medical University.

Surgical technique

All the operations were performed by the corresponding author and his group members. Patient was placed in a prone position with hips and knees flexed on the Jackson table and abdomen was kept vacant. Following routine sterile preparation and draping, 1% lidocaine was utilized for local infiltration anesthesia. The skin entry point was 6-7 cm lateral to posterior midline in the disc plane and the target position was the triangle compassed by sacral ala, L5 transverse process and S1 superior articular process (SAP) (Fig. 2). When the position was confirmed in the light of fluoroscopic guidance, the endoscope was located after the withdrawal of obturator and guidewire, then the procedure continued under direct visualization with constant irrigation with normal saline. When SAP became a barrier on the way to disclose injured nerve root, it would be resected with a high-speed diamond burr under direct visualization (Fig. 3). After the compressed nerve root was exposed and gently retracted, the protruded disc fragment was detected and removed with forceps. While completely decompressed, the affected nerve root was checked carefully for being freely movable with Valsalva maneuver. A flexible radiofrequency bipolar probe was employed for hemostasis, ablation of the nucleus pulposus, and closure of the annulus fibrillar cleft. Finally, the working cannula was carefully retracted, skin was closed with a single suture, and the incision was covered with sterile dressing.

Postoperative care

Antibiotic was given once to prevent infection. All patients were required to lie on bed for at least 6 hours and were allowed to walk with the assistance of the waist brace afterwards. Heavy lifting was prohibited

and rehabilitation exercises were encouraged. All patients were requested to return to outpatient for subsequent visits at postoperative 3 and 12 months.

Assessments

The VAS, ODI, and M-JOA scores were recorded before operation and at postoperative 1 day, 7 days, 3 and 12 months. The fractional anisotropy (FA) values were also recorded before and at 3 months after operation. The mean incision length, operation duration, intraoperative blood loss, hospital stay and complications were observed. The excellent and good rate was calculated at the final follow-up according to the modified MacNab criteria [15].

Statistical analyses

The quantitative data were presented as mean $\pm$ standard deviation. ANOVA was employed to compare dynamic changes in the VAS, ODI, and M-JOA scores before and after operation. Student's *t* test was used in comparison of the Fractional anisotropy (FA) values at pre- and post-operation. The SPSS 21.0 software package (SPSS Inc., Chicago, IL, USA) was used for statistical analyses and difference of results was considered significant at $p \leq 0.05$.

Results

Baseline characteristics of the patients

A total of 17 patients, including 10 males and 7 females, were screened and enrolled in this study. The average age and duration of symptoms were 57.63 ± 15.830 years (range, 26–84 years) and 2.25 ± 2.152 months (range, 1–10 months). The mean follow-up period was 20.34 ± 3.958 months (range, 12–35 months).

Clinical outcomes

The mean incision length and operation duration were 0.74 ± 0.058 cm and 55.64 ± 8.635 minutes, respectively. The blood loss was 27.42 ± 4.936 ml and the average hospital stays were 3.74 ± 1.052 days. The postoperative VAS scores fell and ODI and M-JOA scores rose significantly, compared with pre-operative data ($p \leq 0.05$), but no difference was observed among the postoperative scores ($p \leq 0.05$), as shown in table 1. The FA value of nerve root at injured side was lower than that at unaffected side and significantly increased from preoperative 0.250 ± 0.0296 to postoperative 0.339 ± 0.0314 ($p \leq 0.05$), as shown in the table 2. Herniation recurrence occurred to one patient, and no other complications were observed during the whole follow-up period. The overall complications rate was 5.88% (1/17). At the final follow-up, the excellent and good rate was 94.12% (16/17).

Table 1
Pre- and post-operative clinical scores (mean $\pm$ SD)

	Pre-operation	Postoperative 1d	Postoperative 7d	Postoperative 3 m	Postoperative 12 m
VAS score	7.76 $\pm$ 0.562	0.94 $\pm$ 0.899*	1.41 $\pm$ 0.507*	0.95 $\pm$ 0.659*	1.02 $\pm$ 0.612*
ODI score	38.06 $\pm$ 1.345	12.53 $\pm$ 1.068*	14.24 $\pm$ 1.251*	12.43 $\pm$ 0.874*	13.09 $\pm$ 2.031*
M-JOA score	10.24 $\pm$ 1.091	25.29 $\pm$ 0.920*	24.59 $\pm$ 0.870*	25.94 $\pm$ 0.748*	25.35 $\pm$ 1.169*
* $p < 0.05$ vs. pre-operation. VAS: visual analogue scale, ODI: Oswestry disability index, M-JOA: modified Japanese Orthopedic Association					

Table 2
Pre- and post-operative FA values (mean $\pm$ SD)

	Pre-operation	Postoperative 3 m	t value	p value
injured side	0.250 $\pm$ 0.0296	0.339 $\pm$ 0.0314	-8.489	< 0.001
unaffected side	0.357 $\pm$ 0.0252	0.355 $\pm$ 0.0364	0.164	0.871
t value	-4.002	-1.868		
p value	0.001	0.071		
FA: Fractional anisotropy				

Discussion

Once FLLDH was suspected according to the clinical manifestations, physical and radiological examinations ought to be adopted subsequently. Manual muscle testing, sensory testing, supine straight-leg raising, Lasegue sign, and crossed Lasegue sign were recommended for diagnosis [16]. However, FLLDH was prone to be ignored on conventional sagittal and axial MRI scans because the extrusion was not intracanal. DTI has been proven to be an effective tool to locate injured nerve roots at the very early time [17, 18]. Conservative treatment for FLLDH with only 10% success rate was reported,⁵ and surgical intervention was necessary.

PELD, with the advantages of minimal injury, postoperative pain relief, short hospital stays, and early return to daily life or work, has been widely used to manage FLLDH. Jang et al. [19] applied PELD to 35 patients with FLLDH. The mean VAS improved from 8.6 before operation to 3.2 after operation, and 30 patients (85.7%) obtained excellent results. Cho et al. [20] utilized PELD in 41 patients with FLLDH, with an average follow-up of 34.1 months, and the excellent and good curative effect rate was 92%. Fifteen

patients diagnosed with FLLDH underwent PELD in the study conducted by Liao et al. [10] gained an overall excellent and good rate of 93.3%. Ren et al. [21] concluded that PELD had a shorter operation time and less surgical trauma, being a less invasive and more economical method for middle-aged and elderly FLLDH patients. A research conducted on 22 patients with FLLDH at the L5-S1 level and treated by PELD also revealed that overall excellent or good outcomes were 81.8 % [22].

Nevertheless, when FLLDH was at L5/S1 level, even at L4/5 level in some patients, due to the presence of high iliac crest or/and transverse process hypertrophy, it was difficult to insert the working canula of PELD [23, 24]. Choi et al. [12] retrospectively evaluated 100 consecutive patients underwent PELD via the transforaminal route for L5/S1 disc herniation and concluded that conventional transforaminal access could be utilized with ease in low iliac crest cases where the iliac crest was below the mid-L5 pedicle in lateral radiography. Therefore, some other approaches ought to be considered to be treatment choices for FLLDH patients with high iliac crest. In 2009, Choi et al. [14] first created a transiliac approach to treat a 51-year-old man manifested left gluteal and leg pain due to an up-migrated soft disc herniation at the L4/5 level and achieved complete decompression of the nerve root Bai et al. [11] also employed a transiliac approach in 19 patients and described the safety and clinical efficacy of the technique. They achieved good clinical outcomes. However, no obvious anatomical positioning mark on the ilium surface could be used to locate the vessels superior gluteal artery and other blood vessels accurately, which could lead to severe and uncontrollable bleeding. Besides, the working channel mobility was determined by the diameter of the hole in ilium, while big hole could cause fracture of the ilium.

In 2016, Chun et al. [4] reported a modified PELD technique for one case of FLLDH at L5/S1 level. Based on the preoperative MRI, the skin entry point was closer (9 cm) and the angle of needle insertion was steeper (42°) than those of traditional transforaminal approach (10 – 13 cm, 25 – 30°). The final target point for introducing the spinal needle was the medial pedicular line on the anteroposterior image and the posterior vertebral line on the lateral image. At consecutive follow-ups, the patient continued to report complete pain relief. In 2018, Yang et al. [25] introduced another modified PELD technique to remove extraforaminal disk herniation at the L5/S1 segment. The distance from possible skin entry points to midline varied from 33.28 to 84.18 mm. Clinical symptom relief after surgery was obtained, while no neurologic deficit or surgical site infection occurred.

The modified posterolateral PELD technique in our study was similar to that described by Yang et al. The skin entry point was 6–7 cm lateral to posterior midline in the disc plane and the needle insertion angle was about 20°. The target position was the triangle compassed by sacral ala, L5 transverse process and S1 SAP. The mean incision length was 0.74 cm, operation duration was 55.64 minutes, the blood loss was only about 27.42 ml and hospital stays were less than 4 days. During the follow up, the postoperative VAS and ODI scores dropped while M-JOA scores grew significantly, comparing with those at pre-operation. FA, based on DTI, is a parameter of anisotropic strength. The FA value of the compressed nerve root tended to lower than that of the normal nerve root and could be an indicator for injured nerve root [18, 26, 27]. In our study, the FA value of nerve root at affected side at post-operation was higher than that at pre-operation, which was consistent with the dynamic change of clinical scores,

further indicating an effective relief of symptoms. At the final follow-up, the overall excellent and good rate was 94.12%. Above results demonstrated that PELD via a modified posterolateral approach was an effective and minimally invasive choice for FLLDH at L5/S1 with high iliac crest.

In this study, only one patient suffered from recurrent herniation and the overall complication rate was 5.88% (1/17), which was approximately to 3.6%-7% reported by several literatures [28, 29], probably because of the small diameter of the working channel and limited operation window. While the protruded nucleus pulposus was eliminated, the remaining nucleus fragment could herniate through the breach, so it was recommended that the working canula should be appropriately rotated to detect and remove residual nucleus pulposus as fully and widely as possible to reduce the recurrence rate. No other complications, such as neurologic deficit, surgical site infection and cerebrospinal fluid leakage were detected. Above results suggested that PELD via a modified posterolateral approach was safe for FLLDH at L5/S1 with high iliac crest.

PELD could be performed under local anesthesia, and the effective doctor-patient interaction during the operation produced a positive significance for avoiding nerve root damage. Furthermore, the posterior spinal structure was better preserved, which generated little effect on the stability of the spine and permitted early straight exercises. The operation field was clear under constant irrigation with normal saline, which also limited blood loss. Finally, the spinal canal was free to be invaded to avoid interference or accidental injury to the dura sac and nerves.

However, there were some limitations in our study. This was a retrospective study and lack of strict double-blind randomized control. The sample size was relatively small, and the follow-up period was relatively short. The learning curve of PELD remained steep and mass practice was required to avoid iatrogenic injuries.

Conclusion

Taken together, PELD via a modified posterolateral approach was an effective, minimally invasive and safe technique for FLLDH at L5/S1 level with high iliac crest.

Abbreviations

PELD: Percutaneous endoscopic lumbar discectomy; DTI: Diffusion tensor imaging; LDH: Lumbar disc herniation; FLLDH: Far lateral lumbar disc herniation; VAS: Visual analogue scale; ODI: Oswestry disability index; M-JOA: modified Japanese Orthopaedic Association; FA: Fractional anisotropy; SAP: Superior articular process.

Declarations

Ethics approval and consent to participate

The procedure was approved by the ethical committee of The First Affiliated Hospital of Nanjing Medical University. Before operation, all patients were explained the treatment process in detail and signed the informed consents.

Consent for publication

Not applicable.

Availability of data and materials

All data generated during this study are included in this published article.

Competing interests

The authors declare that they have no conflict of interest.

Funding

Not applicable.

Authors' contributions

Qirui Ding and Yongxin Ren contributed to the conception and design of the study. Cheng Ma and Feng Zhao contributed to the acquisition of data. He Li, Lijia Liu and Yifan Wei contributed to the analysis and interpretation of data. Qirui Ding and Haonan Qin contributed to the drafting of the manuscripts. Yongxin Ren is responsible for the critical revision of the manuscript for important intellectual content. All authors read and approved the final manuscript.

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Figures

Figure 1

Characters of high iliac crest on plain films. (A) The highest point of the iliac crest was above L5 pedicles (red line and white circle) on anteroposterior plain film. (B) The highest point of the iliac crest was above upper endplate of L5 vertebral body (white curve) on lateral plain film.

Figure 2

Establishment of working channel. (A) In the lateral view, the cannula is landed at the posterior and inferior edge of L5 vertebral body. (B) In the anteroposterior view, the cannula is docked at triangle compassed by sacral ala, L5 transverse process (TP) and S1 superior articular process (SAP). (C) Schematic drawing of target position (blue triangle). NR: nerve root.

Figure 3

SAP resection. (A) Endoscopic view of resected SAP and herniated disc. (B-C) Coronal reconstruction of preoperative and postoperative CT scans showed the intact (blue ring) and resected S1 SAP (white arrow).

Figure 4

Typical case. A 36-years-old man complained about pain and numbness on the left lower limb for 1 month. VAS score was 8, ODI score was 32 and M-JOA score was 13 when admitted. He was diagnosed of FLLDH at L5/S1 level with high iliac crest and accepted PELD via modified posterolateral approach. Preoperative sagittal (A) and axial (B) MRI showed protruded disc (yellow arrow). DTI (C) showed apparent compression of the left L5 nerve roots and local nerve fiber bundles were sparse (blue arrow). Sagittal (D) and axial (E) MRI at postoperative 3 months. DTI (F) revealed excellent recovery of nerve fiber bundle morphology and no obvious sparse fiber bundle was observed.