

# Percutaneous Endoscopic Lumbar Discectomy for Treating Cauda Equina Syndrome Due To Lumbar Disc Herniation

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## Research article

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# Abstract

## Background

In recent decades, endoscopic techniques to treat lumbar disc herniation (LDH) have gained popularity in clinical practice. However, there is little literature on the use of percutaneous endoscopic lumbar discectomy (PELD) to treat cauda equina syndrome (CES) due to LDH. This study aims to evaluate the feasibility and clinical efficacy of PELD for treating CES caused by disc herniation, and as well as to report some technical strategies.

## Methods

Between October 2012 and April 2018, 15 patients with CES caused by LDH at the early and intermediate stages of Shi's classification were selected as the subjects of study, and underwent PELD. All patients were followed up for at least two years. The patients' back pain and leg pain were evaluated using visual analogue scale (VAS) scores and the Oswestry Disability Index (ODI). Patient satisfaction was evaluated using the MacNab outcome scale. Clinical outcomes were measured preoperatively and at 3 days, 3 months, 6 months and the last follow-up.

## Results

The VAS score for back pain, leg pain and ODI score significantly decreased from preoperatively scores of  $6.67 \pm 1.05$ ,  $7.13 \pm 1.19$  and  $62.0 \pm 6.85$  respectively, to postoperatively cores of  $1.80 \pm 0.41$ ,  $1.47 \pm 0.52$  and  $12.93 \pm 1.03$  at the last follow-up postoperatively. These postoperative scores were all significantly different compared with preoperative scores ( $P < 0.01$ ). According to the modified MacNab outcome scale, 86.67% of these patients had excellent and good outcomes at the final follow-up. Complications included one patient with cerebrospinal fluid leakage and one patient who developed recurrent herniation; the latter patient finally achieved satisfactory results after reoperation.

## Conclusion

PELD could be used as an alternative surgical method for the treatment of CES due to LDH in properly selected cases and appropriate patient selection. However, the operator should pay attention to foraminoplasty to enlarge the working space.

## Background

Cauda equina syndrome (CES) as a rare consequence of lumbar disc herniation was first reported in 1929 by Dandy Walter [1]. Resulting from the compression of the cauda equine, a critical feature of CES is autonomic dysfunction [2]. Clinical symptoms of CES include back pain, saddle anaesthesia, unilateral or

bilateral sciatica, and motor weakness of the lower extremities, with bladder and bowel dysfunctions [3]. Reportedly, the incidence rate of CES ranges from 1/33,000 to 1/100,000 in general populations, and CES occurs in approximately 2% of all patients with lumbar disc herniation [4].

Based on resultant dysfunctions, CES can be classified as incomplete or complete CES, and the recovery rate of bladder and bowel functions after decompression surgery was higher in patients with incomplete CES than that with complete CES [5]. Upon clinical symptoms and physiological dysfunction, in clinical practice CES can also be classified as preclinical, early, middle, or late stage [6]. For early and middle stage CES, nerve root decompression should be performed as early as possible to save neurological functions. Laminectomy and discectomy are the routine procedures for treating CES, and a few have used micro-discectomy [7]. Laminotomy and hemilaminectomy, as prior to micro-discectomy, usually are not recommended, as such procedures have to considerably retract the thecal sac during decompressing and thus may further damage the nerve roots [8]. A sufficiently wide laminectomy and extensive decompression of the nerve roots are regarded as the keys for a successful surgery for treating CES [4,5,9,10,11].

Recently, minimally invasive surgeries are routine procedures in spine practice to minimize surgical tissue damage. Percutaneous endoscopic lumbar discectomy (PELD) is such a minimally invasive technique that can deal with most cases of lumbar disc herniation. PELD has been reported as an alternative procedure for treating CES secondary to disc herniation, and preliminary results showed that endoscopic discectomy is safe and efficacious for treating CES due to disc herniation [12,13]. Yet, some other scholars did not recommend PELD for treating CES, as such a minimally invasive procedure potentially is risky and may deteriorate neurological deficits, particularly in unsophisticated hands [14]. The purposes of this case series are to further assess the feasibility, safety, and clinical efficacy of PELD for treating CES due to LDH, and as well as to report some technical strategies.

## **Materials**

### **Clinical data**

This is a perspective clinical case series study to investigate the clinical efficacy of PELD in treating CES due to LDH. The study was approved by the ethical committee at the author's institute, and each patient signed an informed consent. PELD is a routine technique for the author's team to treat symptomatic lumbar disc herniation since 2012.

Each LDH patient who consulted our surgical team was carefully evaluated for the presence or absence of CES. CES was established upon main complains, physical examinations, and lumbar spine magnetic resonance (MR) imaging. If present, the case was further classified as preclinical stage (low back pain with only bulbocavernosus reflex and ischiocavernosus reflex abnormalities), early stage (saddle sensory disturbance and bilateral sciatica), intermediate stage (saddle sensory disturbance, bowel or bladder dysfunction, motor weakness of the lower extremity, and reduced sexual function), or late stage (absence

of saddle sensation and sexual function in addition to uncontrolled bowel function) using Shi's approach [6]. For CES case at early or middle stage, the team discussed the advantages and disadvantages of PELD and traditional open laminectomy with the patient. PELD or open laminectomy therefore was selected by the patient, depending on his or her own preference and demands.

Inclusion criteria were: 1) patients with early or middle stage CES, which was attributable to a herniated lumbar disc; 2) with preoperative and follow-up radiological studies, including X-ray, CT, and MR images; 3) treated with PELD.

Exclusion criteria were: 1) Chose open laminectomy or hemilaminectomy; 2) complete CES; 3) lumbar instability, as reflected on dynamic lumbar spine radiographs; 4) CES due to other pathologic conditions, such as canal stenosis, spinal tumours, or infection.

Before for surgery, back pain and leg pain were evaluated using visual analogue scale (VAS) and the Oswestry Disability Index (ODI). Neurological examinations were carefully performed to evaluate the physical functions of the cauda equine. A throughout radiological assessment of X-ray, CT, and MR images were performed to establish the diagnosis of clinical lumbar disc herniation and CES. For all cases, PELD procedure was performed as an emergency surgery.

## **Surgical techniques**

The patient was placed in a lateral position and transforaminal PELD was performed under local anaesthesia. PELD was performed using a transforaminal endoscopic system (Jiomax, Germany) and a radio-frequency electrode system (Ellman, USA). With fluoroscopy, percutaneous puncture was performed and a guide needle was placed. The ideal puncture needle point was between the spinous process and medial margin of the vertebral arch on the anteroposterior radiology, and at the upper edge of the inferior vertebral body on the lateral radiology. The needle was adjusted according to location of the herniated disc.

Foramenoplasty is a key step for a successful and safe decompression in CES cases. Under fluoroscopy, the superior articular process was partially removed with an red biggest eccentric trepan to expand the intervertebral foramen. A tip for this maneuver is pushing the head of the circular saw as far dorsal as possible. We usually perform once or twice foramenoplasties to sufficiently enlarge the target foramen for safe decompression.

Then, a working cannula was placed along the guide rod. Elements of an endoscopy were connected and endoscopic discectomy was performed, including complete removal of the protruded intervertebral disc, decompression of the nerve root, as well as intradiscal electrothermal annuloplasty. During the procedure, the patient was repeatedly asked if there is any aggravation of neurological symptoms. When the patient's self-feeling symptoms were better, and the dural sack and nerve roots beat well after decompression, the endoscope was pulled out and the wound sutured (Figs. 1 and 2).

## **Postoperative care**

The patients had bed resting for 6 hours after the surgery and then were encouraged to get up. Bending and weight-bearing activities were avoided within 6 weeks after surgery, and excessive physical activity and strenuous physical exercise were avoided within 3 months.

## **Efficacy evaluation**

Clinical outcomes were evaluated using VAS and Oswestry Disability Index (ODI) [15] at 3 days, 3 months, and 6 months after surgery, and at the last follow-up. The recovery of lumbar function after surgery was evaluated using the modified MacNab score [16] at the final follow-up. The patients were followed for 2 years or more.

## **Statistical analysis**

Data are expressed as mean  $\pm$  standard deviation (SD). Statistics were performed using SPSS (version 22.0, USA).  $P < 0.05$  was considered statistically significant.

## **Results**

Between October of 2012 and April of 2018, there were more than 1300 patients with LDH at the authors' institute. There were 22 patients with CES, in which 4 patients at late stage and 3 patients at intermediate stage underwent open laminectomy, occurs in approximately 1.7% of all patients with LDH. There were 10 at the early stage and 5 at the intermediate stage, who met the inclusion criteria and were included in this study.

There are 9 men and 6 women, with an average age of  $39.73 \pm 10.54$  years (range 24 to 58 years). Lumbar disc herniation occurs at L5/S1 in 10 patients, and at L4/5 spinal level in the other 5 patients.

### **Clinical Outcomes**

PELD surgery was finished for all the 15 CES patients, and none was transformed to open surgery. The average surgery time was  $106.67 \pm 10.43$  minutes (ranged 90–120 minutes), and hospital stay ranged from 3 to 5 days. Each patient was followed up for 2 years or more.

One patient had CSF leakage after surgery, and was cured by enhancing the incision. Another patient developed recurrent disc herniation 5 months later and was re-operated with PELD and acquired satisfactory results after the second surgery. No other complication was observed in this case series.

The back pain, limb pain and ODI scores were significantly improved after PELD (Table 1). For all patients, neurological functions immediately improved to some degrees after surgery. At last follow-up, residual saddle sensory disturbance and bladder dysfunction remained in two patients, though their radicular pain was relieved. At the last follow-up, the modified MacNab score was excellent in 8 cases, good in 5 cases, fair in 2 cases. After 2 years, the overall excellent and good rate for PELD in treating CES due to lumbar disc herniation was 86.7%.

**Table 1.** Changes of clinical outcomes after PELD surgery in 15 cases with CES due to lumbar disc herniation

Time of evaluation	VAS and ODI score (mean±SD)		
	Back pain	Leg pain	ODI
Before surgery	6.67±1.05	7.13±1.19	62.0±6.85
3 days after surgery	3.27±0.96*	2.93±0.80*	
3 months after surgery	2.73±0.46*	2.60±0.51*	18.80±4.06*
6 months after surgery	2.40±0.51*	2.20±0.56*	17.73±4.13
last follow-up (2-year)	1.80±0.41*	1.47±0.52*	12.93±1.03*

\*:  $P < 0.01$ , as compared with that before PELD surgery. PELD: percutaneous endoscopic lumbar discectomy; CES: cauda equina syndrome; SD: standard deviation.

## Discussion

CES is a rare but serious condition, defined as “a spectrum of low back pain, uni-or bilateral sciatica, saddle anaesthesia and motor weakness in the lower extremities with variable rectal and urinary symptoms” [17]. Different stages of CES show different clinical characteristics and should be treated differently. For patients with CES at the late stage, wide laminectomy may be the first choice for those patients. Patients at the preclinical and early stages have better functional recovery than patients in later stages after surgical decompression [6]. Surgical goals are to relieve local compression as soon as possible to reduce the degeneration and death of sensory neurons in the ganglia. However, traditional surgery usually brings relatively large trauma to patients and may also damage the patient's spinal stability, which in turn increased the risks for posterior spinal fusion rate as well as morbidity and rehabilitation needs. Reducing surgical trauma and maintaining the integrity and stability of the spine are challenges in the treatment of LDH. With the rapid development of modern spine surgery technology, PELD has gained popularity in clinical practice. Cong et al. [18] pooled results comparing endoscopic discectomy versus open microdiscectomy and found a significantly higher satisfaction rate in patients who underwent endoscopic discectomy. Recent meta-analyses and systematic reviews have reported that transforaminal PELD is comparable or superior to conventional open discectomy in terms of its effectiveness and minimal invasiveness for soft LDH [19]. PELD is a minimally invasive surgery under local anaesthesia, known as endoscopy, and provides huge expectancies for the treatment of CES. Li X et

al. [12] reported that PELD could be used as an alternative surgical method for the treatment of CES in properly selected cases.

In this study, we only took patients with CES at the early and middle stages according to Shi's classification as the subjects of study. Unlike the Li X study, all of our patients were treated with PELD by a transforaminal lumbar approach. The good and excellent outcome of PELD in our study was 86.67%, corresponding closely to the results of previous studies of conventional open surgery for incomplete CES. These 15 patients with CES treated with PELD techniques under local anesthesia showed that such a procedure is safe and effective.

In fact, patients with disc herniation related CES often have a large volume of herniated lumbar disc materials. If the surgeon does not have sophisticated surgical skills, it is likely that the free nucleus pulposus is not completely removed or a serious nervous injury may occur during the surgery. In this study, the modified MacNab score was fair in 2 cases at the last follow-up. The main reason is considered that the foraminoplasty was not insufficient, and the working cannula was inserted into the spinal canal to further squeeze the nerve, resulting in the aggravation of transient nerve compression during the operation.

Therefore, we need to elaborate the technical details of endoscopic treatment of CES. In the transforaminal lumbar approach, the extent of disc herniation, degree of migration, severity of adhesion, softness of the herniated disc, location of exiting nerve root, risk of dural tear, and concurrent spinal stenosis should be evaluated first. The landing on the disc should be as near as possible to the target and as far as possible from the exiting nerve root, which is the first key to surgical success. Second, we should have performed sufficient foraminoplasty by using an red biggest eccentric trepan, different from the traditional TESSYS step-by-step foraminoplasty, to avoid further compression of the nerve root by the placement of the working channel. This is the most important key point to ensure the success and excellent effect of PELD in the treatment of CES. Because disc herniation, which can cause CES, is huge, if the intervertebral foramen is not fully formed during the operation, it will cause iatrogenic nerve injury. Therefore, adequate lumbar foraminal plasty needs to be emphasize. Reasons for failed endoscopic surgery in CES include incomplete decompression, recurrent herniations, haematoma and cerebrospinal fluid leakage [20,21]. Recently, several authors have emphasized the significance of foraminoplasty [22,23]. Even during the operation, if considered necessary, foraminoplasty should definitely be performed again to enlarge the working space. Finally, the herniated fragment should be completely removed after an adequate release process, and the surgeon should not be in a hurry to directly remove the herniated fragment. We need to explore the ventral and dorsal sides of the nerve root and confirm that decompression is sufficient during the operation.

## Conclusion

According to our results, the lumbar pain, limb pain and ODI scores improved significantly after PELD, and the excellent and good rate was 86.67%. Based on our research, PELD is an effective and safe surgical

method for treating early or middle stage CES caused by lumbar disk herniations. In this study, we described the technical points, and clearly pointed out adequate foraminal plasty is the most important part of PELD in the treatment of CES. However, the sample of patients was relatively small, which could affect the results of this study. Further prospective studies comparing PELD with open surgery are required to evaluate the feasibility and safety of PELD in a large number of patients. And this study included only LDH at L4/5 and L5/S1, could the result of this study apply to CES caused by LDH at higher spinal levels is needed further research.

## **Abbreviations**

LDH

Lumbar disc herniation; CES:Cauda Equina Syndrome; PELD:percutaneous endoscopic lumbar discectomy; VAS:Visual analogue scale; MRI:Magnetic resonance imaging; CT:Computed tomography

## **Declarations**

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None

### **Availability of data and materials**

We declared that the materials described in the manuscript, including all relevant raw data, will be freely available to any scientist wishing to use them for non-commercial purposes, without breaching participant confidentiality.

### **Authors' contributions**

Hai-Chao He carried out the studies and drafted the manuscript. All authors participated in the design of the study and performed the statistical analysis. Xiao-qiang Lv and Yong-jin Zhang revised it critically for important intellectual content. All authors read and approved the final manuscript.

### **Ethics approval and consent to participate**

I confirm that I have read the Editorial Policy pages. This study is a retrospective study conducted with approval from the Ethics Committee of Affiliated Dongyang Hospital of Wenzhou Medical University. This study was conducted in accordance with the Declaration of Helsinki.

### **Consent for publication**

Written informed consent for publication of their clinical details and clinical images was obtained from the patient.

### Competing interests

The authors declare that they have no competing interests

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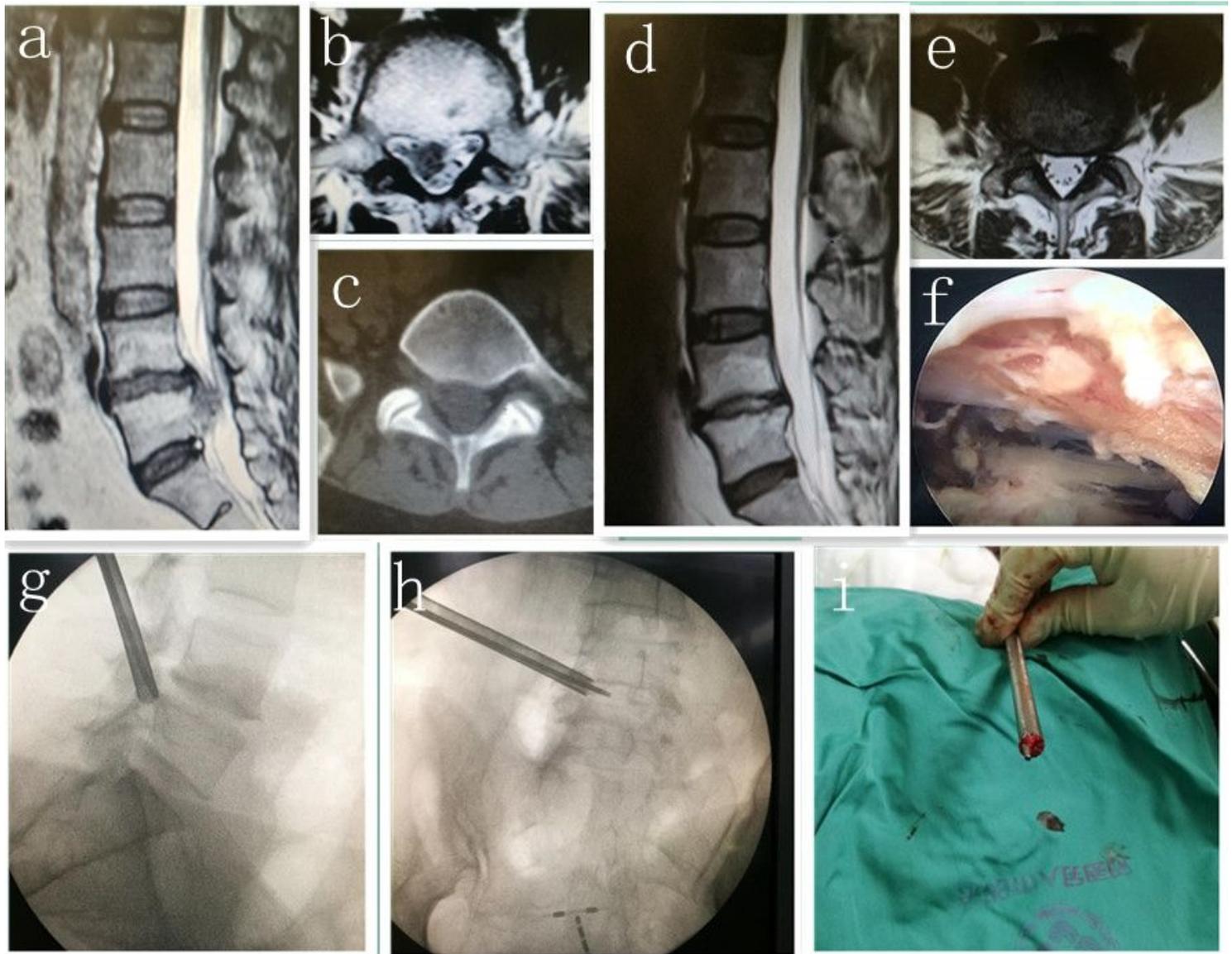
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## References

1. Dandy WE. Loose cartilage from intervertebral disk simulating tumor of the spinal cord. *Arch Surg*. 1929;19:660–672.
2. Heyes G, Jones M, Verzin E, Mclorinan G, Darwish N, Eames N. Influence of Timing of Surgery on Cauda Equina Syndrome: Outcomes at a National Spinal Centre. *J Orthop*. 2018;15:210–215.
3. Gardner A, Gardner E, Morley T. Cauda equina syndrome: a review of the current clinical and medico-legal position. *Eur Spine J*. 2011;20:690–697.
4. Gitelman A, Hishmeh S, Morelli BN, Joseph SA JR, Casden A, Kulik P, et al. Cauda equina syndrome: a comprehensive review. *Am J Orthop (Belle Mead NJ)*. 2008;37: 555–562.
5. Tamburrelli F C, Genitiempo M, Bochicchio M, Donisi L, Ratto C. Cauda equina syndrome: evaluation of the clinical outcome. *Eur Rev Med Pharmacol Sci*. 2014;18:1098–1105.
6. Shi J, Jia L, Yuan W, Shi G, Ma B, Wang B, et al. Clinical classification of cauda equina syndrome for proper treatment: a retrospective analysis of 39 patients. *Acta Orthop*. 2010;81:391–395.
7. Srikandarajah N, Wilby M, Clark S, Noble A, Williamson P, Marson T. Outcomes reported after surgery for Cauda Equina Syndrome: A Systematic Literature Review. *Spine (Phila Pa 1976)*. 2018;43:E1005-E1013.
8. Kapetanakis S, Chaniotakis C, Kazakos C, Papathanasiou J. Cauda Equina Syndrome Due to Lumbar Disc Herniation: a Review of Literature. *Folia Med (Plovdiv)*. 2017;59:377–386.
9. Chang HS, Nakagawa H, Mizuno J. Lumbar herniated disc presenting with cauda equina syndrome. Long-term follow-up of four cases. *Surg Neurol*. 2000;53:100–104; discussion 105.
10. McLaren AC, Bailey SI. Cauda equina syndrome: a complication of lumbar discectomy. *Clin Orthop Relat Res*. 1986;204:143–149.
11. Shapiro S. Medical realities of cauda equina syndrome secondary to lumbar disc herniation. *Spine (Phila Pa 1976)*. 2000;25:348 – 51; discussion 352.
12. Li X, Dou Q, Hu S, Liu J, Kong Q, Zeng J, et al. Treatment of cauda equina syndrome caused by lumbar disc herniation with percutaneous endoscopic lumbar discectomy. *Acta Neurologica Belgica*. 2016;116:185–190.

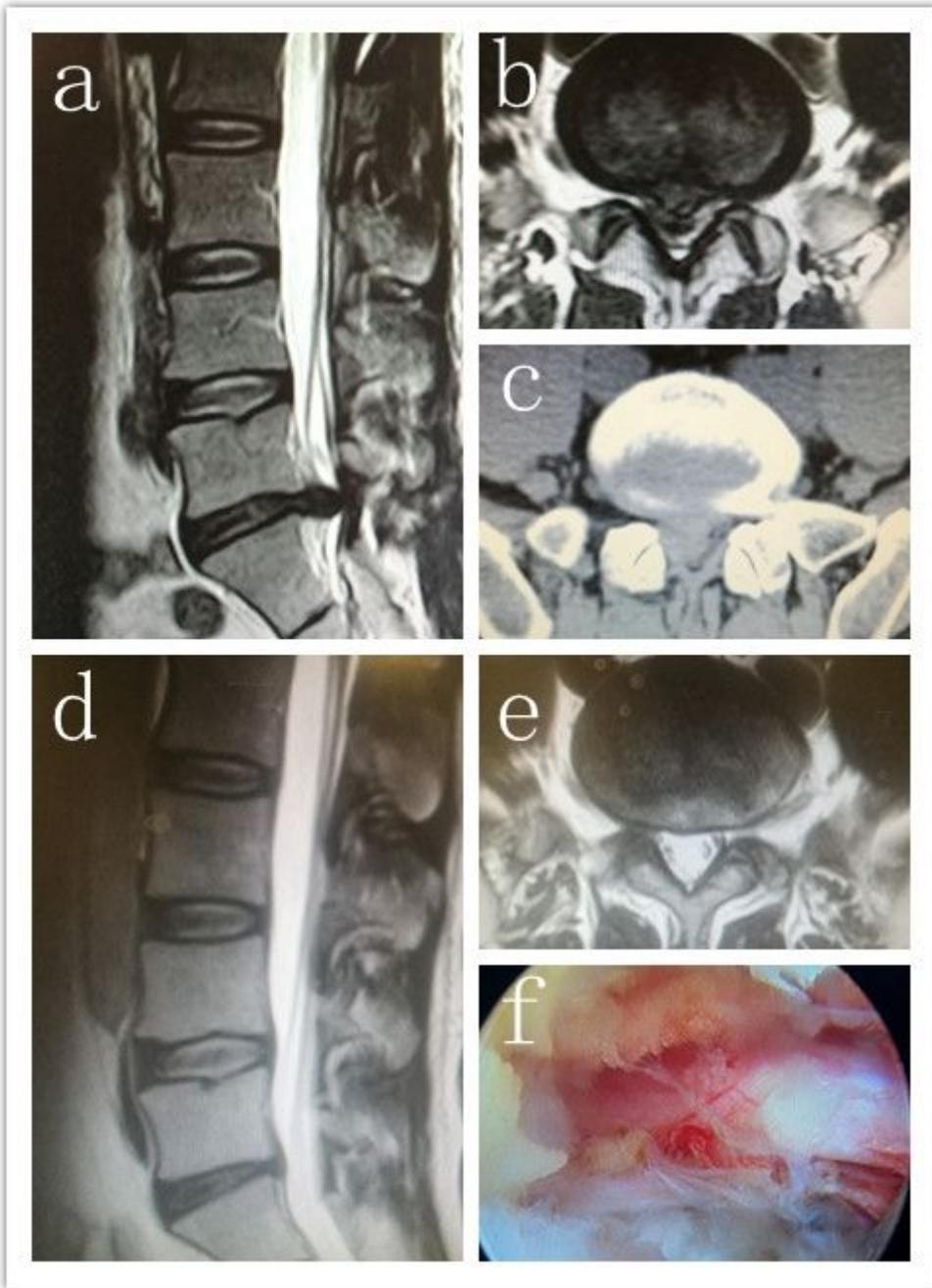
13. Kim HS, Kim SW, Lee SM, Shin H. Endoscopic discectomy for the cauda equina syndrome during third trimester of pregnancy. *J Korean Neurosurg Soc.* 2007;42:419–420.
14. Ahn Y. Endoscopic spine discectomy: indications and outcomes. *Int Orthop.* 2019;43:909–916.
15. Fairbank J C, Pynsent P B. The Oswestry Disability Index. *Spine(PhilaPa 1976).* 2000; 25:2940–2953.
16. MacNab I. Negative disc exploration. An analysis of the causes of nerve-root involvement in sixty-eight patient. *J Bone Joint Surg.* 1971; 53:891–903.
17. McCarthy MJ, Aylott CE, Grevitt MP, Hegarty J. Cauda equina syndrome: factors affecting long-term functional and sphincteric outcome. *Spine.* 2007; 32:207–216.
18. Cong L, Zhu Y, Tu G. A meta-analysis of endoscopic discectomy versus open discectomy for symptomatic lumbar disk herniation. *Eur Spine J.* 2016;25:134–143.
19. Ruan W, Feng F, Liu Z, Xie J, Cai L, Ping A. Comparison of percutaneous endoscopic lumbar discectomy versus open lumbar microdiscectomy for lumbar disc herniation: a meta-analysis. *Int J Surg.* 2016;31:86–92.
20. Gillard DM, Corenman DS, Dornan GJ. Failed less invasive lumbar spine surgery as a predictor of subsequent fusion outcomes. *Int Orthop.* 2014;38:811–815.
21. Cheng J, Wang H, Zheng W, Li C, Wang J, Zhang Z, Huang B, Zhou Y. Reoperation after lumbar disc surgery in two hundred and seven patients. *Int Orthop.* 2013; 37:1511–1517.
22. Choi KC, Shim HK, Park CJ, Lee DC, Park CK. Usefulness of Percutaneous Endoscopic Lumbar Foraminoplasty for Lumbar Disc Herniation. *World Neurosurg.* 2017;106:484–492.
23. Li ZZ, Hou SX, Shang WL, Song KR, Zhao HL. Modified Percutaneous Lumbar Foraminoplasty and Percutaneous Endoscopic Lumbar Discectomy: Instrument Design, Technique Notes, and 5 Years Follow-up. *Pain Physician.* 2017;20:E85-98.

## Figures



**Figure 1**

A 52-year-old female patient underwent PELD for disc herniations at L4-5 level. The preoperative MRI and CT scans showed lumbar disc herniation at the L4-5 level and dissociation to the caudal side (a-c). Postoperative MRI after 5 months (d, e) showing no disc herniation. Postoperative intraoperative endoscopic images showed that the nerve was completely relaxed and the protrusion was completely removed (f). Intraoperative C-arm showing the eccentric foraminoplasty with the first stage guide rod and biggest red circular saw to enlarge the working space (g, h). Photograph of the large bone fragment that had been removed with an eccentric trepan (i).



**Figure 2**

A 40-year-old male patient underwent PELD for disc herniations at the L5-S1 level. Preoperative MRI (a, b) and CT (c) scans demonstrating a huge herniation at the L5-S1 level. Postoperative MRI after 4 months (d, e) showing no disc herniation. Postoperative intraoperative endoscopic images showed that the nerve was completely relaxed and the protrusion was completely removed (f).