

# A Retrospective Study of Percutaneous Endoscopic Interlaminar Discectomy for L5-S1 Calcified Lumbar Disc Herniation

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## Research article

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## Abstract

**Background:** Calcified lumbar disc herniation (CLDH) is considered to be a special type of lumbar disc herniation (LDH). Percutaneous endoscopic interlaminar discectomy (PEID), with safety and efficacy, has been proved to be a minimally invasive surgery for LDH. However, there are few studies on PEID in the treatment of CLDH at L5-S1 level. This research aimed to analyze the clinical efficacy of PEID for L5-S1 CLDH.

**Methods:** From August 2016 to April 2020, we retrospectively analyzed 28 consecutive patients (17 males; 11 females) with L5-S1 CLDH treated with PEID at our institution. All the patients were followed up for greater than 1 year postoperatively. The demographic characteristics, surgical results and clinical outcomes estimated by the visual analog scale (VAS) for leg pain, Oswestry disability index (ODI) and modified MacNab criteria were collected.

**Results:** All patients were successfully performed by PEID. The mean operative time and intraoperative blood loss were  $65.36 \pm 5.26$  minutes and  $13.21 \pm 4.35$  ml, respectively. The VAS for leg pain and ODI scores improved remarkably from  $7.54 \pm 0.96$  to  $1.50 \pm 0.51$  ( $P < 0.05$ ) and from  $69.29 \pm 9.91$  to  $17.43 \pm 3.69$  ( $P < 0.05$ ) a year after operation, respectively. According to the modified MacNab criteria of the last follow-up, the excellent and good rates are 92.86%. Two of the patients had complications, one had nerve root injury and the other had postoperative dysesthesia.

**Conclusions:** PEID achieved good clinical outcomes in the treatment of L5-S1 CLDH. And PEID was a safe and effective minimally invasive surgery for L5-S1 CLDH.

## Background

Calcified lumbar disc herniation (CLDH) is considered as a special type of lumbar disc herniation (LDH). Baron was the first to report a case of intervertebral disc calcification in 1924[1]. However, the etiology of intervertebral disc calcification is still unclear. Calcified disc may be observed when the duration of LDH is greater than 6 months[2]. The main symptoms of CLDH include severe leg pain, lower limbs numbness and sometimes lower limbs weakness. More seriously, calcified disc may cause dural tear and nerve root injury[3]. The patients with CLDH should be treated via a surgical operation after the failure of conservative treatments such as drugs, bed rest and physical therapy.

Traditional open surgery, with the complete removal of calcified disc, the sufficient decompression of spinal canal and the loosen of nerve root, is often used to treat CLDH in clinic. Regardless of the satisfactory clinical outcomes, traditional open surgery has some drawbacks, including large tissue damage, long operation time, considerable blood loss, slow postoperative recovery, and even muscle denervation and atrophy[4]. Deyo et al[5] concluded that traditional open surgery may cause long-term complications such as spinal stenosis and spondylolisthesis.

Percutaneous endoscopic interlaminar discectomy (PEID), with a short incision, less trauma, little intraoperative blood loss and fast postoperative recovery, is a minimally invasive surgical procedure. PEID, with safety and effectiveness, has been proved to have the comparable clinical efficacy to traditional open surgery in the treatment of soft LDH[6,7]. However, PEID is difficult to treat CLDH because the calcified disc is hard and tightly adheres to nerve root and the dural sac. With the development of spinal endoscopic instruments such as ultrasonic osteotome, PEID is gradually used in the treatment of CLDH. However, there are few reports on PEID in the treatment of CLDH at L5-S1 level. The purpose of the research is to discuss the clinical efficacy of PEID for L5-S1 CLDH and provide clinical guidance for spinal surgeons.

## Materials And Methods

### General Information

From August 2016 to April 2020, 28 consecutive patients with L5-S1 CLDH underwent PEID at our institution. The informed consents of all patients were obtained before they were included in the study. The inclusion criteria included symptoms of pain and numbness of lower limbs, single-segment L5-S1 CLDH diagnosed by computed tomography (CT) and magnetic resonance imaging (MRI), failure of conservative treatments for greater than 3 months and the follow-up time for greater than 12 months. The exclusion criteria included noncalcified lumbar disc herniation at L5-S1 level, lumbar spinal stenosis, lumbar spondylolisthesis, lumbar tuberculosis, lumbar infection, spinal tumor. A percutaneous transforaminal endoscopic spine system (Joimax, Karlsruhe, Germany), ultrasonic osteotome (SMTp, China) and tip-flexible bipolar radiofrequency system (Ellquence LLC, USA) were used during operation.

### Surgical Procedure

The patient was placed on the operating table in the prone position, and the procedure was performed under general anesthesia. The operative segment was identified under fluoroscopic guidance. The entry point on the body surface was determined at 1.0 cm from the posterior midline. The puncture needle was inserted under fluoroscopic guidance, and the target position was the lateral edge of the interlaminar space. The guidewire, blunt dilator and working cannula were introduced in turn. After connecting and checking operating system, the operation was conducted under endoscopic visualization. Under the endoscope, the ligamentum flavum was cut by the scissor. After removing the fat from the epidural space, the nerve root and dural sac were exposed. The position of dural sac, compressed nerve root and herniated disc was defined before the removal of calcified intervertebral disc. Under the endoscope, the calcified disc was carefully removed with the ultrasonic osteotome (SMTp, China), and the herniated disc fragment was removed using the endoscopic forceps. Finally, no obvious compression of the nerve root and dural sac was observed under endoscopic visualization. The working cannula was removed after sufficient hemostasis. All patients underwent CT scans before (Figure 1A-B) and after (Figure 1C-D) operation.

### Measures

Demographic characteristics, including age, sex, body mass index (BMI), and follow-up time, were collected. Surgical outcomes, such as operative time, intraoperative blood loss, intraoperative fluoroscopy times, postoperative hospital stay and complications, were recorded. Clinical outcomes, including the visual analog scale (VAS)[8] for leg pain, Oswestry disability index (ODI)[9] and modified MacNab criteria[10], were investigated.

## Statistical Assessments

Clinical outcomes were statistically analyzed by the IBM SPSS Version 24 software (IBM Corporation, Armonk, New York, USA). The results were presented by mean and standard deviation (SD) values calculated from the data. Statistical analysis was carried out via repeated measures analysis of variance.  $P < 0.05$  indicated a statistically significant difference.

# Results

## Demographic characteristics and surgical outcomes

All patients underwent successfully PEID by the same experienced surgeon. We followed up all 28 patients (17 male and 11 female) for at least 12 months (range, 12–24 months). The demographic characteristics (age, sex, BMI and follow-up time) and surgical outcomes (the operative time, intraoperative fluoroscopy times, postoperative hospital stay and intraoperative blood loss) of all patients were shown in Table 1. The mean operative time, intraoperative fluoroscopy times, postoperative hospital stay and intraoperative blood loss were  $65.36 \pm 5.26$  minutes,  $2.96 \pm 0.88$  times,  $2.64 \pm 1.16$  days and  $13.21 \pm 4.35$  ml, respectively.

**Table 1**  
**Demographic characteristics and surgical outcomes of all patients**

| <b>Variables</b>   | <b>Value</b>     |
|--|------------------|
| Patients (number)  | 28               |
| Age (years)  | $38.61 \pm 8.79$ |
| Sex (male/female)  | 17/11            |
| BMI ( $\text{Kg}/\text{m}^2$ )                               | $25.03 \pm 3.27$ |
| Follow-up (months)   | $15.21 \pm 2.64$ |
| Operative time (minutes)                                     | $65.36 \pm 5.26$ |
| Fluoroscopy times (n)  | $2.96 \pm 0.88$  |
| Intraoperative blood loss (ml)                               | $13.21 \pm 4.35$ |
| Postoperative hospital stay (days)                           | $2.64 \pm 1.16$  |
| Complications  | 2 (7.14%)        |
| Values are mean $\pm$ SD, number, or as otherwise indicated. |                  |
| BMI, body mass index.  |                  |

## Clinical outcomes

The VAS scores of the all patients were ( $2.86 \pm 0.71$ ,  $2.46 \pm 0.51$ ,  $2.18 \pm 0.55$ ,  $1.71 \pm 0.53$ ,  $1.50 \pm 0.51$ ) at 1 day postoperatively, 1 month postoperatively, 3 months postoperatively, 6 months postoperatively, and 12 months postoperatively, which were significantly lower than those preoperatively ( $7.54 \pm 0.96$ ), with statistically significant differences ( $P < 0.05$  for all; Fig. 2A). The ODI scores of all patients were ( $23.93 \pm 3.98$ ,  $20.21 \pm 3.78$ ,  $17.43 \pm 3.69$ ) at 3 months postoperatively, 6 months postoperatively, and 12 months postoperatively, which were significantly lower than those preoperatively ( $69.29 \pm 9.91$ ), with statistically significant differences ( $P < 0.05$  for all; Fig. 2B). Based on the modified MacNab criteria at the last follow-up, 15 cases were excellent, 11 cases were good, 1 case was fair, and 1 case was poor. The excellent and good rates were 92.86% (Fig. 2C).

## Complications

In the study, one case had nerve root injury and one case had postoperative dysesthesia. The two patients recovered after conservative treatments. During the follow-up period, no complications such as dural tear, cerebrospinal fluid leakage, epidural hematoma or infection were observed.

## Discussions

CLDH, with a low incidence rate, is a relatively rare type of LDH. Although the pathogenesis is still uncertain, a study demonstrated that intervertebral disc calcification may be caused by some factors such as infection, trauma and blood supply disruption[11]. Intervertebral disc calcification is relatively rare in children, but more common in adults[12]. Some studies[13, 14] have shown that calcified disc herniation in children is usually treated conservatively, and calcified discs could even disappear spontaneously. However, the symptoms of adults are difficult to relieve or even worsen after conservative treatments such as non-steroidal anti-inflammatory drugs (NSAIDs), stay in bed, physiotherapy and epidural steroid injection[15, 16].

Some surgical techniques, with good clinical results, are applied to the treatment of CLDH[17–20]. Traditional open surgery, with complete removal of calcified disc, is the most commonly used surgical procedure. However, some complications of traditional open surgery, such as dural tear, cerebrospinal fluid leakage, incision infection, long-term chronic low back pain and spinal instability, still need to be widely concerned[5, 21, 22]. Some studies reported that percutaneous endoscopic transforaminal discectomy (PETD) was used to treat CLDH and achieved good clinical outcomes[23, 24]. Yu et al[25] reported that 25 CLDH patients were treated by PETD with ultrasonic osteotome. Unfortunately, they found that 7 patients had postoperative dysesthesia and 1 patient had recurrence of herniation. Shim et al[26] showed that PETD achieved a good clinical result in the treatment of CLDH. However, there were two serious complications of dural tear. The high incidence of complications seemed to be closely related to the variant anatomy of L5-S1, such as high iliac crest and intervertebral foramen stenosis. Moreover, PEID had a long and difficult learning curve, which limited the use of the procedure and increased the risk of surgical complications[27].

In this study, PEID combined with ultrasonic osteotome was performed to treat L5-S1 CLDH. The symptoms of all patients were relieved, and no serious complications occurred during the follow-up period. There is the natural advantage of a larger lamina space at L5-S1 level, but no the variant anatomy, such as high iliac crest or foraminal stenosis. Under endoscopic visualization, PEID can remove easily the calcified disc and release sufficiently the compressed nerve root with minimal damage to the nerve root and dural sac. The trephine may damage nerve root and dural sac when removing calcified disc[28]. Calcified intervertebral disc was safely and effectively removed with ultrasonic osteotome during operation in our study, which reduced the risk of nerve root injury and dural tear. Ultrasonic osteotome has some characteristics, such as tissue selectivity, anti-rolling, hemostasis and easy to handle[29–32]. According to our experience, the following points need to be emphasized. 1) The location and size of calcified intervertebral disc should be accurately evaluated by Preoperative X-ray, CT and MRI examinations. 2) A safe working area should first be created by removing epidural space fat and soft intervertebral disc. 3) A clear surgical view was ensured by timely and adequate hemostasis during operation. 4) violent separation, exposure and removal of the calcified disc could easily cause nerve root injury and dural tear because the calcified disc was hard and closely adhered to the nerve root and dural sac. Therefore, the calcified disc was carefully separated and exposed, and the nerve root and dural sac must be tracted gently during operation. 5) The purpose of procedure was to release the compressed

nerve root and dural sac. However, the excessive pursuit of completed removal of calcified disc may increase the risk of complications such as nerve root injury and dural tear.

There were some previous studies on PEID in the treatment of CLDH[33, 34]. Dabo et al[28] reported that 30 patients with CLDH were treated by PEID. However, they concluded that the incidence of postoperative complications was significantly high due to the trephine. Chen et al[23] treated 13 cases with PEID. One case had a dural tear and cerebrospinal fluid leakage due to the adhesion. In our study, however, PEID combined with ultrasonic osteotome well solved the problems of trephine and adhesion, greatly reduced the risk of the procedure and significantly improved the clinical effects.

There were some limitations in this retrospective study. Firstly, this study had a small sample size and lack control group. Secondly, the short follow-up period did not evaluate the long-term efficacy. Prospective randomized controlled trials with large sample size, multicenter and long-term follow-up are still needed to better evaluate the clinical efficacy of this procedure in the future.

## Conclusions

PEID was a safe and effective minimally invasive procedure and achieved good clinical outcomes in the treatment of L5-S1 CLDH. We believed that PEID could be used as an alternative procedure to treat CLDH at L5-S1 level.

## Abbreviations

CLDH: calcified lumbar disc herniation; LDH: lumbar disc herniation; MRI: magnetic resonance imaging; CT: computed tomography; PEID: percutaneous endoscopic interlaminar discectomy; PETD: percutaneous endoscopic transforaminal discectomy; BMI: body mass index; VAS: visual analog scale; ODI: Oswestry disability index

## Declarations

### Ethics approval and consent to participate

This study was approved by the ethics committee of China-Japan Union Hospital of Jilin University and was therefore performed in accordance with ethical standards. All patients provided their informed consent prior to inclusion in the study.

### Consent for publication

Written informed consent was obtained from all participants.

### Availability of data and materials

The corresponding author could provide the date of the study if necessary.

## **Competing interests**

The authors declare that they have no competing interests.

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None.

## **Authors' contributions**

Authors YP C and H W designed the study. Authors YB L, XP C, BX W, LM J, JX Z, Z T and YW P collected the clinical data and conducted the statistical analysis. Author YP C wrote the draft of manuscript. Authors YPC and H W revised the manuscript. The final manuscript was approved by all authors.

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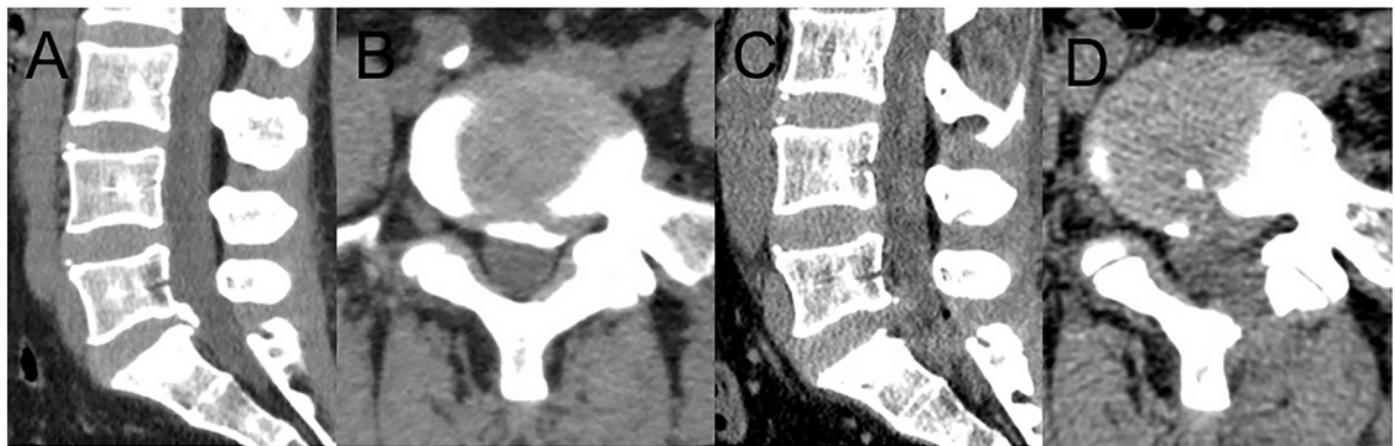
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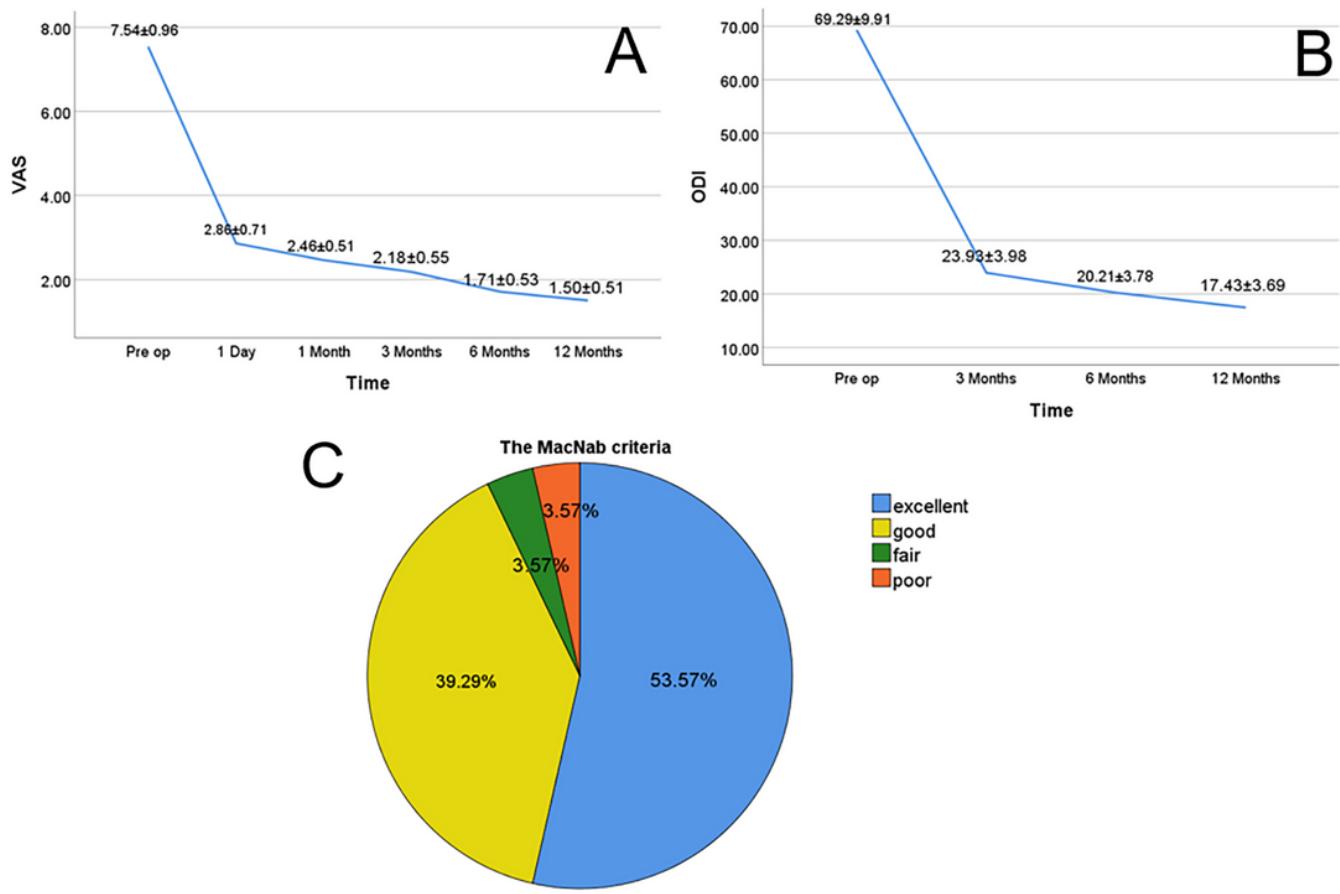
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## Figures



**Figure 1**

Pre- and post-operative CT (A-D). A-B Preoperative CT revealed lumbar disc herniation combined with calcification. C-D Postoperative CT revealed that the calcified intervertebral disc was removed and the compressed nerve root had been relieved by PEID.



**Figure 2**

Clinical outcomes at different follow-up time points pre- and post-operative PEID (A-C). A VAS scores pre- and post-operative PEID. B ODI scores pre- and post-operative PEID. C The modified MacNab criteria of all patients. P < 0.05. VAS, visual analog scale; ODI, Oswestry Disability Index; Pre op, preoperation.