

# Clinical Outcome of Percutaneous Endoscopic Lumbar Surgery (PELS) in Treatment of Lumbar Disc Herniation

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## Abstract

Lumbar disc herniation is a spinal problem seen in both young and old people causing pain in the back with pain and numbness in lower extremity leading to disability limiting daily activities. When conservative treatments are ineffective, then it is treated by surgeries, more recently with minimal invasive percutaneous endoscopic lumbar surgery (PELS). One of the mostly accepted PELS by spinal surgeons is percutaneous transforaminal endoscopic lumbar discectomy, which can be performed for any age. The main aim of this review was to evaluate clinical outcome and safety based on the Oswestry Disable Index (ODI), Visual Analog Scale (VAS) and MacNab criteria and complications of PELS surgery and its advantages in clinical basis.

## Keywords

Lumbar Disc Herniation (LDH), Percutaneous Endoscopic Lumbar Surgery (PELD), Percutaneous Transforaminal Endoscopic Lumbar Discectomy (PTELD), Interlaminar Percutaneous Endoscopic Lumbar Discectomy (ILPELD)

## 1. Introduction

Lumbar disc herniation is one of the common causes of low back pain with sciatica in young and adult with huge economic burden to family and society [1] [2] [3]. Point prevalence of lumbar disc herniation is 37.1%, 1-year prevalence of 76.0%, and lifetime prevalence of 85.5% [4]. About 70% - 80% of population experiences back pain in lifetime. It's reported that the prevalence of herniated discs are higher among people 35 - 45 years old [5]. Not all herniated disc need operative treatment but when sign and symptoms such as back with or without radicular leg pain progressively increase despite of conservative treatment for more than 6 weeks, neurological deficits as foot drop, cauda equine, etc. are seen

then has to undergo for surgery. Currently, there are numerous surgical interventions for lumbar disc herniation. They can be broadly classified as posterior open discectomies and percutaneous techniques. Posterior open discectomies include open laminectomy and discectomy, micro discectomy, micro endoscopic discectomy, hemi laminectomy with discectomy, among which micro discectomy remains the standard surgery for lumbar disc herniation. Whereas, percutaneous techniques include chemonucleolysis, nucleoplasty, intradiscal electrothermal therapy, percutaneous laser discectomy and percutaneous endoscopic lumbar surgery (PELS) [6] [7] [8]. Except PELS, all of the percutaneous techniques are blind procedure, whereas, PELS is performed under direct endoscopic vision.

Percutaneous endoscopic lumbar surgery is one of the latest emerging techniques in treatment of lumbar disc herniation. Kambin and Gellman in 1973 and Hijikata in 1975 first introduced non-visualized percutaneous central nucleotomy via posterolateral approach [9] [10]. After introduction of direct visualization of intervertebral disc space with modified arthroscopy by Forest and Housman in 1983, this technique has been widely practiced for treatment of lumbar disc herniation [7]. In 1992 Kambin P. further defined removal of protruded disc passing through Kambin's triangle, considered to be a safe site in posterolateral region [11]. Recently, there are 2 techniques widely used for percutaneous endoscopic surgery: 1) transforaminal approach described by Yeung (Yeung Endoscopic spinal surgery, YESS) in 1997 and Hoogland (Transforaminal endoscopic spine surgery system, TESSYS) in 1994 [12] [13]; 2) Interlaminar approach described by Ruetten in 2008 [14]. The indications for transforaminal endoscopic treatment are the same as classical discectomy procedures. Now due to advancement of instrumentation and skill of surgeon indication has broadened.

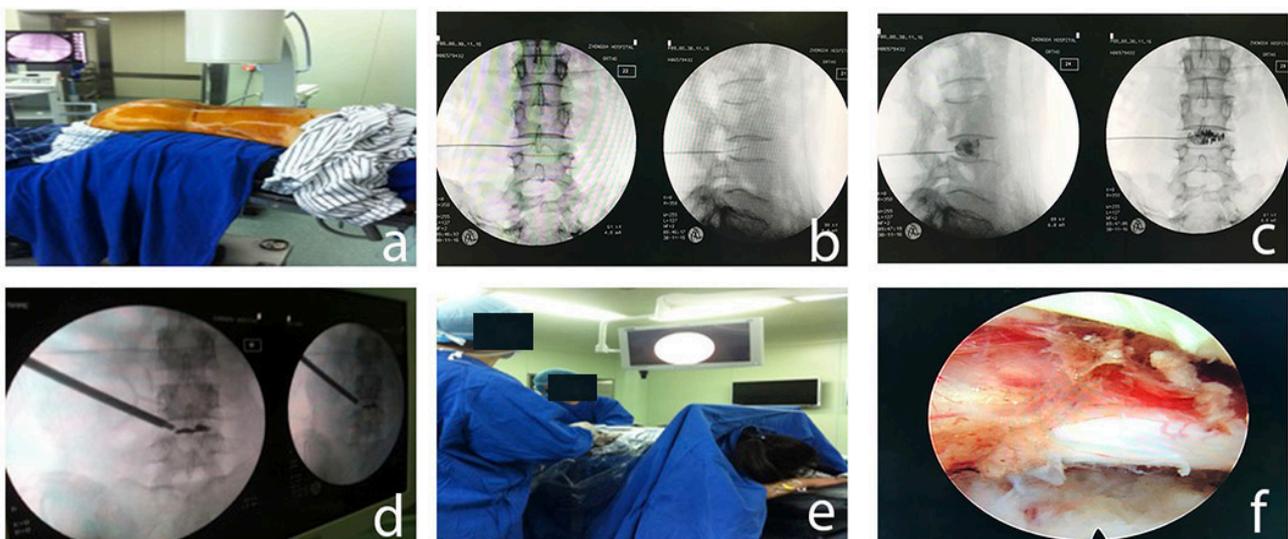
## 2. Surgical Technique

If the surgery is indicative then all pre-operation evaluation and preparation are performed; this surgery can be done in two positions; prone or lateral decubitus position. If the patient is placed in prone position then hip and knee are flexed and pillow is placed between lower abdominal and chest so that abdomen is hanged freely. For lateral decubitus position, pillow is placed under the waist, which will open up the foramen and allow the Dura to fall down to the contra-lateral side avoiding damage on introduction of the cannula and the also reduced intra-abdominal pressure and decrease bleeding. Then under guidance of C-arm, entry point is marked 8 - 16 cm from midline of vertebra to lateral side according to the disc interval at an angle of 15 - 25 degrees in horizontal plane [15] [16]. Under all aseptic condition and local anesthesia (1% lidocaine), and under anteroposterior (AP) and lateral view, a 25 cm 18 gauge needle is inserted in the level of herniated disc through the posterolateral approach. Intraoperative discogram is then performed with a 2 mL mixture of contrast medium and methylene blue at the ratio of 9:1 and help of c-arm. If the dye is seen in the epidur-

al space nucleus then it indicates the herniated fragment. Then guide wire is inserted and the needle is removed leaving the guide wire in situ. A small skin incision of 8 mm is then given over the guide wire entry point. A 2 mm conical rod is introduced over the guiding wire, and then sequentially the first, second and third sleeves were inserted dilating the soft tissues up to 6.5 mm. Then the reamer is introduced anti clockwise, to avoid damage to the spinal muscles and continuously under the guidance of image intensifier reamed to 1 or 2 mm inside the medial pedicular line. The procedure is repeated with each of the sequentially larger rods, tubes and reamers. Then working cannula is introduced over the third conical rod and its tip should be located on the herniated disc. Then image intensifier is removed and working endoscope set introduced and herniated disc is removed under direct visualization as in **Figure 1**. After complete decompression, the dural sac and the lumbar exiting nerve root is checked for freely movable with the valsalva maneuver. Bleeding of the small vessels is controlled with a flexible bipolar radio frequency probe. Communication with patients is maintained throughout the procedure. Though the technique is considered to be much safer but it involves several technical challenges, such as the critical narrow access through the foraminal triangular window and the limited intradiscal and epidural working space.

### 3. Discussion

In recent time, percutaneous endoscopic lumbar surgery specially transforaminal approach is widely used to treat lumbar disc herniation due to its comparable significant outcome as shown in **Table 1**. This transforaminal approach can be approached by two techniques YESS and TYSSYS. The standard indication for percutaneous transforaminal endoscopic lumbar discectomy (PTELD) is limited to soft (non calcified) and contained LDH, which caused discogenic leg pain that



**Figure 1.** Procedure for percutaneous endoscopic lumbar surgery. (a) positioning of patient in operating table, (b) Insertion of 25 cm 18-gauge needle, (c) discogram with mixture of contrast medium and methylene blue, (d) reaming over dilator, (e) removal of content under direct vision with endoscope and (f) free nerve root after discectomy.

**Table 1.** Result and complication of some studies done in last 2 years.

Author	Year	Diagnosis	No. Of Patients	Follow up	Result	Complication	Research conclusion
Kun Wang <i>et al.</i> [30]	2015	LDH	207 ≤45 age 108 patient, 76 male 32 female and >45 age 99 patient, 47 male, 52 female	2 year	MacNab: -≤45 group and 84% < 45 and 71% > 45 have excellent or good result. Length of hospital stay: 6.8 and 8.4 days, respectively Operation time: 94 and 97 minutes respectively	Recurrence rates at 12 months post operation were 3% and 5%. Dural tear 1 patient in each group. Nerve injury 1 patient in > 45 and 2 patient in < 45 Recurrence: -5 case (3.7%)	The efficacy of PTELD is relatively good for the selected young and elderly patients
Zhen Zhou <i>et al.</i> [27]	Sep 2015	LDH	134 Mean age 41.4 year, male: female = 68:66	2 year	MacNab: 92.5% excellent or good		New PTED instrument is safe and effective for percutaneous foraminoplasty
Chau <i>et al.</i> [38]	Feb 2017	Recurrent lumbar disc herniation	401 MIS-TLIF 192, mean age 55.9, male: female=92:100 and PELD 209, mean age 57.2, male: female=110:99	46.5 months	The recovery rate was 92.3% in the PELD and 97.4% in the MIS-TLIF group. Regarding satisfactory rate, the PELD group (91.3%) was lower than the MIS-TLIF group (95.2%)	Dural tear 6 patients, 1 patient permanent neurological deficit and 1 infection patient in MIS-TLIF. 12 patients reherniation in PELD.	Both PELD and MIS-TLIF showed favorable clinical outcomes for recurrent disk herniation. PELD has the following several advantages: 1) performed under local anesthesia; 2) Performed with very few approach-related complications, such as dural tear; and 3) rare possibility of fusion disease, such as adjacent segment.
Jung-Sup Lee <i>et al.</i> [23]	Aug 2016	L5-S1 discs herniation	80 Age range 18 - 73, mean age 40 ± 12 year, male: female = 51:29	13+- 6 month	65 cases were complete, 15 cases were insufficient, and 0 cases were incomplete. VAS was decreased at the last follow-up (leg: from 7.91 ± 0.73 to 1.15 ± 0.62; back: from 5.15 ± 0.71 to 1.19 ± 0.75). A (excellent or good outcome by MacNab criteria) was achieved in 77 patients (96.25%).	2 cases (2.5%) of recurrence	According to the result, we could obtain the favorable clinical and radiological outcomes while simultaneously removing pathologic discs using the ligamentum flavum splitting and annular fissure sealing technique.
Kyung-Chul Choi <i>et al.</i> [24]	June 2015	L5-S1 Disc Herniation	100 Mean age 36.5 ± 11.3, male: female = 49:51	2 year	VAS scores for back and leg pain decreased from 6.0 to 2.3 and from 7.5 to 1.7. The mean ODI (%) improved from 54.0 to 11.6. A MacNab criterion, a good outcome was 92%.	Reherniation 2 case	In high iliac crest cases where the iliac crest is above the mid L5 pedicle in lateral radiography, foraminoplasty may be considered for transforaminal access of L5-S1 disc herniation.
Jin Wei Ying <i>et al.</i> [33]	2016	Down migrated intra-canal disc herniation	45 Foraminoplasty 22 patient mean age 39.4 ± 11.0, male: female = 12:10 and PTELD 23 patients, mean age 44.9 ± 13.1, male: female = 14:9	1 year	ODI score reduced from preoperative 55.44 ± 14.73 and 59.51 ± 16.96 to postoperative 12.42 ± 6.98 and 13.91 ± 6.27 (P < 0.001). VAS was 5.95 ± 1.33 and 6.30 ± 1.72, which decreased significantly to 1.05 ± 0.90 and 1.30 ± 0.82 at the final follow-up, respectively (P < 0.001).	3 case out 5 patient with unpleasant feed back had transient post operative dysesthesia	Foraminoplasty-PELD via upper border of inferior pedicle can serve as a safe and effective minimally invasive technique for removal of down-migrated herniation.
Sinkemani A <i>et al.</i> [28]	April 2015	LDH	86 MED 50, mean age 41.46 ± 7.22, male: female = 29:21 and PTED 36 patients, mean age 44.17 ± 6.54, male: female = 23:13	12 month	ODI: - MED and PTED groups (53.00 ± 14.18 vs. 48.72 ± 11.55) before treatment (4.96 ± 10.34 vs. 3.61 ± 8.5) after surgery. MacNab criteria, 92.0% of the MED group and 94.4% of the PTED group had excellent or good results with no significant difference.	No serious complication	There was no significant difference between MED and PTED outcomes. Further large-scale, randomized studies with long-term follow-up are needed.

didn't respond to respond to any conservative treatment. But In the hands of an experienced operator, PTELD is also indicated for most spectrums of LDH, except for calcified discs or sequestration discs which are separate and migrating from the disc space. The continuity of the hernia with the disc space but not its size is the key determinant of the indications for PTELD. Sang Soo Eun *et al.* in 2016 performed PTELD among 38 patients which showed favorable long term outcome of PTELD [17]. Another study by Zhimin Pan *et al.* in China in 2015 showed TYSSYS was well tolerated by 106 patients studied and entailed less trauma and quick recovery [18]. The clinical outcome of these techniques is basically evaluated by Oswestry Disable Index (ODI 0% - 100%) [19] based on daily activities of the patient, Visual Analogue Scale (VAS, 0 - 10) [20] for pain severity and MacNab criteria [21] for therapeutic evaluation.

### 3.1. Clinical Outcome Evaluated by ODI, VAS and MacNab Criteria

A MacNab criterion is evaluated in four ratings as per their symptomatic relief; excellent, good, fair and poor. (Excellent: no pain, no restriction of mobility, return to normal work and level of activity; Good: occasional non radicular pain, relief of presenting symptoms, able to return to modified work; Fair: some improved functional capacity, still handicapped and/or unemployed; Poor: continued objective symptoms of root involvement, additional operative intervention needed at the index level irrespective of the length of postoperative follow-up). Based on the modified MacNab criteria, study done in Taiwan showed 89% of patients achieved excellent (28%) or good (61%) outcomes after surgery [22]. Similarly, other studies till date showed good outcome 80% - 96.7% after PTELD surgery [14] [23]-[29]. The studies have shown that the most of the patients after PELS had the 'good' outcome on the basis of MacNab criteria. A Study done by Kun Wang *et al.* also indicated that outcome based on MacNab criteria can be different based on age as they found out that outcome in the age  $\leq 45$  group were better than the age  $> 45$  group ( $p = 0.03$ ) [30]. Few other studies also found better result based on MacNab criteria in younger patients than old ones [16]. PTELD was also able to get 75.77% - 81.4% excellent or good outcome on basis of MacNab criteria even for recurrent disc herniation [29] [31] [32].

ODI is another factor to determine the clinical efficacy of treatment related to spine problems. This is indexed based on the symptomatic relief of leg and back pain after the treatment. In PELS, many studies have used to evaluate the outcome and found that the value of ODI is remarkably decreased after this surgery. Kyung Chui *et al.* found out that the mean ODI (%) improved from 54.0 to 11.6 among 100 patients after PELS [24]. Another study done in two groups showed the mean ODI score reduced from preoperative  $55.44 \pm 14.73$  and  $59.51 \pm 16.96$  to postoperative  $12.42 \pm 6.98$  and  $13.91 \pm 6.27$  respectively ( $P < 0.001$ ) [33]. Another two studies compared the outcome based on age and sex of the patients, which showed no difference in ODI [16] [30], VAS was also seen significantly improved after PELS, which is evaluated, based on the symptomatic relief. Prospective Study done by Pravesh S. gadjradj *et al.* in 167 LDH who underwent

PELS, The mean VAS score for leg pain was 82.5 mm (range 5 - 100 mm), Six weeks after the surgery, the scores on the VAS was found to be significantly reduced ( $p < 0.001$ ), which was progressively reduced after 52 weeks of follow up [25]. Another study by Kyung Chui *et al.* found significant improvement in VAS of leg and back pain from 7.5 to 1.7 and from 6.0 to 2.3 [24]. Another study performed in two groups found that the mean preoperative VAS was  $5.95 \pm 1.33$  and  $6.30 \pm 1.72$ , which decreased significantly to  $1.05 \pm 0.90$  and  $1.30 \pm 0.82$  at the final follow-up, respectively ( $P < 0.001$ ) [33]. The improvement in VAS score didn't have any significance based on age, which was found in studies that compared age and sex of the patients showed no difference in VAS score [16] [30].

### 3.2. Complication

Despite many researches till date have discussed about the clinical efficacy of PELS and its wide, certainly some complications of the surgeries have also been reported such as Dural tear, hematoma collection, residual disc specimen, vascular injury, infection, thrombophlebitis, etc. [34]. During the procedure there is also potential risk of damaging the nerve roots as they are in close proximity to the intra foraminal disc space [35] [36]. 1% - 2% cases of nerve injury have been seen in some reported studies [30]. Different studies till date studies have showed the reherniation rate of 3 - 6.6 [14] [16] [25] [27] [29]. A study in China reported one patient experienced recurrent LDH 4 months after surgery. Moreover, eight patients (6%) sustained temporary dysesthesia over the proximal lower limb of the operated side during the early days of the surgery [22]. Study by Wang Cheng *et al.* study showed 5.9% postoperative dysesthesia. However, There has not yet been a report of any intra-canal or foraminal adhesions following the procedure in the literature [18]. Though few complications have been seen post procedure but literatures have reported the complication rate to be very low. So, we still believe this technique is safe to be performed for the treatment of the patients.

### 3.3. Comparison of PELS and Other Techniques

Since the advancement in spinal surgery, various techniques have been developed to treat the spinal problems. Especially in recent years, minimally invasive procedures are overtaking open surgeries because of their extensive benefit. Various Studies have been done to see outcome of percutaneous endoscopic surgery, between PTELD and MED, PTELD and open lumbar discectomy, etc. A randomized trial done by lei pan *et al.* between open lumbar discectomy and PTELD showed MacNab satisfaction of above 90% in both groups after surgery while no significant difference noted in pain index ( $p > 0.05$ ) [34]. Sand-soak Ahn *et al.* showed significant difference in vas score of back pain at 6-month 12 month  $P < 0.001$ ,  $P = 0.012$  respectively but no significant difference in VAS score of leg pain  $p = 0.553$ ,  $0.259$  respectively in open lumbar discectomy (OLD) and PELS groups after surgery [16]. The comparative studies indicated that the both OLD and PES are similar in clinical efficacy in pain relief whereas Dong

Yeob Lee *et al.* showed less rate of complication 4% in PES compare to 10.3% in OLD [31]. Comparative Study by Lei Pan *et al.* found PTES has less hospital stays  $1.9 \pm 0.74$  days compared to OLD  $5.6 \pm 1.26$  respectively. Due to the statistically significant difference in CRP, CPK and IL-6 between the two groups, the PELD had less tissue damages to the human body than OLD surgery [34]. In addition, the patients underwent PELD had less recovery time and shorter hospital stay and early return to work compared to the patients treated with OLD. The clinical outcome of PELD based on MacNab criteria was better than the open lumbar discectomy whereas both the surgeries were seemed similar in alleviating the pain index of the patients.

Several comparisons have also been done between another two minimally invasive techniques, PTED and MED. The clinical outcome according to MacNab criteria was found to be mixed, Sinkemani *et al.* showed 92.0% of the MED group and 94.4% of the PTED group had excellent or good results according to MacNab criteria with no significant difference [28]. Whereas Liuwen Gui *et al.* showed 75.96% in the PELD group and 84.15% in the MED group achieved excellent or good results respectively, which was statistically significant ( $p = 0.0402$ ). However, the hospitalization duration of the MED group was 11.6 days, significantly longer than that of the PLD group (7.9 days,  $P < 0.01$ ), and the mean cost of the MED group was, significantly higher than that of the PELD group ( $P < 0.01$ ) [37]. Chao Liu *et al.* in 2016 compared PELD and Minimally Invasive Transforaminal Lumbar Interbody Fusion for Recurrent Lumbar Disk Herniation; the recovery rate was 92.3% in the PELD and 97.4% in the MIS-TLIF group. During the follow-up period, postoperative data between both groups showed no significant differences in the mean total postoperative VAS score for leg pain, and ODI score [38]. The PELD was found to have lesser hospital stay days than open surgery and other percutaneous surgeries, low cost study done by Ruetten *et al.* [14], very less blood loss [39], early return to work, and minimal scar and tissue damage [34]. Kyung-Chul Choi *et al.* compared transforaminal PELD (TF-PELD) and interlaminar PELD (IL-PELD) both of which are the types of percutaneous surgeries; a significant difference between groups was demonstrated in terms of disc type, location, and migration. TF-PELD was preferred for shoulder type, centrally located, and recurrent disc herniation, while IL-PELD was preferred for axillary type and migrated discs, especially those of a high grade [24].

#### 4. Conclusion

PTED can be an alternative technique in spine surgery. The clinical outcome is very satisfactory for the treatment of lumbar disc herniation which was similar to other surgeries, but the short hospital stay, minimal blood loss and low cost than other open surgeries and even than other percutaneous surgeries such as MED are some of the benefits of PTED over them. The clinical outcome on the basis of MacNab criteria, ODI and VAS all showed significant clinical improvement post PTELD. The clinical TF-PELD was preferred for shoulder type, cen-

trally located, and recurrent disc herniation. Few complications like reherniation and dysesthesia could occur post surgery but was found to be very low thus implying the safety of the procedure. Therefore, wide acceptance of this procedure is increasing more all over the world. Further studies with long-term follow up should be performed on the percutaneous surgeries to enhance the use of this surgery.

### Conflict of Interest

None.

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## Abbreviation

LDH = lumbar disc herniation

PELS = Percutaneous endoscopic lumbar surgery

PELD = Percutaneous endoscopic lumbar discectomy

PTELD = Percutaneous transforaminal endoscopic lumbar discectomy

IL-PELD = Interlaminar percutaneous endoscopic lumbar discectomy

TF-PELD = Transforaminal Percutaneous endoscopic lumbar discectomy

MED = Micro endoscopic discectomy

OLD = open lumbar discectomy

ODI = Oswestry Disable Index

VAS = Visual Analog Scale

YESS = Yeung Endoscopic spinal surgery

TESSYS = Transforaminal endoscopic spine surgery system



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