

Comparison of Percutaneous Endoscopic Lumbar Discectomy between Transforaminal Approach and Interlaminar Approach on Lumbar Disc Herniation of L4-L5: An Observational Study

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Objective: To evaluate the clinical outcomes and complications of post percutaneous endoscopic lumbar discectomy (PELD) via transforaminal (TF) approach and interlaminar (IL) approach in patients with lumbar disc herniation L4-L5 level.

Materials and Methods: Eighty-five patients diagnosed with lumbar disc herniation on L4-L5 level and who underwent PELD were non-randomly recruited and assigned into two groups. Fifty-two patients underwent PELD via the IL approach and thirty-three patients underwent PELD via the TF approach. The demographic data, resting visual analog scale (VAS), activity VAS, Oswestry Disability Index (ODI), and complications were obtained before the operation, and at follow-up on day 1, and at 2-, 6-, 12-, and 24-months post operation.

Results: Resting VAS and activity VAS statistically significantly declined in both groups ($p=0.001$). Activities of daily living (ADL) as assessed by ODI increased significantly in both groups ($p=0.001$). However, there was no significant differences between the groups. The TF approach group had significant more dysesthesia and re-surgery ($p=0.009$, $p=0.05$, respectively) than the IL approach group. The total re-surgery rate during the two years of follow-up was in the 9.4%.

Conclusion: PELD is a safe and effective minimal invasive spine surgery. The clinical results via both approaches have similar result but PELD via the TF approach had higher post-operative complications than via the IL approach. Additionally, PELD via the TF approach required higher skill to puncture and there is a steeper learning curve than PELD via the IL approach.

Keywords: Percutaneous endoscopic lumbar discectomy, PELD, Transforaminal, Interlaminar

Received 27 August 2019 | Revised 24 July 2020 | Accepted 24 July 2020

J Med Assoc Thai 2020;103(12):1277-83

Website: <http://www.jmatonline.com>

Lumbar disc herniation is the most common low back pain and sciatica in adolescences. About 60% to 95% of herniated discs occur at the lower lumbar spine (on L4 to L5 and L5 to S1 level)⁽¹⁻⁴⁾. The signs and symptoms of lumbar disc herniation are pain in the back or the leg, paresthesia, or weakness of

the lower extremities. There are several lumbar disc herniation treatments to relieve symptoms. The non-surgical treatments are alternate bed rest, medications, and physical therapy. Surgical treatments include open surgery, micro endoscopic discectomy, and percutaneous endoscopic discectomy. The patients with a lumbar disc herniated will get better without surgery in only 1% to 10% of the cases, the others will need surgical treatment⁽¹⁻³⁾. Recently, the endoscopic spinal surgery, which initially was limited to the treatment of soft tissue lesions, has expanded to include other aspects of spinal disease and good clinical results have been reported⁽⁴⁻⁹⁾. Advantages of the minimally invasive procedure include preservation of the bony structure and lumbar mobility^(4,5), minimal blood loss⁽⁶⁾, rapid recovery⁽⁷⁾, reduce time of hospitalization⁽⁸⁾, and decrease of postoperative morbidity⁽⁹⁾.

Percutaneous endoscopic lumbar discectomy

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How to cite this article:

Bamrunghthin N. Comparison of Percutaneous Endoscopic Lumbar Discectomy between Transforaminal Approach and Interlaminar Approach on Lumbar Disc Herniation of L4-L5: An Observational Study. J Med Assoc Thai 2020;103:1277-83.

doi.org/10.35755/jmedassocthai.2020.12.10563

(PELD) is a minimal invasive spine surgery for decompression of the lumbar disc space and removal of nucleus pulposus. There are two different operative approaches, transforaminal (TF) and interlaminar (IL). However, PELD has some anatomical limitations for endoscopic insertion.

The PELD via TF approach has two anatomical limitations. First, there are bony limitation that includes the facet joint in high canal compromise and the pedicle in highly inferiorly migrated discs. Second, there is the neurological limitation of the exiting root. The exiting roots include the dorsal root ganglion in relation with a foraminal disc^(10,11). The insertion of the spinal needle for TF approaches is a blind procedure that requires a “Triangle working zone”^(8,12,13) and need a higher skill to puncture through the fluoroscopic guide. On the other hand, the insertion for IL approach is performed under endoscopic visualization, but it is impossible to completely avoid direct retraction of neural structure by operative instruments⁽⁸⁻¹⁰⁾. Presently, there are no study that compared clinical outcomes and complications between the TF approach and the IL approach in patients with L4 to L5 lumbar disc herniation. Therefore, it is questionable which approach is the better solution. The decision of the technique of PELD for L4 to L5 level depends on the surgeon’s experience and the anatomy limitation. The objective of the present retrospective study was to evaluate and compare the clinical outcomes and complications of using PELD via the TF approach and the IL approach in patients with L4 to L5 lumbar disc herniation.

Materials and Methods

The present study is a retrospective, non-randomized controlled study. The patients diagnosed with lumbar disc herniation on L4 to L5 level that underwent spinal surgery between October 2013 and December 2018 were enrolled. The present study was approved by the Ethics Committee of Chaiyaphum Hospital (Approval no.021/2019). Inclusion criteria were unilateral radicular pain, single level of lumbar disc herniation on L4 to L5 level, and failed conservative treatments for more than six weeks. The exclusion criteria were patients with migrate sequestered disc above or below the mid-pedicle level, spinal instability, spinal stenosis, recurrent lumbar disc herniation, and previous back surgery. The patients were assigned into two groups, the IL or the TF approach. The present study was approved by Chaiyaphum Hospital Ethics Committee. The demographic data, resting visual analog scale

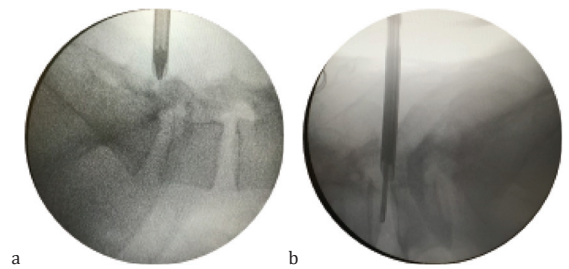


Figure 1. PELD via IL approach.

(a) Intraoperative of C arm image for confirm an endoscopic position, (b) Intraoperative of C arm image showing an endoscopic disectomy via the interlaminar route

(VAS), activity VAS, Oswestry Disability Index (ODI) and the complications were obtained before the operation and at follow-up on day 1, and at 2-, 6-, 12-, and 24- months post operation. All the clinical data were obtained from the medical charts review and telephone interview.

Surgical technique

PELD via IL approach: Full-endoscopic visualized disectomy performed via IL approach was under general anesthesia in the prone position. All operations were performed by single surgeon, who had many years of experience in endoscopic spine surgery. Posteroanterior and lateral views were obtained by C-arm fluoroscopy to identify the intervertebral space and IL window. An 8 mm skin and fascia incision were made at the entry point through the IL window and the dilator was inserted through the outside of the spinal canal. The dilator’s position was confirmed by fluoroscopy on the lateral view. Next, a working sleeve and endoscopic was inserted to the laminar window from medial to lateral of the facet joint exposed to the ligamentum flavum. After confirming the position of the working sleeve and the endoscopic surgery system into the epidural space, the dura matter and nerve root were exposed. The gentle retraction of the root was accomplished by rotating the working sleeve to protect the neural structures. The subsequent procedures were performed with visualization via the endoscopic camera under continued saline irrigation. A radiofrequency electrode was applied to control the bleeding. After the protruded or sequestered disc was removed to ensure sufficient decompression of the nerve root, the working sleeve was carefully removed, and the skin was closed by a single suture (Figure 1).

PELD via TF approach: Full-endoscopic

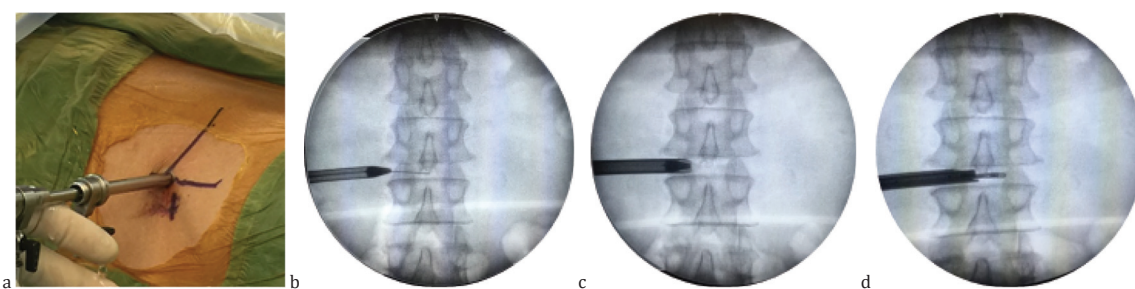


Figure 2. PELD via TF approach.

(a) Lateral approach for PELD via TF approach; (b, c) Intraoperative of C arm image for confirm the intervertebral gap, guide wire, dilator and endoscopic; (d) Intraoperative of C arm image showing an endoscopic discectomy via the TF approach

visualized foraminoplasty and discectomy was performed via the TF approach under general anesthesia in prone position. All operations were performed by the same surgeon. Posteroanterior and lateral views were obtained by C-arm fluoroscopy to identify the intervertebral disc space and foramina. At the entry point, the puncture target and direction were marked according to the C-arm fluoroscopy. The identified horizontal line was located between the spinous process line and facet line using C-arm fluoroscopy in lateral view. The transversal line was identified and located in the midline of the disc space that would be operated by C-arm fluoroscopy in posteroanterior view. After, the entry point was identified as the intersected of the transversal and horizontal line, the spinal needle was inserted under the guidance of the C-arm fluoroscopy in lateral view. The spinal needle was close to the medial pedicular line in the anteroposterior view of the C-arm fluoroscopy as well as close to the posterior vertebral line in the lateral view of the C-arm fluoroscopy. A guidewire was inserted through the spinal needle, then the spinal needle was removed. A dilator was inserted along with the guidewire until touching the annulus fibrosus and through the disc by hammering. The guidewire was removed. The working sleeve and endoscopic surgical systems were inserted. All subsequent steps were performed with endoscopic visualization under continuing saline irrigation. The working sleeve was inserted until touching the facet joint and then rotated 180 degrees to get away from an existing nerve root. The endoscopic was then inserted. A radiofrequency electrode was applied to control the bleeding. The herniated fragments were completely removed until the thecal sac was floated, fluctuated, and free from compression. The working sleeve was carefully removed, and the skin was closed by a single suture (Figure 2).

Statistical analysis

Demographic data were divided into quantitative and qualitative. Quantitative data distributions were analyzed with Kolmogorov-Smirnov test. Mean and standard deviation (SD) were used for describing continuous data. Percentage was used for describing the category data. Repeated measures ANOVA was used for comparison the mean of clinical outcomes within group. Independent t-test was used for comparison the mean of clinical outcomes between group. Chi-square test and Fisher's exact test were used for comparison the complication after operation. IBM SPSS Statistics for Windows, version 23.0 (IBM Corp., Armonk, NY, USA) was used for data analysis. A p-value of less than 0.05 was considered as statistically significant.

Results

One hundred nine patients diagnosed with lumbar disc herniation on L4 to L5 level underwent spinal surgery were recruited between October 2013 and December 2018. Only 85 patients diagnosed with lumbar disc herniation at L4 to L5 level underwent PELD by a single surgeon. Sixteen patients had lumbar disc herniation with spinal stenosis, three patients had spine surgery at more than one level, and five patients had previous spine surgery, thus, were excluded from the present study. Therefore, 85 patients diagnosed with lumbar disc herniation on L4 to L5 level that underwent PELD and were included in this study. The IL approach group had 24 males (46.2%) and the TF approach group had 20 males (60.6%). There was no significant difference in gender between the groups ($p=0.28$). Non-significant difference in each group was observed in term of age, onset before surgery, time of surgery, and length of stay (LOS) in hospital. Demographic data comparison between TF and IL approach are shown in Table 1.

Table 1. Demographic data and surgical characteristic of participants in PELD via IL and TF approach groups

Characteristics	IL (n=52)		TF (n=33)		p-value
	Mean±SD	Min-max	Mean±SD	Min-max	
Age (years)	43.7±11.8	17 to 74	45.1±9.7	24 to 68	0.57
Onset before surgery (months)	3.4±3.0	1 to 12	4.1±3.9	1 to 12	0.74
Time of surgery (minutes)	45.2±18.3	17 to 120	51.9±20.6	30 to 165	0.12
LOS (days)	3.1±2.6	2 to 14	3.8±2.2	2 to 10	0.24

IL=interlaminar; TF=transforaminal; SD=standard deviation; LOS=length of stay

The mean of operative time in the IL approach was shorter than in the TF approach ($p=0.12$). In both groups, the operative time rapidly decreased over the early cases and tapered to steady after 30 cases. In IL approach group, the mean of operative time of the first ten patients, 11 to 20 patients, and 21 to 30 patients were 73.3 ± 25.4 , 63.5 ± 18.3 , 59.3 ± 16.7 minutes, respectively, and the overall mean of the operation time was 45.2 ± 18.3 minutes. In the TF approach group, the mean of operative time of the first ten patients, 11 to 20 patients, and 21 to 30 patients was 94.8 ± 20.4 , 88.4 ± 18.8 , 73.3 ± 16.7 minutes, respectively, and overall mean of the operation time was 51.9 ± 20.6 minutes. The learning curve of the TF approach group was steeper than in the IL approach group.

Clinical outcomes

The results showed that the resting VAS and activity VAS at pre- and post-operative statistically significantly declined in both group ($p=0.001$). However, there were no significant difference between the groups in resting VAS or activity VAS (Figure 3). Forty-eight patients (92.3%) in the IL approach and 27 patients (81.8%) in the TF approach group had significant improvement of leg pain immediately after surgery and were able to walk in only six hours after surgery. The activities of daily living (ADL) as assessed by ODI, increased significantly in both groups ($p=0.001$). However, there was no significant difference between the groups in preoperative and post-operative ODI score (Figure 4).

After surgery, 73 patients (85.8%) reported no post operation complication and showed excellent outcome. The author found 10 patients (11.8%) that had persistent leg pain, 12 patients (14.1%) that had dysesthesia, eight patients (9.4%) that needed revision of surgery, and four patients (4.7%) that had transient motor deficit. There was less occurrence of complications in the IL approach group than in the TF approach group. The transient motor deficits were

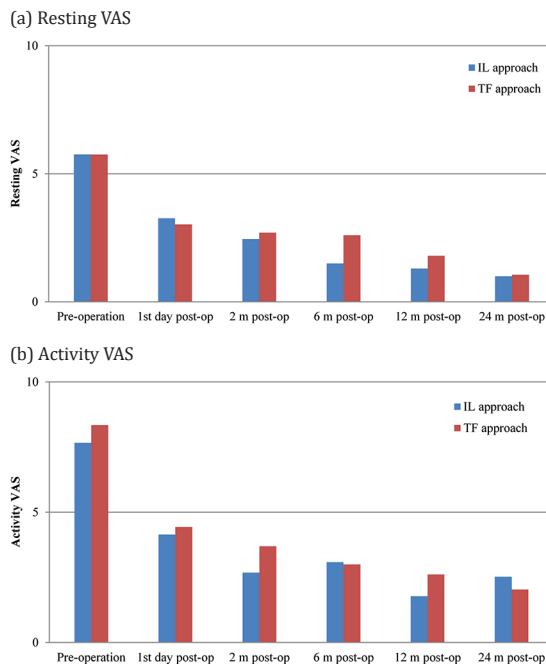


Figure 3. Compare the mean of resting VAS and activity VAS on pre-operative and post-operative periods in patients with PELD in both groups.

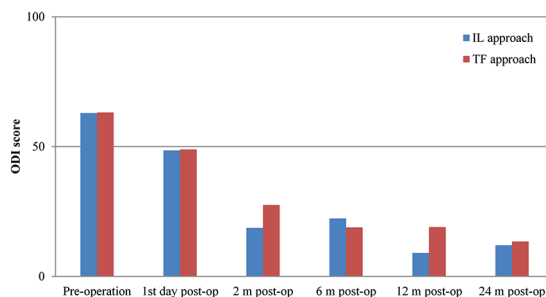


Figure 4. Compare the mean of ODI score on pre-operative and post-operative periods in Patients with PELD in both groups.

completely resolved later in the follow-up period.

Table 2. Post-operative complications in PELD via IL and TF approach groups

Complications	Total n (%)	IL (52) n (%)	TF (33) n (%)	p-value*
Pain	10 (11.8)	4 (7.7)	6 (18.2)	0.17
Dysesthesia	12 (14.1)	3 (5.8)	9 (27.3)	0.009
Transient Motor deficit	4 (4.7)	1 (1.9)	3 (9.1)	0.29
Revision of surgery	8 (9.4)	2 (3.8)	6 (18.2)	0.05

IL=interlaminar; TF=transforaminal

* Fisher's exact test

These patients were discharged from the hospital on the third or fourth day after the operation.

Revision of surgery in the TF approach group was higher than in the IL approach group with statistical significance ($p=0.05$). The patients of the TF approach group had revision surgery due to dysesthesia and persistent leg pain (Table 2).

Discussion

The present study provides additional evidence that the PELD via IL and TF approaches are as safe and effective methods for lumbar disc herniation treatment as the conventional surgery⁽³⁻⁸⁾. Advantages of PELD included minimal tissue trauma, reduced of blood loss, decreased risk of infection, less post-surgical scarring, and reduced length of hospital stay. The present study showed that the resting VAS and activity VAS declined statistically significantly in both groups. The clinical results of the current study are similar to a previous PELD study by Ruetten et al^(8-10,14) who reported that 79% to 84% of the patients who underwent full endoscopic resection of lumbar disc herniation via the IL and TF approach achieved good clinical outcomes. Senser et al⁽¹⁵⁾ reported 70% of the patients who underwent endoscopic surgery in disc herniation achieved good clinical outcomes and no complaints and Ahn et al⁽¹⁶⁾ reported 81.4% of the patients who underwent PELD for recurrent disc herniation had excellent or good outcomes based on MacNab criteria

The present study also reported that post-surgery complications in the IL approach occurred less than in the TF approach, which consistent to the study of Yadav et al⁽¹⁷⁾ who reported that the IL approach is a safer alternative to the endoscopic surgery. The anatomical limitation, visualization, and steep learning curved plays a role in the post-surgery complications in both groups. In PELD via the IL approach, access to the axillary and migrated disc

herniate to remove the disc fragment is similar to the visualization offered by an open surgery^(11,17). On the other hand, PELD via the TF approach has anatomical barriers therefore, it seems impossible to access via the entry route. The TF window in the lower lumbar becomes progressively narrower and faces a large facet joint. PELD via TF approach has the possibility of incomplete decompression. In the present study, the author found the dysesthesia and re-surgery in the TF approach was higher than in the IL approach with statistical significance. The author hypothesized that the complications were due to multiple adjustment of the spinal needle and rotation of the working sleeve through the neural foramen, which could result in compression or injury to the existing nerve root. The hypertrophy of facet joint reduced the size of the triangle working zone and increased the chance of nerve root injury. The results of the present study are opposed to the study of Hua et al⁽¹¹⁾ that assessed the clinical outcomes of discectomy by using full-endoscopic visualization technique via the IL approach versus the TF approach in the treatment of L5-S1 disc herniation. It reported intraoperative epineurium injuries that occurred in both groups. The total recurrence rate during the 18 months follow-up was 3.3% in the IL group and 0% in the TF group. Choi et al⁽¹⁸⁾ reported no dysesthesia after PELD via the TF approach and had recurrence of 6.7% in the IL group and 3.3% in the TF group. Chen et al⁽¹⁹⁾ studied meta-analytic of the efficacy and safety in patients with lumbar disc herniation and reported no recurrence after PELD via the TF approach and had recurrence of 3.3% in the IL group. In the present study, steep learning curve was observed in both groups^(8,17,18,20). In addition, the number of cases collected is also the case that made the first experience of endoscopic spine surgery. Therefore, these have more complications than other study reports. Prospective randomized controlled trials with large sample size should be conducted to assess the clinical outcome and complications.

Conclusion

PELD via the IL and the TF approaches were safe and effective minimal invasive surgery. The clinical results via both approaches have similar result, but PELD via the TF approach had higher post-operative complications than PELD via the IL approach. The patho-anatomy and development of instrumentation for PELD are on the rise and safe. PELD via the TF approach require a better skill in doing puncture and a steeper learning curve than PELD via the IL approach.

The surgical technique selection affects the efficiency of surgery.

What is already known on this topic?

PELD is a safe and effective method for lumbar disc herniation treatment. The advantages of minimal spinal surgery were less tissue trauma, less blood loss, decreased chance of infections, less post-surgical scar, and reduce length of hospital stay. However, it is not clear which is the appropriate surgical technique for patients with L4 on L5 lumbar disc herniation.

What this study adds?

PELD via the IL and the TF approaches are safe and effective method for lumbar disc herniation treatment. The post-operative complications found pain, dysesthesia, slight motor deficit, and re-surgery in both approaches. However, more post-operative complications occurred in patients of the TF approach than of the IL approach. The author hypothesized that the complications were due to the multiple adjustment of the spinal needle and that rotation of the working sleeve through the neural foramen could result in compression or injury to the nerve root. PELD via the TF approach requires more puncture skills than PELD via the IL approach. Experience in epidural steroid injection (ESI) would increase the puncture skills, which is necessary for PELD via the TF approach.

Acknowledgement

The author is grateful to the PELD patients for giving their time and allow us to conduct the present study. Their generosity allowed us to gain new knowledge.

Conflicts of interest

The author declares no conflict of interest.

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