Retrospective Evaluation

Long-term Follow-up Results of Percutaneous Endoscopic Lumbar Discectomy

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Background: Open lumbar microdiscectomy (OLM) has been considered the gold standard in the management of lumbar disc herniation (LDH) for its favorable outcomes in long-term follow-up. Nowadays, percutaneous endoscopic lumbar discectomy (PELD) is gaining recognition. However, greatest limitation of studies of PELD is the lack of long-term follow-up outcomes.

Objective: To investigate the long-term outcomes of PELD in terms of clinical and radiographic findings and revision surgery rate.

Study Design: Retrospective study.

Setting: Spine hospital.

Methods: Sixty-two patients who underwent PELD 10 years previously were contacted for follow-up. Clinical parameters such as the visual analog scale scores for the back and legs (VAS-B and VAS-L, respectively), the Oswestry disability index (ODI), and radiographic findings such as the disc-height ratio and change in the difference between flexion and extension were recorded and compared to the preoperative values.

Results: For 62 followed patients, 38 met our inclusion criteria (35 transforaminal, 3 interlaminar). Excluded were 6 patients (9.4%) who underwent revision OLM at same level and 17 patients (26.6%) who underwent lumbar spine surgery at other levels. The average follow-up period was 11.22 (± 0.83) years. For the remaining 38 patients who had no further surgery, the postoperative VAS-B (2.53 ± 1.98), VAS-L (1.82 ± 1.92), and ODI (12.69 ± 11.26) were significantly different from the pre-operative values (8.45 ± 1.52, 7.40 ± 3.04, and 55.33 ± 24.63, respectively; all $P = 0.01$). The average disc-height ratio was 81.54% of the original disc height. There was no evidence of instability after long-term postoperative follow-up.

Limitation: Retrospective nature of data collection.

Conclusion: PELD has favorable long-term outcomes.

Key words: Long-term, PELD, endoscopic lumbar discectomy, revision rate, disc height, instability

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Open lumbar microdiscectomy (OLM) has been considered the gold standard in the management of lumbar disc herniation (LDH) because of its favorable outcomes in long-term follow-up (1-3). Nowadays, minimally invasive discectomy (MID) is gaining recognition. According to a 2014 Cochrane Review comparing MID and OLM for disc herniation, MID was associated with comparable results and had potential advantages such as a lower risk of infections and shorter hospital stay (4). The same review stated

that the greatest limitation is the lack of long-term follow-up outcomes for MID.

The most common endoscopic MID procedures are the transforaminal (TF) and interlaminar (IL) approaches of percutaneous endoscopic lumbar discectomy (PELD) (5-7). The purpose of this study is to investigate the long-term outcomes of PELD in terms of clinical and radiographic findings and revision surgery rate.

Methods

This study was approved by our institutional review board. The study included patients who underwent TF or IL PELD in our center with at least 10 years of postoperative follow-up and who were diagnosed with symptomatic disc herniation at one level with no prior or subsequent surgery at any other spinal level.

The exclusion criteria included multiple levels of discectomy; concomitant surgery in addition to PELD performed at the same or different levels; and evidence of stenosis, infection, fractures, or tumors.

All enrolled patients were clinically assessed with the visual analog scale score for the back (VAS-B) and legs (VAS-L) and Oswestry disability index (ODI). We compared the preoperative and long-term postoperative values.

Standing lateral, flexion, and extension radiographs were taken on the patients' long-term follow-up visit. The Mochida method (Fig. 1) was used to measure the disc-height ratio to address radiographic magnification discrepancies in lateral radiographs (8). The disc-height ratio at the long-term follow-up visit was compared to the preoperative value. Intervertebral instability was defined as a greater than 10-degree change of the angle formed by the superior and inferior disc space of the index level between the flexion and extension radiographs (Fig. 2).

For the preoperative and long-term postoperative clinical analysis, statistical analysis was performed via a paired t-test using SPSS for Windows (version 12.0; SPSS, Inc, Chicago, IL). Significant differences between

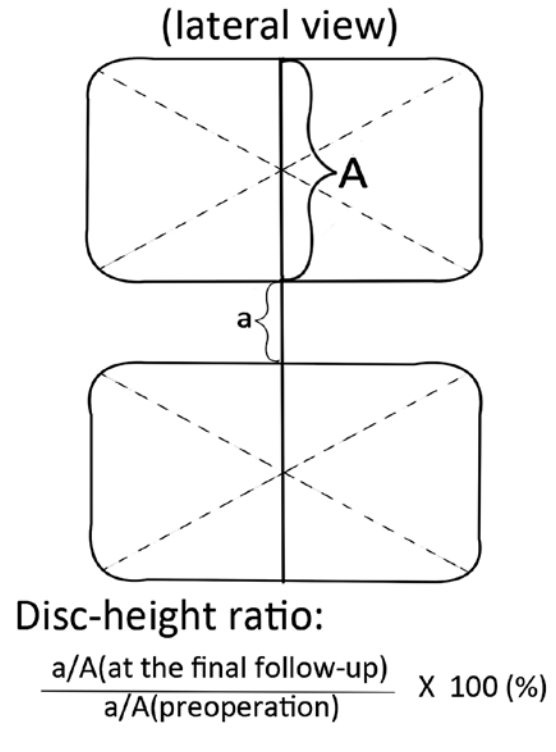

Fig. 1. *Mochida method for measuring the disc height ratio.*

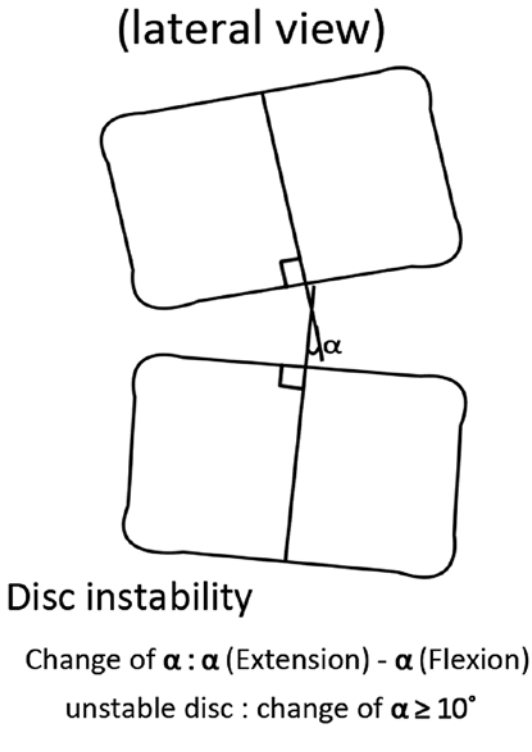

Fig. 2. *Method for checking for disc instability.*

age and clinical score and between disc height ratio and clinical score were analyzed using Pearson's correlation analysis. Differences were considered significant at $P < 0.05$.

Surgical Technique

The following techniques have been described in previous publications (9,10).

TF PELD

TF PELD was performed under local anesthesia with the patient in a prone position on a radiographic table. The index level was identified under fluoroscopy and labeled. An 18-gauze spinal needle was inserted laterally from the midline to a distance premeasured on magnetic resonance imaging (MRI) preoperatively. Fluoroscopic verification confirmed that on the lateral view, the needle tip was at the level of the posterior disc space, and on the anterio-posterior (AP) view, the needle tip was located at the ipsilateral mid-pedicular line. Epidural anesthesia was administered followed by entering the disc space and injecting a radio-opaque dye (Telebrix, Gluerbet, Aulnay-sous-Bois, France). The annulus was then penetrated and discography was done with an indigo carmine (Carmine, indigotindisulfonate sodium injection) and normal saline mix. A guidewire was inserted in the cannula, and a stab incision was made on the skin to pass sequential serial dilators ending with an obturator that entered intradiscally. A multichannel endoscope was then inserted (YESS, Richard Wolf GmbH, Knittlingen, Germany), and discectomy was performed first by releasing the intra-annular disc attachments to the sequestered disc. The herniated fragment was then removed within the spinal canal with forceps slowly while gradually retrieving the working channel and endoscope (Fig. 3). A Holmium-YAG side-firing laser was used to vaporize disc fragments that were not removed by the forceps, and a radiofrequency bipolar coagulator was used to coagulate bleeding vessels. Decompression was confirmed visually.

IL PELD

IL PELD was performed under local anesthesia with the patient in a prone position on a radiographic table. The index level was identified under fluoroscopy and labeled. A perpendicular incision was made medial to the IL window. Serial dilation was performed, and the endoscope was inserted. Under direct visualization and irrigation, the ligamentum flavum was dissected or removed to permit the endoscope to gain access to the spinal canal. Discectomy was then performed by visualizing and resecting the herniated fragment with forceps. Holmium-YAG lasers and radiofrequency coagulators were used in a similar manner as described for the TF approach. Decompression was confirmed visually.

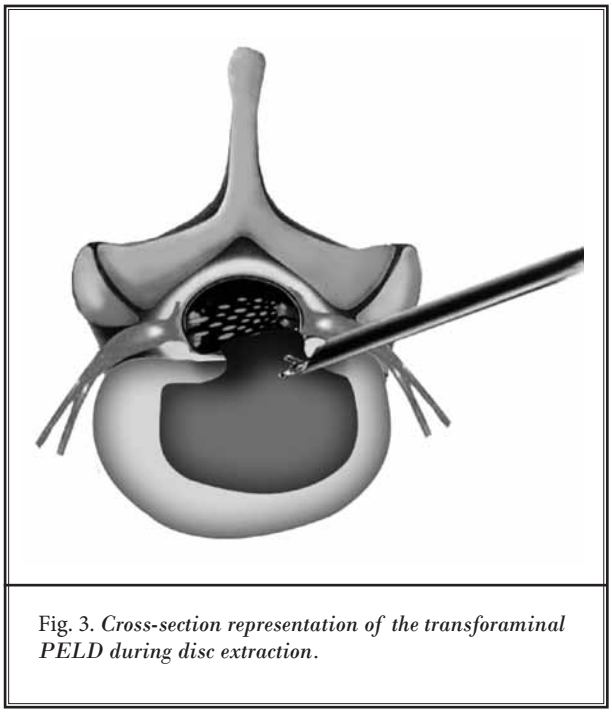

Fig. 3. *Cross-section representation of the transforaminal PELD during disc extraction.*

Results

The average follow-up period of the patients was 11.22 (± 0.83) years (range 10.42 – 12.5 years). For 62 followed patients, 38 met our inclusion criteria (35 TF, 3 IL). The reasons for exclusion of the 24 patients were as follows: 6 patients had revision to OLM at the same level, 14 patients underwent a subsequent surgery (non-PELD) at another level, 3 patients underwent an additional PELD at another level, and one patient had a concomitant compression fracture at the follow-up. Therefore revision surgery rate at the same level is 9.6% and subsequent surgery rate at another level is 27.4%.

The average patient age at the time of follow-up was 53.74 years. The patient demographics are presented in Table 1. The postoperative VAS-B (2.53 ± 1.98) and VAS-L (1.82 ± 1.92) of this series were significantly decreased from the preoperative values (8.45 ± 1.52 and 7.40 ± 3.04, respectively; both $P = 0.01$). In addition, the postoperative ODI (12.69 ± 11.26) of our patient

series was significantly different from the preoperative value (55.33 ± 24.63; $P = 0.01$). The average postoperative disc-height ratio was 81.54 ± 17.40% of the original disc height. There was no correlation between changes in disc height and clinical outcomes. There was no evidence of instability after long-term postoperative follow-up. Clinical scores according to levels and type of surgery are presented in Table 2.

Discussion

Revision and Recurrence

Revision rates for OLM range from 3% to 18% (3,11). Our study identified a long-term revision rate of 9.6% in patients who initially underwent PELD. Reasons for revision are all recurring LDH. OLM was performed in revision surgeries to treat recurrent LDH. An advantage of a revision OLM from PELD is the absence of scar tissue in the posterior route, which is evident in revision OLMs of previous OLM surgeries. Revision OLM to treat recurrence following an initial OLM has resulted in poor revision-related results (12,13).

Recurrence rates because of reherniation have been reported to range from 0% to 7.4% in PELD surgeries, whereas those for OLM range from 1% to 21% (14). Our long-term recurrence rate of 9.6% following PELD is slightly higher than those reported in short- and mid-term studies for PELD surgeries but considerably lower than the highest recurrence rates following OLM.

Table 1. *Patient demographic data.*

Demographic Data		
Item		**Average (± standard deviation)**
Total number		38
Gender	Male	24 (63.2%)
	Female	14 (36.8%)
Level	L3-4	6 (15.8%)
	L4-5	28 (73.7%)
	L5-S1	4 (10.5%)
Side	Left	22 (57.9%)
	Right	16 (42.1%)
Current age		53.74 (13.62)
Preoperative VAS (back)		8.45 (1.52)
Preoperative VAS (leg)		7.40 (3.04)
Preoperative ODI		55.33 (24.63)
Post-op 10 year VAS (back)		2.53 (1.98)
Post-op 10 year VAS (leg)		1.82 (1.92)
Post-op 10 year ODI		12.69 (11.26)
Disc-height ratio		81.54 (17.40)

Abbreviations: VAS: visual analog scale; ODI: Oswestry disability index

Disc Degeneration

In the current study, the average postoperative disc-height ratio was 81.54% of the original disc height. Disc degeneration and the resulting loss of disc height are normal features of aging (15). Yorimitsu et al (3) noted an average disc-height ratio of 78.8% in their series of 40 patients who underwent OLM after long-term follow-up. Another study showed disc height preservation of 75% after OLM (11). However our study as well as other studies (12,16,17) found no correlation between changes in disc height and clinical outcomes.

Instability

Operation-induced instability is a common consequence of OLM, and it may occur in as many as 22% of patients after OLM (18). The resulting instability is significantly associated with back pain during long-term follow-up because of soft tissue resection of the small lumbar muscles attached to the lamina and the resection of the facet joints. The preservation of these structures with PELD results in less chance of instability, whereas these structures would otherwise be resected in OLM. In a short-term retrospective study compar-

Table 2. *Clinical scores according to levels and type of surgery.*

	Pre-op VAS-B	Pre-op VAS-L	Pre-op ODI	Post-op VAS-B	Post-op VAS-L	Post-op ODI
L34	9.33	6.66	57.33	4.16	1.66	25.11
L45	8.25	7.5	56.29	2.1	1.8	10.97
L56	8.75	7.75	45.67	3	2	6.06
Interlaminar	9	7.66	57.71	2.66	2.33	11.67
Transforaminal	8.42	7.37	55.13	2.51	1.77	12.77

Abbreviations: VAS: visual analog scale; ODI: Oswestry disability index

ing PELD and OLM, the researchers found out on final follow-up that 3.4% of patients who underwent OLM developed instability, while no patients in the PELD group developed instability (17).

Clinical Outcomes (VAS, ODI)

OLM has been the gold standard for the management of LDH for the last few decades because of success rates ranging from 76% to 93% in long-term follow-up studies (1-3). We observed significant improvements in measured clinical parameters such as VAS-L, VAS-B, and ODI during long-term follow-up. The reason for relatively good clinical results in this study can be explained by several factors. The minimally invasive nature of PELD may have contributed to a good result. Less muscle damage and less nucleus pulposus removal is expected with PELD. Admittedly, we have excluded patients with revisions for this study, since these revisions may have factors unrelated to the initial PELD.

TR PELD which was done at 10 years ago usually removed intradiscal fragments only. Nowadays, instruments and skills have improved so that most of the herniated epidural fragments could be removed. Authors expect clinical results of PELD nowadays will be better than this study.

Limitations

Our study has considerable limitations with the retrospective nature of the data collection. Readers should note that success rate in our study is from a patient group that did not undergo any other subsequent surgery. Six patients who had revision to OLM at the same level were excluded because our purpose was to know the long-term result of PELD, not revision OLM. Nevertheless, this is the first study of the long-term outcomes of PELD providing clinical results and revision rates.

Conclusion

In the long-term follow-up of PELD patients groups, 9.6% of patients underwent revision OLM at same level and 26.6% of patients underwent lumbar spine surgery at other level. The disc-height was relatively well preserved. The long-term result of PELD performed on patients who do not require subsequent surgery is favorable. Therefore PELD should be considered as a surgical option for the treatment of lumbar disc herniation.

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