ORIGINAL STUDY

Transforaminal Percutaneous Endoscopic Lumbar Discectomy in Caudal Migrated Lumbar Disc Herniations: A Case Series and Literature Review

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Abstract

Background data: Since the initial idea by Kambin and Gellman in 1973 of percutaneous posterolateral lumbar disc decompression, the evolution of minimally invasive interventions in disc herniation has been widely growing. The advancements in optics and surgical instruments allowed surgeons to perform true minimally invasive procedures in a wide range of spine pathologies. In addition, transforaminal percutaneous endoscopic lumbar discectomy (TPELD) has been widely used in various degenerative spine pathologies, owing to the presence of high-speed drills, flexible forceps, scissors, curettes, and probes to manage pathologies such as disc herniation or canal stenosis.

Study design: A prospective clinical case study was performed.

Purpose: The primary objective of this study was to assess the feasibility of migrated lumbar disc excision by TPELD, and the secondary objective was to report any technical difficulty or complications related to the technique.

Patients and methods: Between January 2018 and January 2020, 20 patients who underwent TPELD for radiologically verified caudally migrated lumbar disc prolapse after the failure of conservative therapy were reported. Preoperative and postoperative clinical evaluations were performed for back pain and leg pain by the visual analog scale (VAS) score and for patients’ disability by Oswestry Disability Index (ODI). The radiological evaluations preoperatively and postoperatively were done by lumbosacral MRI complemented by lumbosacral radiography anteroposterior and lateral views. The follow-up visits for the evaluation were immediately after surgery and 6 months and 1 year postoperatively.

Results: A total of 20 cases were involved in this series from January 2018 to January 2020. Nine females and 11 males were included in the study. Postoperatively, the clinical assessment showed improvement in the VAS score of the back pain and leg pain as the mean VAS scores for back pain and leg pain immediately were 4.55 ± 1.70 and 2.4 ± 0.68, respectively. At the 6-month follow-up, the mean VAS scores for back pain, leg pain, and ODI were 2.15 ± 1.03, 1.35 ± 0.74, and 22.2 ± 6.59, respectively. Finally, after 12 months, the mean VAS scores for back pain, leg pain, and ODI were 1.25 ± 0.71, 0.8 ± 0.52, and 15.85 ± 9.22, respectively.

Conclusion: Minimally invasive TPELD proves to be a valuable utility in managing migrated disc fragments in lumbar disc prolapse (LDP). However, it is a technically demanding procedure, but with appropriate tools and introducing angles, it efficiently removes migrated fragments with the preservation of anatomy. Consequently, the stability of the spine is not harmed (2021ESJ248).

Keywords: Caudal migration, Disc, Endoscopic, Lumbar, Transforaminal

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Introduction

The utilization of minimally invasive endoscopic procedures in degenerative spine diseases is increasing. This is due to the acquisitions of similar results compared with conventional open surgeries and minimal iatrogenic insults such as muscle and ligaments injury, which are crucial structures for spine stability, intraoperative bleeding, hospital stay, and postoperative rehabilitation period and pain [1–3].

Since the initial idea by Kambin and Gellman in 1973 of percutaneous posterolateral lumbar disc decompression, the evolution of minimally invasive interventions in disc herniation has been widely growing [4]. The advancements in optics and surgical instruments allowed surgeons to perform true minimally invasive procedures in a wide range of spine pathologies [5]. In addition, transforaminal percutaneous endoscopic lumbar discectomy (TPELD) has been widely used in various degenerative spine pathologies, owing to the presence of high-speed drills, flexible forceps, scissors, curettes, and probes to manage pathologies such as disc herniation or canal stenosis [6,7].

In contrast to its steep learning curve, TPELD carries in its concepts a tremendous challenge for both surgeon and patient. This is owing to the difficulty of the approach, the availability of the surgical optics and instruments, and the patient predictions and satisfaction to undergo the procedure. Still, fewer surgeons worldwide perform it as standard care for their patients. Although it is technically demanding, it carries projections for improving degenerative spine care [5,8].

Far-migrated fragments hold an obstacle for minimally invasive TPELD owing to the anatomical barriers and the inability to introduce tools away from the rigid field of the endoscope. It has been reported in various literature that TPELD can be used in low-grade ‘simple’ disc herniations, whereas in high-grade herniations, TPELD failed to adequately remove the migrated part [9,10]. Lee et al. [24] proposed a classification for the type of migrated disc fragments and suggested that in high grades of herniation and far migration, open surgery is the optimal intervention. Consequently, some authors published data stating that TPELD can be utilized in far-migrated disc herniations by either transfomarinal approach or interlaminar approach [5,11].

The primary objective of this study was to assess the feasibility of migrated lumbar disc excision by TPELD, and the secondary objective was to report any technical difficulty or complications related to the technique.

Patients and methods

This prospective clinical case study was conducted between January 2018 and January 2020 at Suez Canal University Hospital. This study included patients with the following criteria: (a) age between 18 and 60 years; (b) no previous spine surgery; (c) radiologically verified prolapsed lumbar disc with caudal migration; (d) levels from L1 to L5; and (e) failure of adequate conservative therapy for at least 3 months. The patients with abnormal segmentation of the lumbosacral spine with ‘sacralization of L5, lumbar disc prolapse at L5/S1’, and incomplete follow-up were excluded. In this study, we followed the World Medical Association Declaration of Helsinki, as a statement for ethical principles for medical research involving human patients. All patients consented to the surgical intervention along with research consent to publish the medical data. The study was approved by our IRB.

The reported preoperative data included age, sex, work status, BMI, and comorbidity. All patients were subjected to full general and neurological examination before the scheduled surgery. Preoperative and postoperative clinical evaluations were conducted for low back pain (LBP) and leg pain by visual analog scale (VAS) [12] and for patients’ disability by Oswestry Disability Index (ODI) [13]. The radiological evaluations preoperatively and postoperatively were done by lumbosacral MRI complemented by lumbosacral radiography anteroposterior and lateral views. The follow-up schedule for the evaluation was immediately (for clinical assessment, LBP, and leg pain by VAS), 6 months, and 1 year postoperatively (for clinical assessment, LBP, and leg pain by VAS and ODI). The operative data were collected in terms of operative time, blood loss, and hospitalization period postoperatively. We reported complications or setbacks in this technique as a secondary objective.

Operative technique

In a prone position on a radiolucent table (Fig. 1A), the patient is positioned under local anesthesia with a conscious sedation process. The skin entry point is set by fluoroscopy ipsilateral to the desired level by 10–14 cm (Fig. 1B) and confirmed by lateral fluoroscopy view where the mark does not pass the facet line preferably to lie.
within the spinous process line ‘avoidance of retrointrapitoneal injury.’ The trajectory is taken into consideration for the migrated fragment; as for the caudally migrated fragments, a more angled trajectory downward is designed (Fig. 1C). Skin infiltration with lidocaine 1% a 22-G needle is inserted and introduced under fluoroscopy in anteroposterior view to reach the superior facet and then introduced into disc space ventrally through the Kambin’s triangle. A guide wire is introduced on the needle followed by a muscle dilator. Finally, the endoscopic sheath is bypassed over the dilator, and then the endoscope ‘KARL STORZ Spine TIP and KARL STORZ endoscopic video tower’ is advanced (Fig. 2). Standard intradiscal decompression by discectomy is done until an annular tear is observed by the presence of epidural fat and pulsation sign. A curved endoscopic hook is introduced with fluoroscopy guidance and passed through the annular tear to the adjacent endplate, and manual dissection carefully is done to dissect the migrated fragment, which is commonly found under the posterior longitudinal ligament (Fig. 3). Afterward, the part of the fragment is visualized and taken out by the rongeur and in cases of caudal migrated fragments, drilling of the superior articular facet (foraminoplasty) was conducted (Fig. 4). It is not uncommon to extract the fragment as one piece (Fig. 5), but sometimes, especially in more chronic cases, piecemeal excision is optimal and sufficient. The surgeon detects a satisfactory decompression by the pulsations of the neural structure and epidural fat, and also, hook navigation is useful for checking for complications by asking the patient to move the corresponding myotome intraoperatively. Hemostasis is achieved by bipolar cautery followed by the closure of the endoscopic skin incision by a single stitch of a monofilament nonabsorbable ‘Proline’ 2-0 suture.

Statistical analysis

The data collected from medical records were coded and entered using Microsoft Excel Software. The collected data were processed using SPSS, version 19 (SPSS Inc., Chicago, Illinios, USA). The quantitative data were expressed as means ± SD,
whereas the qualitative data were expressed as numbers and percentage. \(\chi^2\) was used to test the significance of the difference for the quantitative variables. Results were presented in tables and graphs. A \(P\) value less than 0.05 was considered statistically significant.

Results

A total of 20 patients were prospectively recruited in this series after excluding five patients owing to incomplete follow-up data. Nine females and 11 males with a mean age of 35.15 ± 16.9 years (14–75 years) were reported in the study. The mean BMI was 32.75 ± 5.17 (25–42) (Table 1).

A total of 20 levels were operated upon in this series, including L4–L5 (\(n = 13\)), L3–L4 (\(n = 6\)), and L2–L3 (\(n = 1\)) levels. The average preoperative VAS scores for back pain, leg pain, and ODI were 5.5 ± 2.06 (0–7), 6.8 ± 1.05 (5–8), and 54.55 ± 12.03 (30–69), respectively. Four patients had a motor weakness; two of them had weakness in ankle dorsiflexion motor power grade (MPG) (4+), one of them had weakness in ankle dorsiflexion MPG (3), and one patient had partial cauda equina syndrome (weakness in ankle dorsiflexion and plantarflexion MPG 3 and weakness in knee flexion MPG 3 and positive saddle hypoesthesia).

The operative details are summarized in Table 2. Postoperatively, the clinical assessment showed improvement in the back pain and leg pain, as the means of the VAS scores of back pain and leg pain were 4.55 ± 1.70 and 2.4 ± 0.68, respectively. At the 6-month follow-up, the mean VAS scores of back pain, leg pain, and ODI were 2.15 ± 1.03, 1.35 ± 0.74, and 22.2 ± 6.59, respectively. Finally, after 12 months, the mean VAS scores of back pain, leg pain, and ODI were 1.25 ± 0.71, 0.8 ± 0.52, and 15.85 ± 9.22, respectively (Table 3).

In this series, no operative complications were encountered or added neurological deficits or infection postoperatively. However, during follow-up, one patient had recurrent L4–L5 lumbar disc prolapse after a 12-month follow-up, and after clinical and radiological review, the patient responded well to conservative therapy.

The neurological examination at the 12-month follow-up showed improvement of two of the four patients preoperatively who presented with motor weaknesses through an intensive physiotherapy course after surgery.

Postoperatively, a good MRI radiological sign was discovered, which is the empty disc sign at the same previous site of herniation (Fig. 6). This sign was reported in 16 patients.

Discussion

TPELD procedures have become popular among spine surgeons nowadays. These are technically demanding procedures that provide a minimally invasive intervention to manage the lumbar disc prolapse, in addition to providing a safe and efficient approach with fewer complications than traditional disc surgery [14,15]. TPELD protects patients from the risks associated with traditional disc surgery, such as postdiscectomy syndrome, epidural scarring, and postlaminctomy instability [16–19]. Migrated disc fragments occurred in 35–72% of lumbar disc prolapse (LDP) [7,9]. The complete
excision of migrated lumbar fragments requires wide dissection around epidural space through the lamina, pars, and facets; consequently, instability may occur, and further instrumentation will be required [20].

The use of TPELD in migrated disc prolapse has been challenging, and some authors preferred the use of interlaminar percutaneous endoscopic lumbar discectomy (PELD) for accessing migrated fragments [9,14,21]. Owing to the evolutionary improvements in the surgical instruments and improved endoscopic instruments, migrated fragments can be excised using TPELD. Endoscopic instruments such as semiflexible, articulating, and curved forceps and flexible curved probes allowed the access to remote areas and the excision of the migrated fragments [22–24].

TPELD has advantages over the interlaminar approach in managing migrated disc prolapse. First, there is a low incidence of dural sac injury in TPELD as the first encounter during the approach is the disc space and during discectomy, the dural sac is pushed away from the field by the prolapsed disc [25]. Second, intradiscal decompression by TPELD (the removal of the main bulk of the iceberg) allows neural decompression and better navigation afterward for a migrated fragment, whereas interlaminar PELD requires neural retraction during the early stages of the procedures to access the migrated fragment [26]. Huang et al. [14], in their retrospective study, reported that TPELD as a minimally invasive technique is capable of managing caudal migrated fragments; however, they stated that interlaminar PELD had superior results related to residual fragments, operative time, and fluoroscopic exposure.

In this study, we demonstrated our technique and reported our experience of the TPELD in managing migrated lumbar disc prolapse. A total of 20 patients were involved in this study, comprising nine females and 11 males. All patients underwent the procedures with a conscious sedation anesthesia technique, with no reported cases of severe morbidity, mortality, or neurological deterioration.

Ahn et al. [1], in their series of 13 patients who underwent TPELD in migrated disc prolapses, showed that TPELD had improved the mean VAS of leg pain from $7.86 \pm 1.28$ preoperatively to $1.85 \pm 1.07$ after 12 months and the mean ODI from $84.92 \pm 6.36$ preoperatively to $17.54 \pm 13.40$ after 12 months. They had 92.3% symptomatic improvements after 12 months. Osman et al. [28], in their series, reported improvement of the VAS of leg pain from $9.32 \pm 0.43$ preoperatively to $1.78 \pm 0.71$ 1 after 1 week. They also reported improvement in the ODI from $79.82 \pm 4.53$ preoperatively to $15.27 \pm 3.82$ a week postoperatively. Kim et al. [22], in their series,

<table>
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<th>Parameters</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>$35.15 \pm 16.9$ (75–14)</td>
</tr>
<tr>
<td>Sex</td>
<td>9 females and 11 males</td>
</tr>
<tr>
<td>BMI</td>
<td>$32.75 \pm 5.17$ (42–25)</td>
</tr>
<tr>
<td>Level</td>
<td>L2–L3 1 level</td>
</tr>
<tr>
<td></td>
<td>L3–L4 6 levels</td>
</tr>
<tr>
<td></td>
<td>L4–L5 13 levels</td>
</tr>
<tr>
<td>Comorbidity (%)</td>
<td></td>
</tr>
<tr>
<td>Hypertension (HTN)</td>
<td>10</td>
</tr>
<tr>
<td>Diabetes mellitus (DM)</td>
<td>15</td>
</tr>
<tr>
<td>Ischemic heart diseases (IHD)</td>
<td>10</td>
</tr>
</tbody>
</table>

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<tr>
<th>Parameters</th>
<th>Results</th>
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</thead>
<tbody>
<tr>
<td>Operative time (min)</td>
<td>$44 \pm 8.065$ (3–155)</td>
</tr>
<tr>
<td>Blood loss (ml)</td>
<td>$36.5 \pm 13.088$ (20–50)</td>
</tr>
<tr>
<td>Hospital stay (h)</td>
<td>$6.95 \pm 2.7$ (6–18)</td>
</tr>
</tbody>
</table>
reported similar successful results with improvements in VAS of leg pain from $7.5 \pm 1.7$ preoperatively to $2.6 \pm 1.8$ in the final follow-up. They stated that the average return to work duration was 14 days, and there were no approach-related complications. Parker et al. [29], in their retrospective study, reported that additional foraminoplasty is required to manage migrated fragments, and their technique, vertebral trench technique, managed to excise even the upward migrated fragments easily.

In 2017, Choi et al. [10] reported a total of 149 patients: 134 patients underwent TPELD and 15 interlaminar PELD. They reported a 90.6% favorable outcome in all patients.

However, these results are promising in utilizing TPELD in managing migrated disc fragments; still, there are concerns regarding the failure to achieve maximal satisfaction by completely relieving the patients’ pain or the potential recurrence of the disc prolapse. Choi et al. [10] reported that five of 59 patients failed to have complete symptom relief owing to residual disc remnants. Kim et al. [22] also reported 13% of the residual disc material. The failure is not due to an improper technique selection for pathology but mostly owing to the nature of the pathology of the migrated fragments itself. Migrated fragments are seen to be a multifragmentation structure, and this might be a deceiving nature not probably apparent on the MRI [33]. TPELD can be used but with patience and the application of flexible tools such as the hook that can sweep subligamentally and dissect any residue during the surgery. In addition, positive signs of decompression such as the appearance of the epidural fat and the apparent dural pulsations augment the concept of total disc excision.

TPELD, like other procedures, requires a learning curve, and after mastering it with adherence to technical guidelines, it can adequately manage disc prolapse with migrated fragments. Introduction trajectory is important in preplanning to properly study the patient’s MRI and decide the proper angle.

### Table 3. Clinical data between preoperatively and 12 months postoperatively.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Preoperatively</th>
<th>Immediately postoperatively</th>
<th>6 months</th>
<th>12 months</th>
<th>t score</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAS back pain</td>
<td>5.5 ± 2.06 (0–7)</td>
<td>4.55 ± 1.70 (0–6)</td>
<td>2.15 ± 1.03 (0–4)</td>
<td>1.25 ± 0.71 (0–2)</td>
<td>–8.72</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>VAS leg pain</td>
<td>6.8 ± 1.05 (5–8)</td>
<td>2.4 ± 0.68 (1–4)</td>
<td>1.35 ± 0.74 (0–3)</td>
<td>0.8 ± 0.52 (0–2)</td>
<td>–22.9</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>ODI</td>
<td>54.55 ± 12.03 (30–69)</td>
<td>–</td>
<td>22.2 ± 6.59 (10–32)</td>
<td>15.85 ± 9.22 (5–48)</td>
<td>–11.419</td>
<td>&lt;0.0001*</td>
</tr>
</tbody>
</table>

ODI, Oswestry disability index; VAS, visual analog scale.

*P value at a 95% confidence interval is less than 0.05, statistically significant.

Fig. 6. MRI lumbosacral spine sagittal view. (A) Preoperative caudally migrated fragment. (B) Postoperatively after fragment removal; white arrow at the hyperintense area shows an empty disc sign, axial view of MRI lumbosacral spine. (a) Preoperatively left-sided disc prolapse with a caudally migrated fragment. (b) Postoperatively, arrowhead shows the prior site of the fragment after excision ‘empty disc sign.’
Severe foraminal stenosis impairs the application of TPELD due to the risk of root injury. Conscious sedation anesthesia is important with the procedure to allow live feedback from the patient.

The small sample size may affect the statistically significant results. Consequently, it is advocated for randomized clinical trials to assess the role of TPELD in managing caudal migrated fragments in lumbar disc prolapse.

This study recommends using TPELD to manage caudally migrated fragments in lumbar disc prolapse. Moreover, it is recommended that the spine society should brace the use of the endoscope as a minimally invasive procedure that allows better quality intervention for both the surgeon and the patient with less operative risks and a safer application. Spine surgeons should brace this maneuver as its promising learning curve allows rapid implementation in spine surgeries.

Conclusion

Minimally invasive TPELD proves to be a valuable utility in managing migrated disc fragments in LDP. However, it is a technically demanding procedure, but with appropriate tools and introducing angles, it will efficiently remove migrated fragments with the preservation of anatomy. Consequently, the stability of the spine will not be harmed.

Conflict of interest

There are no conflicts of interest.

Abbreviations list

AP  Anteroposterior
BMI  Body mass index
LBP  Low back pain
MRI  Magnetic resonance imaging
MPG  Motor power grade
ODI  Oswestry disability index
PELD  Percutaneous endoscopic lumbar discectomy
TPELD  Transforaminal percutaneous endoscopic lumbar discectomy
VAS  Visual analog score

References


