Original Article

Percutaneous Endoscopic Lumbar Discectomy for the Treatment of Lumbar Disc Herniation — A Novel Approach

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ABSTRACT

Introduction: *Lumbar disc herniation (LDH) is a prevalent condition causing significant morbidity and disability. Traditional open lumbar microdiscectomy (OLM) has been the gold standard for treatment, but percutaneous endoscopic lumbar discectomy (PELD) has emerged as a promising minimally invasive alternative.* ***Methods & Materials:*** *A cross-sectional analytical study was conducted at the Department of Neurosurgery, National Institute of Neuro Sciences & Hospital. Thirty-three patients with LDH at the L4/L5 level who underwent PELD were included. Preoperative and postoperative pain levels were measured using the Visual Analogue Scale (VAS), and functional disability was assessed using the Oswestry Disability Index (ODI).* ***Results:*** *The mean age of participants was 42.21 ± 12.13 years. Postoperative outcomes showed the mean VAS scores for lower back pain decreased from 6.17±3.70 to 1.78±0.72, right lower leg pain from 6.55±3.50 to 1.79±0.76, and left lower leg pain from 6.51±3.22 to 1.75±0.55. The mean ODI score improved from 86.16±8.01 to 22.49±7.08. The improvement rates at 90th POD were 84.84% for lower back pain, 84.84% for*

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right lower leg pain, 87.87% for left lower leg pain, and 93.93% for ODI. The mean hospital stay was 5.17±3.67 days, with a disc space infection rate of 3.03%. ***Conclusion:*** *PELD is a highly effective and safe alternative to OLM for treating LDH, offering significant pain relief and functional improvement with minimal complications. Further research with larger sample sizes and long-term follow-up is needed to validate these findings and refine patient selection criteria.*

Keywords: *Lumbar disc herniation, percutaneous endoscopic lumbar discectomy, Visual Analogue Scale, Oswestry Disability Index, minimally invasive surgery.*

INTRODUCTION

Lumbar disc herniation (LDH) is a prevalent condition causing significant morbidity and disability worldwide. It occurs when the inner core of the intervertebral disc protrudes through the outer ring, often impinging on adjacent neural structures and resulting in symptoms such as lower back pain, radiculopathy, and neurologic deficits in the lower extremities[1]. Traditional surgical approaches for LDH, such as open lumbar microdiscectomy (OLM), have long been the gold standard for decompressing the affected nerve roots. However, these procedures typically involve extensive tissue dissection and larger incisions, which can lead to prolonged recovery times, postoperative pain, and potential complications[2]. In recent decades, percutaneous endoscopic lumbar discectomy (PELD) has emerged as a promising alternative for the treatment of LDH. PELD represents a minimally invasive surgical technique that utilizes endoscopic visualization to access and remove herniated disc material while preserving surrounding structures. This approach was first introduced in the 1980s by Kambin and Gellman, who pioneered the use of percutaneous lateral discectomy for the treatment of lumbar disc herniation[3]. The PELD procedure typically involves making a small incision, usually less than 1 cm in length, through which an endoscope is inserted into the spinal canal under fluoroscopic guidance. Once inside the disc space, specialized instruments are used to remove the herniated disc material, relieving pressure on the compressed nerve roots. Unlike traditional open surgery, PELD requires minimal tissue disruption and can often be performed on an outpatient basis, allowing for faster recovery and shorter hospital stays[4]. Several studies have investigated the efficacy and safety of PELD compared to conventional open surgery for the treatment of LDH. These studies have consistently demonstrated comparable outcomes between PELD and OLM in terms of symptom relief, functional improvement, and patient satisfaction. For example, a prospective randomized controlled trial by Ruetten et al. found that full-endoscopic PELD resulted in similar clinical outcomes and complication rates compared to conventional microsurgical techniques[5-7]. Furthermore, PELD offers several potential advantages over traditional open surgery. The minimally invasive nature of the procedure reduces intraoperative blood loss, postoperative pain, and the risk of wound complications. Additionally, the preservation of surrounding soft tissue and spinal stability may lead to faster rehabilitation and earlier return to normal activities[8,9]. However, PELD is not without its limitations and challenges. The procedure requires

specialized training and expertise to perform safely and effectively, and there is a learning curve associated with mastering endoscopic techniques. Furthermore, PELD may not be suitable for all patients, particularly those with large or centrally located disc herniations, severe spinal stenosis, or complex anatomical variations[10]. However, further research is needed to refine patient selection criteria, optimize surgical techniques, and assess long-term outcomes compared to conventional surgery. So, this study aimed to assess percutaneous endoscopic lumbar discectomy as a treatment for lumbar disc herniation.

METHODS & MATERIALS

This cross-sectional analytical study was conducted at the Department of Neurosurgery, National Institute of Neuro Sciences & Hospital, from 1st January, 2022 to 30th June 2023. This study is a cross-sectional study of patients who underwent Percutaneous Endoscopic Lumbar Discectomy (PELD) for the treatment of Lumbar Disc Herniation (LDH) in patients experiencing Lumbago and right/left-sided sciatica attributed to Posterior Lateral Intervertebral Disc (PLID) at the L4/L5 level. Patients presenting with symptoms of Lumbago and right/left-sided sciatica due to PLID at the L4/L5 level were included purposively in the study. Inclusion criteria encompassed patients aged 16 to 80 years, with a confirmed diagnosis of LDH via clinical assessment and MRI of the lumbosacral spine. Patients with other spinal pathologies, previous lumbar surgeries, or systemic illnesses affecting surgical outcomes were excluded. Prior to surgery, patients underwent comprehensive clinical evaluation, including motor and sensory examinations, and measurement of peripheral pulses. the MRC grade was used to assess muscle strength. Patients were performed sensory examination, SLR, cross SLR and femoral stretch test to evaluate the severity of the diseases. Additionally, patients rated their preoperative pain levels using the Visual Analogue Scale (VAS) for lower back pain and leg pain. The severity of functional disability was assessed using the Oswestry Disability Index (ODI). Additionally, MRI of the lumbosacral spine was performed to determine the level and location of the herniated disc. Following surgery, patients' postoperative pain levels were assessed using the VAS for lower back pain and leg pain. Additionally, ODI scores were recorded to evaluate functional disability postoperatively. Patients were followed up at the 1st, 30th, and 90th postoperative day (PODs) to monitor their recovery and assess the long-term outcomes of the procedures. The primary outcome measures included postoperative pain levels and functional disability scores. Informed consent was obtained from all patients prior to participation in the study. Data collected were analyzed using appropriate statistical methods to compare outcomes between PELD and OLM groups. Descriptive statistics, such as means, standard deviations, and percentages, were calculated for continuous and categorical variables. Inferential statistics, including chi-square tests for categorical variables, was employed to determine significant differences between groups. A p-value <0.05 was considered statistically significant.

RESULTS

The mean age of the participants was 42.21 ± 12.13 years. The baseline characteristics of the study participants (N=33) show a diverse age distribution, with the majority of participants falling within the 31-45 age range (39.39%), followed by the 16-30 age group (33.33%), the 46-60 age group (24.24%), and a small proportion over 60 years old (3.03%). Gender distribution indicates a higher prevalence of males (60.60%) compared to females (39.39%). Regarding occupation, a significant majority of participants are sedentary workers (87.87%), while a minority are manual workers (12.12%). Co-morbidity data reveals that only one participant has hypertension (3.03%), with no reported cases of diabetes mellitus or hypothyroidism among the participants. Clinically, all participants report low back pain (100.0%), making it the most common symptom. Leg pain is also prevalent, with 48.48% experiencing pain in the right leg and 45.45% in the left leg. A notable 90.90% of participants' report weakness in the right lower limb, whereas only 3.03% report similar weakness in the left lower limb. Additionally, abnormal sensation is reported by 75.57% of participants. These statistics highlight the significant burden of musculoskeletal symptoms and the predominance of certain demographic and occupational characteristics among the study population.

Table I: Baseline characteristics distribution among the participants (*n*=33)

Basic	Characteristics *n*(%)
Age	
16-30	11,33.33%
31-45	13,39.39%
46-60	8,24.24%
>60	1,3.03%
Gender	
Male	20,60.60%
Female	13,39.39%
Occupation	
Manual worker	4,12.12%
Sedentary worker	29,87.87%%
Co-morbidities	
Diabetes Mellitus	0, 0.00%
Hypertension	1, 3.03%
Hypothyroidism	0, 0.00%
Clinical feature	
Low back pain	33, 100.0%
Leg pain (right)	16,48.48%
Leg pain (left)	15,45.45%
Weakness of right lower limb	30, 90.90%
Weakness of left lower limb	1, 3.03%
Abnormal sensation	25, 75.57%

The physical examination and radiological findings of the study population highlight several key aspects of their musculoskeletal and neurological status. The motor examination, evaluated using the MRC grade, reveals high average scores across various muscle groups. Specifically, both the right and left hip flexors scored an average of 4.94±0.48, while the knee extensors on both sides achieved a score of 5. The right and left ankle dorsiflexion scored slightly lower, with averages of 4.63±0.54 and 4.69±0.46,

respectively. The Extensor Hallucis Longus (EHL) muscles scored 4.37±0.73 on the right and 4.31±0.71 on the left, whereas the Flexor Hallucis Longus (FHL) muscles scored 5.0 on the right and 4.97±0.70 on the left, indicating near-normal strength. Reflex assessments showed that all participants had a present knee jerk reflex on the right side, while 93.93% had it on the left. The ankle jerk and plantar reflexes were also present in 93.93% of participants bilaterally. In terms of sensory examination, the right-sided sensory system was intact in 51.51% of participants, while the left-sided sensory system was intact in 60.60%. The straight leg raise (SLR) test was positive in 48.48% on the right and 45.45% on the left, with cross SLR positivity being rare (3.03% on both sides). The femoral stretch test showed a high positivity rate of 90.90% bilaterally. Gait examination results indicate that right-sided and left-sided heel walking was intact in 72.72% of participants, while toe walking was intact in 87.87% bilaterally. Spinal examination revealed high incidences of kyphosis, scoliosis, gibbus, and point tenderness, each affecting 90.90% of the participants. The presence of peripheral pulses in the lower limbs was noted in 87.87% of participants. MRI findings indicated that herniation was predominantly paracentral in all participants (100%), with central herniation present in 75.57%.

Table II: Distribution of the study population based on physical examination and radiological findings (*n*=33)

Physical examination and radiological findings	*n*(%)
Motor Examination (Evaluation of MRC grade)	
Mean score of Right-sided Hip flexor	4.94±0.48
Mean score of Left-sided Hip flexor	4.94±0.48
Mean score of Right-sided Knee extensor	5±0.00
Mean score of Left-sided Knee extensor	5.0±0.00
Mean score of Right-sided ankle dorsiflexion	4.63±0.54
Mean score of Left-sided ankle dorsiflexion	4.69±0.46
Mean score of Right-sided EHL (Extensor Hallucis Longus)	4.37±0.73
Mean score of Left-sided EHL	4.31±0.71
Mean score of Right-sided FHL (Flexor Hallucis Longus)	5.0±0.00
Mean score of Left-sided FHL	4.97±0.70
Reflexes	
Right-sided Knee jerk present	33,100.0%
Left-sided Knee jerk present	31,93.93%
Right-sided Ankle jerk present	31,93.93%
Left-sided Ankle jerk present	31,93.93%
Right-sided Planter reflex present	31,93.93%
Left-sided Planter reflex	31,93.93%

present	
Sensory examination	
Right-sided sensory system intact	17,51.51%
Left-sided sensory system intact	20,60.60%
Right-sided SLR positive	16,48.48%
Left-sided SLR positive	15,45.45%
Right-sided Cross SLR positive	1,3.03%
Left-sided Cross SLR positive	1,3.03%
Right-sided Femoral stretch test positive	30,90.90%
left-sided Femoral stretch test positive	30,90.90%
Gait	
Right-sided heel walking intact	24,72.72%
Left-sided heel walking intact	24,72.72%
Right-sided toe walking intact	29,87.87%
Left-sided toe walking intact	29,87.87%
Examination of spine	
Kyphosis	30,90.90%
Scoliosis	30,90.90%
Gibbus	30,90.90%
Point of tenderness	30,90.90%
Presence of peripheral pulses of the lower limb	29,87.87%
MRI findings (Hernial location)	
Central	25,75.57%
Paracentral	33,100.0%

Mean duration of hospital stay was 5.17±3.67. There were no cases of dural tear, partial nerve root injury, wound infection, cerebrospinal fluid (CSF) leak, foot drop, or recurrence, as each of these complications was observed in 0% of the patients. However, disc space infection was the only complication that occurred, affecting a single patient, which corresponds to 3.03% of the study population.

Table III: Distribution of the study population based on complication developed after operation (*n*=33)

Complications	*n*(%)
Dural teat	0,0%
Partial nerve root injury	0,0%
Wound infection	0,0%
Disc space infection	1,3.03%
CSF leak	0,0%
Foot drop	0,0%
Recurence	0,0%

The comparison of pre-operative and post-operative Visual Analog Scale (VAS) scores and Oswestry Disability Index (ODI) scores among the study participants (N=70) demonstrates significant improvements in pain levels and disability following surgery. Pre-operatively, the VAS score for lower back pain averaged 6.17±3.70, indicating moderate to severe pain. Similarly, the VAS scores for right and left-sided lower leg pain were 6.55±3.50 and 6.51±3.22, respectively, also reflecting considerable pain levels. The pre-operative ODI score was 86.16±8.01, suggesting severe disability. At the 90th post-operative day (POD) follow-up, there was a marked reduction in pain levels and disability. The VAS score for lower back pain decreased to 1.78±0.72, and the scores for right and left-sided lower leg pain dropped to 1.79±0.76 and 1.75±0.55, respectively, indicating mild pain. The ODI score improved significantly to 22.49±7.08, showing a substantial reduction in

disability. The improvement rates at the 90th POD highlight the effectiveness of the surgical intervention. The VAS scores for lower back pain and right-sided lower leg pain both improved by 84.84%, while the left-sided lower leg pain VAS score improved by 87.87%. The ODI score showed the highest improvement rate at 93.93%. These statistics underscore the substantial alleviation of pain and enhancement in functional ability post-surgery, reflecting the overall success of the surgical treatment in the study population. The comparison of pre-operative and post-operative Visual Analog Scale (VAS) scores and Oswestry Disability Index (ODI) scores among the study participants (N=70) demonstrates significant improvements in both pain levels and disability following surgery. Pre-operatively, the mean VAS score for lower back pain was 6.17±3.70, indicating moderate to severe pain. The mean VAS scores for right-sided and left-sided lower leg pain were 6.55±3.50 and 6.51±3.22, respectively, also reflecting considerable pain levels. The pre-operative ODI score was 86.16±8.01, suggesting a high level of disability. At the 90th post-operative day (POD) follow-up, there was a marked reduction in pain and disability. The mean VAS score for lower back pain decreased to 1.78±0.72, while the mean VAS scores for right-sided and left-sided lower leg pain dropped to 1.79±0.76 and 1.75±0.55, respectively, indicating a shift to mild pain levels. Correspondingly, the ODI score improved significantly to 22.49±7.08, indicating a substantial reduction in disability. The percentage improvements in the VAS and ODI scores at the 90th POD further underscore the effectiveness of the surgical intervention. The mean VAS scores for lower back pain and right-sided lower leg pain both improved by 84.84%, while the mean VAS score for left-sided lower leg pain improved by 87.87%. The ODI score showed an impressive improvement of 93.93%. These results highlight the substantial alleviation of pain and enhancement of functional ability post-surgery, reflecting the overall success and positive impact of the surgical treatment on the study population.

Table IV: Comparison of pre-operative and post-operative VAS score and Oswestry Disability Index (*n*=33)

VAS score and ODI score	*n*(%)
Pre-operative	
Mean VAS score for lower back pain	6.17±3.70
Mean VAS score for right sided lower leg pain	6.55±3.50
Mean VAS score for left sided lower leg pain	6.51±3.22
ODI score	86.16±8.01
At 90th POD post-operative follow-up	
Mean VAS score for lower back pain	1.78±0.72
Mean VAS score for right sided lower leg pain	1.79±0.76
Mean VAS score for left sided lower leg pain	1.75±0.55
ODI score	22.49±7.08
Improvement of VAS score and ODI score at 90th POD	
Mean VAS score for lower back pain	28,84.84%
Mean VAS score for right sided lower leg pain	28,84.84%
Mean VAS score for left sided lower leg pain	29,87.87%
ODI score	31,93.93%

DISCUSSION

The present study assessed the outcomes of percutaneous endoscopic lumbar discectomy (PELD) for the treatment of lumbar disc herniation (LDH) and compared these findings to conventional open lumbar microdiscectomy (OLM). Our findings demonstrated significant improvements in postoperative Visual Analog Scale (VAS) scores for lower back pain and leg pain, as well as Oswestry Disability Index (ODI) scores, indicating substantial alleviation of pain and enhancement in functional ability. These outcomes are in line with previous studies that have highlighted the efficacy of minimally invasive surgical techniques for LDH. The mean age of participants in our study was 42.21 years, with the majority falling within the 31-45 age range. This demographic is comparable to other studies such as those by McGirt et al. (41 ± 10 years) and *Dewing et al.* (27.0 years), indicating that LDH predominantly affects middle-aged adults[11,12]. Our gender distribution showed a higher prevalence of males (60.60%) compared to females (39.39%), which aligns with the findings of *Varlotta et al.,* who reported a similar gender distribution in patients with LDH[13]. The occupation distribution revealed that a significant majority were sedentary workers (87.87%), a factor known to contribute to the development of LDH, as highlighted by Kelsey[14].

Clinically, all participants reported low back pain, and a significant proportion experienced leg pain and weakness in the lower limbs. These symptoms are consistent with the clinical presentations documented in the SPORT trial, which reported high prevalence of back and leg pain among LDH patients[15]. Our study also demonstrated high average scores in motor examination (MRC grade) and intact reflexes in most participants, comparable to the findings by *Stankovic et al.,* who emphasized the importance of thorough physical and neurological examinations in LDH diagnosis[16]. MRI findings in our study indicated that paracentral herniation was present in all participants, with central herniation in 75.57%. These findings are supported by Modic et al., who found MRI to be a highly reliable diagnostic tool for identifying disc herniations and associated spinal canal stenosis[17]. The postoperative outcomes of PELD in our study showed a mean hospital stay of 5.17 days and a disc space infection rate of 3.03%, with no cases of dural tear, partial nerve root injury, wound infection, CSF leak, foot drop, or recurrence. These results compare favorably with those reported by Zhou et al., who documented low complication rates in patients undergoing PELD and PEID[18]. Similarly, *Chen et al.* reported no major complications in their study of PELD, further validating the safety and efficacy of the procedure[19]. When comparing preoperative and postoperative outcomes, our study found significant reductions in VAS scores for lower back pain (from 6.17 to 1.78), right lower leg pain (from 6.55 to 1.79), and left lower leg pain (from 6.51 to 1.75), along with a substantial decrease in ODI scores (from 86.16 to 22.49) at the 90th postoperative day. These improvements are consistent with the findings of *Hey et al.,* who reported significant enhancements in ODI and EQ-5D scores postoperatively in LDH patients[20]. Similarly, *Mehendiratta et al.* and *Cetin et al.* documented notable reductions in VAS and ODI scores following lumbar microdiscectomy,

underscoring the effectiveness of surgical intervention in alleviating pain and disability[21,22]. Moreover, our study's improvement rates in VAS scores for lower back pain (84.84%), right lower leg pain (84.84%), and left lower leg pain (87.87%), as well as ODI score (93.93%), are in line with the outcomes reported by Kumarasamy et al., who found that patients with LDH showed significant improvements in back pain and functional scores postoperatively[23]. These results suggest that PELD provides comparable, if not superior, outcomes to traditional surgical methods, with the added benefits of shorter recovery times and fewer complications. In conclusion, our study demonstrates that PELD is a highly effective and safe alternative to conventional OLM for the treatment of LDH. The significant improvements in pain and functional disability, along with the low complication rates, make PELD a viable option for patients seeking minimally invasive surgical solutions. Future research should focus on long-term outcomes and the development of standardized guidelines for patient selection and surgical techniques to further optimize the benefits of PELD.

Limitations of The Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

Conclusion:

In conclusion, this study demonstrates that percutaneous endoscopic lumbar discectomy (PELD) is a highly effective and safe surgical technique for the treatment of lumbar disc herniation (LDH). Our findings indicate significant improvements in postoperative pain and functional disability, as evidenced by substantial reductions in Visual Analog Scale (VAS) scores and Oswestry Disability Index (ODI) scores at the 90th postoperative day. The minimally invasive nature of PELD, coupled with its low complication rates and shorter hospital stays, offers considerable advantages over traditional open lumbar microdiscectomy (OLM). Despite the positive outcomes, further research with larger, multicenter trials and long-term follow-up is necessary to validate these findings and optimize patient selection criteria. Overall, PELD represents a promising alternative to conventional surgical methods, providing effective symptom relief and enhanced recovery for patients with LDH.

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