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Comparison of Outcomes Between Percutaneous Endoscopic Lumbar Discectomy and Open Lumbar Microdiscectomy for The Treatment of The Patient with Lumbar Disc Herniation

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Abstract: ***Background:*** Lumbar disc herniation (LDH) is a prevalent cause of lower back and leg pain, affecting a significant portion of the adult population globally. Surgical interventions, namely Percutaneous Endoscopic Lumbar Discectomy (PELD) and Open Lumbar Microdiscectomy (OLM), are common therapeutic options. This study aims to compare the outcomes of these two techniques focusing on demographic factors, clinical assessments, and postoperative recovery metrics. ***Methods:*** This cross-sectional comparative study included 70 patients diagnosed with LDH, who were divided into two groups based on the surgical technique: PELD (Group I, n=33) and OLM (Group II, n=37). Preoperative and postoperative evaluations included Motor and Sensory Examinations, Straight Leg Raise tests, and Magnetic Resonance Imaging (MRI). Pain and disability were quantified using the Visual Analogue Scale (VAS) and the Oswestry Disability Index (ODI). Data analysis involved comparing improvements in VAS and ODI scores, duration of surgery, and the incidence of complications. ***Results:*** Both groups showed significant improvements in VAS and ODI scores post-surgery. Moreover, Group I (PELD) reported more pronounced pain reduction and quicker recovery ($p<0.05$). The average operative time was shorter for Group I, indicating a more efficient surgical process. ***Conclusion:*** PELD and OLM are both effective for treating LDH, but PELD may offer advantages in terms of pain reduction, recovery time, and preservation of neurological function. These findings support the need for individualized surgical planning based on patient-specific demographic and clinical characteristics to optimize outcomes.

Keywords: Lumbar Disc Herniation, Percutaneous Endoscopic Lumbar Discectomy, Open Lumbar Microdiscectomy, VAS Score, Oswestry Disability Index, Surgical Outcomes.

Original Research Article

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Article at a glance:

Study Purpose: *The purpose of this study was to compare the outcomes of these two techniques focusing on demographic factors, clinical assessments, and postoperative recovery metrics.*

Key findings: *Both percutaneous endoscopic lumbar discectomy (PELD) and open lumbar microdiscectomy (OLM) are effective treatments for lumbar disc herniation, with similar success rates in pain relief and functional improvement.*

Newer findings: *Recent studies indicate that PELD, as a minimally invasive procedure, is associated with significantly shorter hospital stays and faster return to daily activities compared to OLM.*

Abbreviations: *VAS: Visual Analogue Scale, OLM: Open Lumbar Microdiscectomy.*

INTRODUCTION

Lumbar disc herniation (LDH) is a common spinal disorder characterized by the displacement of intervertebral disc material, leading to compression of adjacent neural structures and subsequent back pain,

radiculopathy, or neurological deficits. Among the various surgical approaches available for the management of LDH, percutaneous endoscopic lumbar discectomy (PELD) and open lumbar microdiscectomy (OLM) have emerged as prominent techniques. Both procedures aim to alleviate symptoms and improve patients' quality of life, yet they differ significantly in their surgical approach, invasiveness, and postoperative outcomes.[1] PELD, introduced in the 1980s by Kambin and Gellman, represents a minimally invasive alternative to traditional open surgery. It involves accessing the herniated disc through a small incision and using an endoscope for visualization, thereby minimizing soft tissue trauma and preserving spinal stability.[2] Conversely, OLM, pioneered by Caspar in the 1970s, requires a larger incision and more extensive tissue dissection to access the affected disc, potentially leading to greater blood loss, longer hospital stays, and increased postoperative pain.[3] Several studies have compared the outcomes of PELD and OLM in the treatment of LDH, aiming to elucidate the advantages and disadvantages of each technique. Proponents of PELD emphasize its minimally invasive nature, reduced intraoperative blood loss, shorter hospitalization duration, and faster recovery compared to OLM.[4] Moreover, PELD is associated with lower rates of complications such as infection, dural tear, and postoperative instability.[5]

These factors contribute to its growing popularity among surgeons and patients seeking less invasive treatment options for LDH. However, critics argue that PELD may have limitations in cases of complex herniations or multi-level disc disease, where adequate decompression and visualization may be challenging.[6] Furthermore, the steep learning curve associated with mastering endoscopic techniques may result in higher rates of intraoperative complications and suboptimal outcomes during the initial phase of adoption.[7] Conversely, OLM remains a well-established and widely practiced surgical approach for LDH, offering excellent visualization of the operative field and the ability to address complex pathologies effectively.[8] Although it is considered more invasive than PELD, OLM has been refined over several decades, with established surgical techniques and predictable outcomes.[9] Moreover, some studies suggest that OLM may be associated with lower rates of recurrent disc herniation compared to PELD, possibly due to more extensive decompression and direct visualization of neural structures.[10] The choice between PELD and OLM depends on various factors, including the patient's age, comorbidities, anatomical considerations, surgeon's expertise, and patient preferences. While PELD offers the advantages of minimal invasiveness and faster recovery, OLM remains a valuable option for patients with complex disc herniations or those requiring extensive decompression. In this review, we aim to compare the outcomes of PELD and OLM in the treatment of LDH, focusing on key parameters such as surgical efficacy, postoperative complications, recurrence rates, and long-term functional outcomes. By synthesizing existing literature and analyzing clinical data, we seek to provide evidence-based insights that can guide clinical decision-making and optimize patient outcomes in the management of LDH.

METHODS

This cross-sectional comparative 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 comparative analysis between Percutaneous Endoscopic Lumbar Discectomy (PELD) and Open Lumbar Microdiscectomy (OLM) for the treatment of Lumbar Disc Herniation (LDH) in patients experiencing Lumbago and sciatica attributed to Posterior Lateral Intervertebral Disc (PLID) at the L4/L5 level. Patients presenting with symptoms of Lumbago and 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. Patients were divided into two groups based on the surgical technique chosen: PELD or OLM. PELD involves minimally invasive percutaneous access to the disc space using an endoscope (Group I, n=33), while OLM requires a traditional open surgical approach (Group II, n=37). 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. This study was conducted following the principles of the Declaration of Helsinki and approved by the Institutional Review Board. Informed consent was obtained from all patients prior to participation in the study. Data collected from both groups 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, ranging from 18 to 73 years, with similar age distribution across both groups. The age subgroups were divided as follows: 16-30 years (33.33% in Group I vs. 27.02% in Group II), 31-45 years (39.39% vs. 32.43%), 46-60 years (24.24% vs. 29.72%), and above 60 years (3.03% vs. 10.81%). No significant differences in age distribution were observed except for the 31-45 age group which showed a statistical significance with a p-value of 0.003. Sex distribution showed 60.60% males in Group I and 75.67% in Group II, with no significant differences between the groups (p=0.13 for males and p=0.78 for females. 29 patients (87.87%) and 32 patients (86.48%) were sedentary worker. Regarding associated illnesses, very few participants had diabetes mellitus (0% in Group I and 2.70% in Group II) and hypertension (3.03% in both groups), with no significant differences noted. No participants had hypothyroidism in either group. Clinical features were uniformly distributed, with all participants reporting low back pain. Right-sided leg pain was more prevalent in Group I (48.48%) compared to Group II (10.81%), and left-sided leg pain was reported by 45.45% in Group I and 43.24% in Group II. The weakness of the right lower limb was similar between the groups (90.90% in Group I vs. 91.89% in Group II). A notable difference was observed in the weakness of the left lower limb (3.03% in Group I vs. 21.62% in Group II). Abnormal sensation was reported by 75.75% of Group I and 94.59% of Group II, indicating a higher prevalence in Group II. The mean Body Mass Index (BMI) of the study population was 23.41±1.60, with a range from 20 to 29, suggesting a generally healthy weight range across the participants. This comprehensive profiling of the participants ensures a thorough comparative analysis of the outcomes between PELD and OLM in treating lumbar disc herniation at the L4/L5 level.

Table 1: Baseline characteristics distribution among the participants (N=70)

Basic Characteristics	Group I (n=33) (n,%)	Group II (n=37) (n,%)	df, p-value
Age			
16-30	11,33.33%	10,27.02%	9,0.117
31-45	13,39.39%	12,32.43%	6,0.003
46-60	8,24.24%	11,29.72%	2,0.11
>60	1,3.03%	4,10.81%	9,0.65
Sex			

Male	20,60.60%	28,75.67%	1,0.13
Female	13,39.39%	9,24.32%	1,0.78
Occupation			
Manual worker	4,12.12%	5, 15.15%%	-
Sedentary worker	29,87.87%%	32, 86.48%%	-
Associated Illness			
Diabetes Mellitus	0, 0.00%	1,2.70%	9,0.117
Hypertension	1, 3.03%	1, 2.70%	6,0.003
Hypothyroidism	0, 0.00%	0, 0.00%	2,0.11
Clinical Feature			
Low back pain	33, 100.0%	37, 100.0%	1,0.12
Leg pain (right)	16,48.48%	4, 10.81%	1,0.90
Leg pain (left)	15,45.45%	16,43.24%	1,0.22
Weakness of right lower limb	30, 90.90%	34,91.89%	1,0.11
Weakness of left lower limb	1, 3.03%	8,21.62%	1,0.13
Abnormal sensation	25, 75.57%	35,94.59%	1,0.32

The motor examination results revealed no significant differences in the muscle strength measurements between the two groups. Notably, the mean values for the right and left-sided hip flexor strength were 4.94±0.48 and 4.94±0.48 in Group I, respectively, and 4.92±0.58 and 4.90±0.45 in Group II, showing equivalent muscle function. Similarly, knee extensor and Flexor Hallucis Longus strength scores uniformly reached the maximum of 5.00±0.00 across both groups, indicating optimal muscle performance. Reflex examination consistently showed reflex presence across all patients in both groups for knee jerks, with complete presence noted for ankle jerks and planter reflexes, showing no statistically significant differences. The sensory examination results were also similar, with 51.51% of Group I and 51.35% of Group II having an intact right-sided sensory system; the left-sided sensory system was intact in 60.60% of Group I compared to 54.05% of Group II, demonstrating closely matched sensory function between the two surgical groups. Clinical tests such as the Straight Leg Raise (SLR) and Femoral Stretch Test showed high positivity rates with no significant intergroup differences. For instance, the right-sided SLR was positive in 48.48% of Group I and 51.35% of Group II, while the left-sided SLR showed similar rates at 45.45% and 45.94%, respectively. Gait analysis revealed that right-sided toe walking was intact in 87.87% of Group I and 75.75% of Group II, with left-sided toe walking showing a similar trend, indicating good recovery of lower limb function post-surgery. Regarding spine health, the incidence of kyphosis, scoliosis, and Gibbus deformity was noted at over 90.90% in Group I and 78.78% in Group II, with no significant differences found in the point of tenderness across both groups. A notable difference was seen in the presence of peripheral pulses in the lower limb, which was significantly higher in Group I (87.87%) compared to Group II (78.78%), with a p-value of 0.001. MRI findings showed a statistically significant difference in the incidence of central herniation, with 97.29% in Group II and 75.57% in Group I (p=0.008), while paracentral herniation was equally present in 100% of the participants in both groups, emphasizing a consistent surgical target area in both techniques.

Table 2: Distribution of the study population based on physical examination and radiological findings

Characteristics	**Group I (n=33) (n,%)**	**Group II (n=37) (n,%)**	**df, p-value**
Motor Examination (Evaluation of MRC grade)			
Right-sided Hip flexor	4.94±0.48	4.92±0.58	-
Left-sided Hip flexor	4.94±0.48	4.90±0.45	-
Right-sided Knee extensor	5±0.00	5±0.00	-

Left-sided Knee extensor	5.0±0.00	5.0±0.00	-
Right-sided ankle dorsiflexion	4.63±0.54	4.63±0.54	-
Left-sided ankle dorsiflexion	4.69±0.46	4.69±0.46	-
Right-sided EHL (Extensor Hallucis Longus)	4.37±0.73	4.36±0.63	-
Left-sided EHL	4.31±0.71	4.21±0.81	-
Right-sided FHL (Flexor Hallucis Longus)	5.0±0.00	5.0±0.00	-
Left-sided FHL	4.97±0.70	4.96±0.50	-
Reflexes			
Right-sided Knee jerk present	33, 100.0%	37, 100.0%	1,0.05
Left-sided Knee jerk present	31,93.93%	35,94.59%	1,0.09
Right-sided Ankle jerk present	31, 93.93%	36,97.29%	1,0.68
Left-sided Ankle jerk present	31, 93.93%	35, 94.59%	1,0.98
Right-sided Planter reflex present	31, 93.93%	36, 97.29%	1,0.99
Left-sided Planter reflex present	31, 93.93%	35, 94.59%	1,0.32
Sensory examination			
Right-sided sensory system intact	17,51.51%	19,51.35%	1,0.15
Left-sided sensory system intact	20,60.60%	20,54.05%	1,0.09
Right-sided SLR positive	16,48.48%	19,51.35%	1,0.99
Left-sided SLR positive	15,45.45%	17,45.94%	1,0.78
Right-sided Cross SLR positive	1,3.03%	0,0.00%	1,0.19
Left-sided Cross SLR positive	1,3.03%	0,0.00%	1,0.12
Right-sided Femoral stretch test positive	30,90.90%	36,97.29%	1,0.67
left-sided Femoral stretch test positive	30,90.90%	36,97.29%	1,0.51
Gait			
Right-sided heel walking intact	24,72.72%	21,63.63%	2,0.97
Left-sided heel walking intact	24,72.72%	16,48.48%	2,0.86
Right-sided toe walking intact	29,87.87%	25,75.75%	2,0.11
Left-sided toe walking intact	29, 87.87%	26,78.78%	2,0.65
Examination of spine			
Kyphosis	30, 90.90%	26, 78.78%	2,0.17
Scoliosis	30, 90.90%	26, 78.78%	2,0.46
Gibbus	30, 90.90%	26, 78.78%	2,0.31
Point of tenderness	30, 90.90%	26, 78.78%	2,0.65
Presence of peripheral pulses of the lower limb	29, 87.87%	26, 78.78%	3,001
MRI findings (Hernial location)			
Central	25,75.57%	36,97.29%	1,008
Paracentral	33, 100.0%	37, 100.0%	1,004

The pre-operative assessments showed comparable baseline pain and disability scores between the two groups. The average pre-operative VAS score for lower back pain was 6.17±3.70 in Group I and 6.16±3.50 in Group II, indicating a similar level of initial discomfort. The VAS scores for right-sided and left-sided lower leg pain were also closely matched, with Group I scoring 6.55±3.50 and 6.51±3.22, respectively, compared to 6.45±3.40 and 6.71±3.21 in Group II. The initial ODI scores, reflecting severe disability, were nearly identical at 86.16±8.01 for Group I and 86.10±8.00 for Group II. At the 90th post-operative day (POD), significant improvements were observed in both groups, with Group I showing more pronounced reductions in pain levels. The post-operative VAS score for lower back pain decreased to 1.78±0.72 in Group I and was slightly higher at 2.68±0.90 in Group II. Similar patterns were seen in the scores for right and left-sided lower leg pain, with Group I showing scores of 1.79±0.76 and 1.75±0.55 compared to Group II's scores of 2.91±0.88 and

2.50±0.75, respectively. The ODI scores at the 90th POD mirrored these improvements, with both groups recording a score of 22.49±7.08, reflecting a substantial reduction in disability. When examining the improvement percentages from baseline to the 90th POD, Group I consistently outperformed Group II in terms of pain reduction. The improvement in the VAS score for lower back pain was 84.84% in Group I versus 64.86% in Group II, a significant difference with a p-value of 0.02. Improvements for right-sided lower leg pain and left-sided lower leg pain also favored Group I, with respective improvement rates of 84.84% and 87.87% compared to 67.56% in both metrics for Group II, with p-values of 0.08 and 0.04. Notably, the ODI score improvement was significantly higher in Group I (93.93%) compared to Group II (81.08%), with a p-value of 0.001. Additionally, the mean duration of the operative procedure was shorter for Group I at 79.27±27.47 minutes compared to Group II's 91.67±25.82 minutes.

Table 3: Comparison of pre-operative and post-operative VAS score and Oswestry Disability Index (N=70)

VAS score and ODI score	Group I (n=33) (n,%)	Group II (n=37) (n,%)	df, p-value
Pre-operative			
VAS score for lower back pain	6.17±3.70	6.16±3.50	-
VAS score for right sided lower leg pain	6.55±3.50	6.45±3.40	-
VAS score for left sided lower leg pain	6.51±3.22	6.71±3.21	-
ODI score	86.16±8.01	86.10±8.00	-
At 90th POD post-operative follow-up			
VAS score for lower back pain	1.78±0.72	2.68±0.90	-
VAS score for right sided lower leg pain	1.79±0.76	2.91±0.88	-
VAS score for left sided lower leg pain	1.75±0.55	2.50±0.75	-
ODI score	22.49±7.08	22.49±7.08	-
Improvement of VAS score and ODI score at 90th POD			
VAS score for lower back pain	28,84.84%	24,64.86%	2,0.02
VAS score for right sided lower leg pain	28,84.84%	25,67.56%	2,0.08
VAS score for left sided lower leg pain	29,87.87%	25,67.56%	2,0.04
ODI score	31,93.93%	30,81.08%	2,0.001

DISCUSSION

Our study documented a statistically significant difference in the age distribution within the 31-45 age group, with a higher percentage observed in Group I (39.39%) compared to Group II (32.43%, p=0.003). This observation aligns with findings by Lurie et al. (2013), who emphasized the role of age as a predictor of surgical outcomes in lumbar disc herniation.[11] Age-related variations in disc degeneration and recovery potential may account for differences in surgical outcomes, underscoring the need for age-specific preoperative assessments and postoperative care. Additionally, while our study did not find significant differences in sex distribution affecting surgical outcomes, research by Strömqvist et al. (2015) suggests that gender disparities in preoperative conditions can influence recovery, indicating a potential area for deeper investigation in future studies.[12] Consistent with Nezari et al. (2013), our results indicate no significant differences in motor function measurements between the groups, highlighting the challenges in correlating clinical neurological examinations with the underlying pathology.[13] This suggests a potential limitation in the diagnostic utility of such examinations for predicting surgical outcomes, advocating for more comprehensive and sensitive diagnostic tools that can better correlate clinical presentations with surgical expectations. The similarity in clinical test results, particularly the Straight Leg Raise (SLR) test, which showed no significant differences between the groups, is mirrored in findings from Jönsson & Strömqvist (1996), who reported on the preoperative affliction and postoperative recovery, emphasizing the utility of such tests in evaluating radiculopathy pre- and post-intervention.[14] These tests remain critical for assessing nerve root compression and guiding

surgical interventions. The significant improvement in VAS and ODI scores at the 90th postoperative day in our study is echoed in the literature by Cetin & Gokdemir (2018), who reported substantial improvements in pain and quality of life following microdiscectomy.[15] Additionally, our findings of differential improvements in pain scores, more pronounced in Group I, are supported by Maclean et al. (2021), who also noted improvements in clinical outcomes post-surgery related to Modic changes.[16] This suggests that surgical technique and underlying morphological changes, such as Modic changes, can influence recovery trajectories and should be considered in surgical planning. The higher prevalence of central herniation in Group II and its implications for surgical approach and recovery are consistent with the observations made by Lee et al. (2006).[17] This supports the notion that herniation type can significantly impact surgical decisions and outcomes.

Furthermore, the variation in the duration of the surgical procedures between our groups, with Group I experiencing shorter surgeries, parallels findings by Weinstein et al. (2008), who discussed the efficiency and effectiveness of different surgical techniques.[18-23] Efficient surgical procedures, as demonstrated in our Group I, can lead to reduced operative times and potentially quicker recoveries, emphasizing the importance of surgical proficiency and planning. In conclusion, our study corroborates and extends the findings reported in the literature, underscoring the multifactorial nature of lumbar disc herniation surgery outcomes. These insights reinforce the necessity for personalized surgical approaches based on demographic characteristics, clinical presentations, and detailed MRI assessments to optimize patient outcomes. Further research should continue to explore these variables in larger cohorts to refine surgical techniques and improve prognostic accuracy.

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

The findings of this study provide important insights into the outcomes of lumbar disc herniation surgery, underscoring the complex interplay of demographic characteristics, clinical presentations, and surgical techniques. We observed significant demographic differences, particularly in age distribution, which appeared to influence surgical outcomes. Our motor and sensory examination results indicated no significant differences between groups, suggesting that clinical evaluations alone may not fully predict the success of surgical interventions. Furthermore, the significant improvements in VAS and ODI scores postoperatively highlight the efficacy of both surgical approaches, with Group I showing more pronounced pain reduction and functional recovery. Additionally, the shorter operative times observed in Group I suggest that efficiency in surgical procedures can lead to better outcomes and quicker recovery periods.

Authors' contributions

SM, SS, MJI: Concept and design, data acquisition, interpretation and drafting. ATMA and MMA: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

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Ethical approval

The study was approved by the Institutional Ethics Committee

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