ORIGINAL ARTICLE

Comparative study of microsurgical lumbar discectomy and percutaneous endoscopic lumbar discectomy based on clinical outcome and muscle injury markers

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Abstract

Background: Lumbar Disc Herniation (LDH) is the most frequent entity affecting the spine resulting in low back pain and sciatica. Many minimally invasive procedures have been proposed for the treatment of LDH. Percutaneous Endoscopic Discectomy (PELD) is gaining popularity in recent years for the treatment of LDH and its supremacy over the well-established gold standard Microsurgical Lumbar Discectomy (MLD) is yet to be proven. *Aim and Objectives*: To compare pain relief using Visual Analogue Scale (VAS) score, Oswestry Disability Index (ODI), duration of surgery and incision length between MLD and PELD; To evaluate systemic cytokine response (CPK-CK, hs-CRP, IL-6) between MLD and PELD. *Material and Methods:* This was a prospective comparative analysis between MLD and PELD in patients undergoing surgery for single-level lumbar disc prolapse from January 2022 to October 2022 at a single institute. *Results:* The study included 64 patients, divided equally into two groups: 32 patients underwent conventional MLD, and 32 patients underwent PELD. Groups had similar demographic profiles and preoperative clinical features. Postoperatively, both groups showed significant improvements in pain (VAS) scores and functional disability (ODI), with no significant difference between the two groups. However, there were differences in certain biochemical markers: CPK and IL-6 levels were lower in the PELD group compared to the MLD group, and hs-CRP levels were also lower in the PELD group, though statistically significant only on the 3rd postoperative day. The surgery duration and incision length were shorter in the PELD group. Complication rates were low, with two complications in the MLD group and one in the PELD group. *Conclusion*: Both MLD and PELD demonstrated positive outcomes in terms of pain and functional disability reduction, but PELD showed advantages in terms of shorter surgery duration, smaller incision length, and lower levels of certain inflammatory markers. No significant difference was noted in clinical outcomes between MLD and PELD. Postoperative systemic cytokine response is significantly lower in the PELD group than in the MLD group.

Keywords: Lumbar Microdiscectomy, Endoscopic Discectomy, Tissue Injury Markers

Introduction

The treatment options for lumbar disc herniation have been divided into conventional open discectomy and minimally invasive procedures. The development of microscopy, endoscopy, video, and image guidance systems provided the foundation on which minimally invasive spinal surgery is based [1]. Minimally invasive procedures include Microsurgical Lumbar Discectomy (MLD),

Microsurgical Tubular Discectomy (MTD), micro endoscopic discectomy, and Percutaneous Endoscopic Lumbar Discectomy (PELD). Open discectomy procedure leads to more muscle injury, post-operative pain, an increase in tissue injury markers, and significant radiological findings like atrophy of paravertebral muscles compared to minimally invasive discectomy. Among minimally invasive procedures, MLD and PELD have become the standard surgical procedures [2].

There is a significant increase in the level of muscle injury markers such as Creatine Phosphokinase (CPK), C-reactive protein, and Interleukin-6 (IL-6), in the serum of patients who underwent open discectomy technique when compared with minimally invasive techniques [3-4].

There are many publications comparing MLD, MTD, and open discectomy techniques [5-6]. Comparing the gold standard procedure of MLD and a very popular technique like PELD in terms of tissue injury markers is rare in literature. Our center is one of the few centers performing all types of minimally invasive spine surgeries and intended to compare clinical outcomes and biochemical parameters among patients who underwent MLD or PELD.

Material and Methods

This was a prospective study done from January 2022 to October 2022 after getting approval from the Institutional Medical Research Committee. Patients with back pain and predominant unilateral leg pain not relieved by conservative therapy and having single-level lumbar disc prolapse on imaging were included in the study. Only patients with disc herniation at L4–5 and L5–S1 were included in the study as PELD group consisted of only interlaminar approach. Patients with associated stenosis, multilevel disc prolapses, instability, recurrent disc, and having very high pre-operative cytokine values were excluded from the study. The patients were divided into two groups: one group underwent conventional MLD, while the other group underwent endoscopic discectomy. The allocation of patients to these groups was primarily influenced by the recommendations of the surgeons, patient preferences, and their suitability for minimally invasive procedures. To eliminate potential biases, strict adherence to age and gender matching was maintained between the two groups. Every patient in the open surgery group was matched with a counterpart in the minimally invasive surgery group who had a similar age (within ±3 years) and the same gender. This matching strategy allowed any observed differences in outcomes to be attributed to the surgical method rather than factors related to age or gender. To ensure that the two groups were statistically comparable in terms of age and gender, independent-samples t-tests were conducted for age, and chi-square tests were performed for gender. In both tests, the p values were above 0.05, indicating no statistically significant difference between the two groups regarding age and gender. This confirmed that the groups were well-matched, enabling a reliable comparison of surgical outcomes.

All the patients included in the study underwent a full clinical examination and the findings were tabulated. Visual Analog Score (VAS) for low backache and leg pain were assessed preoperatively and postoperatively on days 1 and 3. The disability score using Oswestry Disability Index (ODI) was assessed preoperatively and at 3 months postoperatively.

Serum CPK, highly sensitive C-reactive protein (hs-CRP), and IL-6 were sent on pre-operative

and Post-Operative Days (PODs) 1 and 3. CPK was measured by the kinetic method using STAT FAX 3300 semi-auto analyzer, Kit-Agapperef range: <200U/L, hs-CRP was measured by an immunoturbidimetric method using Beckman coulter AU480 chemistry analyzer, Kit: Beckman, ref range:1-3 mg/L and IL-6 was measured by chemiluminescent immunoassay method using Access 2 Immunoassay analyzer, Kit:Beckman, ref range: 5.3–7.5 pg/mL.

Surgery was done under general anesthesia with patients in prone position using standard techniques for MLD and interlaminar PELD. Duration of surgery, intraoperative and post-operative complications were assessed in both the groups.

Statistical analysis

Statistical analysis was done with Statistical Package for the Social Sciences (SPSS) for windows version 16.0. Student's independent *t*-test was applied for comparison of similar variables before and after treatment. Comparison of mean scores among more than two groups was done with the analysis of variance, repeated measures analysis of variance and Wilcoxon Signed-Ranks test (nonparametric test). Pearson rank coefficient was calculated between variables to explain the correlation. Results with $p \leqslant 0.05$ were considered statistically significant.

Results

A total of 64 patients were included in the study (MLD-32 patients and PELD-32 patients). The mean age of the patients was 51 years with a male predominance. The most common disc herniation was at L5–S1 level. The demographic profiles and the pre-operative clinical features (VAS and ODI) were comparable between the two groups.

Clinical outcomes

VAS scores for both back pain and leg pain significantly decreased ($p < 0.05$) in the post-operative period compared to pre-operative values in both MLD and PELD groups. There was no statistically significant difference in the VAS scores for both back pain and leg pain between MLD and PELD groups. ODI values significantly decreased ($p < 0.05$) in the post-operative period compared to pre-operative values in both MLD and PELD groups. There was no statistically significant difference in the ODI scores in immediate post-operative and 3 months follow-up between MLD and PELD groups.

Change in biochemical markers

Mean CPK values were significantly different on PODs 1 and 3 when compared with the pre-operative values ($p < 0.05$). Peak CPK levels were reached on the 1st POD. CPK values in POD1 and POD3 were significantly lower ($p < 0.05$) in PELD when compared with the MLD group (Figure 1). Mean IL-6 values were significantly different on PODs 1 and 3 when compared with the pre-operative values ($p < 0.05$). Peak IL 6 levels were reached on the 1st POD and post-operative values of serum IL6 in the PELD group were significantly lower on POD1 and POD3 (Figure 2). Mean serum hs-CRP values were significantly higher compared with the pre-operative values ($p < 0.05$) on PODs 1 and 3. Peak hs-CRP levels were reached on the 3rd POD. In comparison between MLD and PELD, POD1 and POD3 hs-CRP values were low in the PELD group (Figure 3) which was not statistically significant for POD1 ($p = 0.07$) but significant ($p = 0.03$) for POD3.

Mean duration of surgery for MLD was 86 min and for PELD was 66.31 min. Mean length of

incision in MLD group was 3.4 cm, in PELD group 1.3 cm. The complications encountered in both the groups were analyzed. The MLD group had two complications (one case of dural injury and one case of wound infection) which were managed conservatively. The PELD group had one case of residual disc and needed redo surgery.

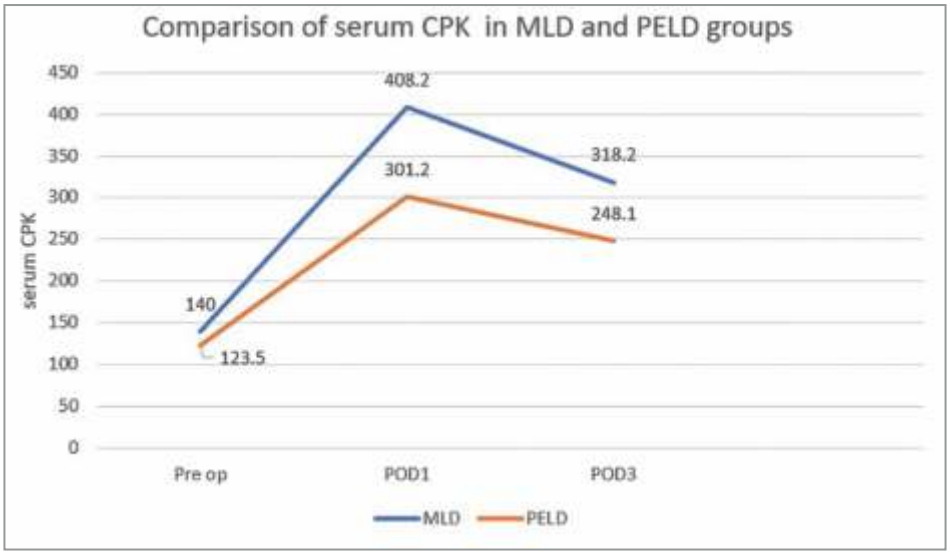

Figure 1: Comparison of CPK values between microsurgical lumbar discectomy and percutaneous endoscopic lumbar discectomy groups

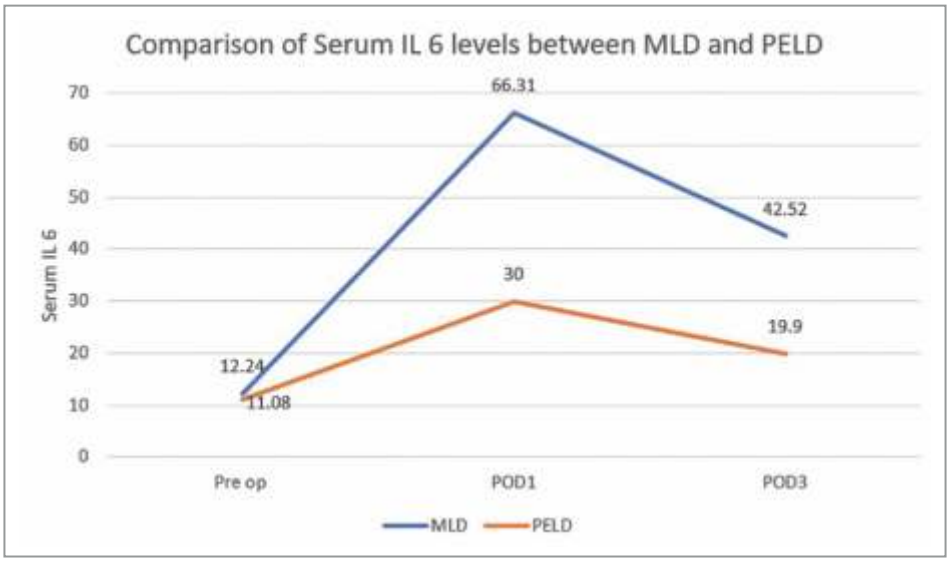

Figure 2: Comparison of interleukin-6 values between microsurgical lumbar discectomy and percutaneous endoscopic lumbar discectomy groups

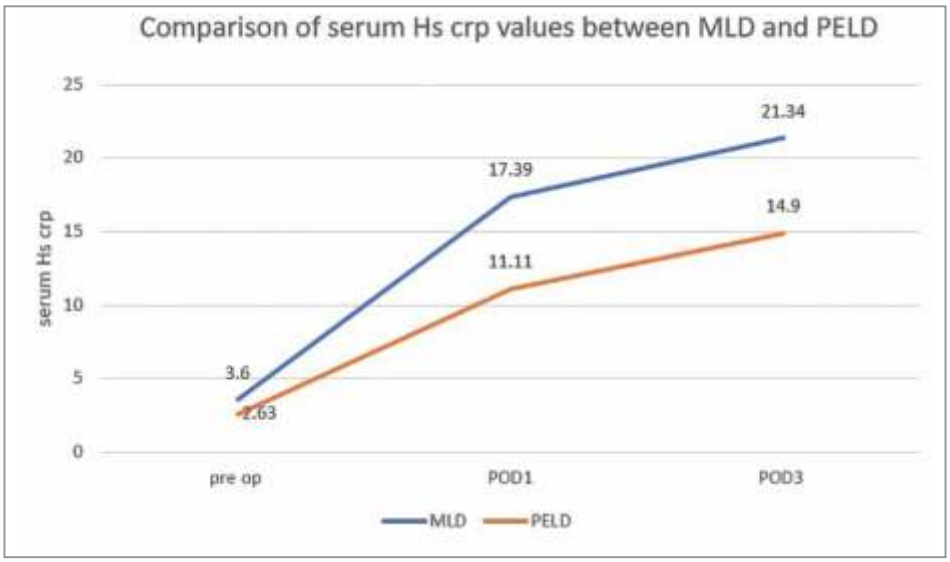

Figure 3: Comparison of highly sensitive C-reactive protein values between microsurgical lumbar discectomy and percutaneous endoscopic lumbar discectomy groups

Discussion

Dissection of soft tissues and paravertebral muscles is a part of discectomy surgery which leads to myonecrosis, denervation, and subsequent postoperative muscle atrophy and scarring [3-4]. Increased intramuscular pressure and ischemia have been reported to play a role in the patho-physiology of this condition [3]. Any surgical intervention induces a stress and inflammatory response in the body, which is proportional to the incision size, blood loss, and length of exposure [4]. Pro-inflammatory IL-6 is produced at the site of insult and subsequently enters the peripheral blood. Liver synthesis of CRP is induced in response to the release of interleukin-1 (IL-1) and IL-6. The post-operative CRP, IL-1, and IL-6 levels quantify the invasiveness of the surgical procedures. Serum CK serves as a marker of myonecrosis secondary to muscle dissection associated with spinal surgery procedures [3-5]. Kumbhare *et al*. found that there is good correlation between CK levels and muscle area during spine surgery [6]. A significant relationship has been reported between CK levels and invasiveness of the surgery [6, 8-10]. The development of muscle damage has been associated with the pressure of the retractor [6]. Inflammatory markers level may change depending on the extent of dissection, blood loss, and surgery duration [7-9, 11]. In our study, post-operative CPK values were significantly less in the PELD group than in the MLD group suggesting less muscle injury in PELD. This is in accordance with the study by Linzer *et al*. [12], Choi *et al.* [13]. Back muscle degeneration could start 3 h after surgery [10]. In our study, peak CPK values are seen on POD1 this is similar to the observation by Linzer *et al*. [12]. In a study by Shin *et al*. [14] peak serum CPK values were seen on POD3. However, the number of patients was lower and the rise of CK levels had different dynamics in the study. The

differences in the conclusions of the studies can be explained by the variability in CK levels following muscle trauma or exercise by Linzer *et al*. [12].

The IL-6 and CRP levels demonstrated a significantly lower stress response in PELD than in MLD. Similar observations were reported by Houten [11] and Linzer *et al*. [12]. In PELD, approach to the disc space is through the interlaminar window and it needs very less muscle dissection to reach interlaminar space. Decreased length of incision in PELD and decreased muscle dissection in PELD explain decreased cytokine response. The comparison of MLD and PELD groups in terms of post-operative VASLBA, and VASR showed no significant difference. This is similar to studies by Hsu *et al*. [14], Choi *et al*. [13], Li *et al*. [15] and Belykh *et al*.[19] who found that PELD is associated with a lower VAS for back pain at discharge than the MLD group. The comparison of MLD and PELD groups in terms of post-operative ODI showed no significant difference. This is similar to observations by Sinkemani *et al*. [18], Hsu *et al*. [16], Choi *et al*. [13], Li *et al*. [15], Belykh *et al*. [19] and Ahn *et al*. [8]. There was no significant difference between the number of complications in MLD and PELD groups. This is similar to the observations by Belykh *et al*. [19], Meyer *et al*. [20], Qin *et al*. [21], Shi *et al*. [22] and Jarebi *et al*. [23]. In our study, number of recurrent discherniations were 1 in the PELD group, but no recurrence was seen in the MLD group. This is similar to the observation by Belykh *et al*. Wound site infection and dural injury were seen more in MLD than in the PELD group. Length of incision was less in PELD than in MLD, this is comparable with results of Qin *et al*. [21] and Ruisui *et al.* [22]. Length of hospital stay was significantly less in PELD compared to MLD group. This is similar to studies by Qin *et al*. [21] and Shi *et al*. [22]. The review of limited literature on comparing MLD and PELD concludes that PELD is comparable to MLD in terms of clinical outcomes and complication profile, but PELD causes lesser systemic cytokine response. The study acknowledges potential sources of bias and limitations. The allocation of patients to surgical groups based on surgeon recommendation and patient preference introduces the possibility of selection bias. Despite efforts to match age and gender, there may still be unmeasured variables that differ between the groups. The generalizability of the study is limited to the single institution where it was conducted. Reliance on self-reported outcomes and retrospective design introduces measurement and recall biases. Caution should be exercised when interpreting the results and applying them to broader populations. Further research with larger sample sizes and longer follow-up periods is needed to determine if the biochemical advantage seen in PELD leads to improved clinical outcomes, which could potentially change the current gold standard for lumbar discectomy procedures. Based on the current evidence, MLD can still be considered the gold standard option for lumbar discectomy.

Conclusion

This study compares two popular surgical techniques described for lumbar discectomy (MLD and PELD). There was no significant difference in the clinical outcomes between MLD and PELD. The slight advantage of lower systemic cytokine and inflammatory response seen in PELD group does not translate into better clinical outcomes. MLD can be considered as the gold standard option for lumbar discectomy till further evidence is obtained on this topic.

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