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Role of Percutaneous Laser Disc Decompression in Patients with Lumbar Disc Herniation on Pain Relief: A Quasi-Experimental Pilot Study

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Abstract

Background: Disc herniation is broadly defined as a localized or focal displacement of disc material beyond the limits of the intervertebral disc space. The disc material may be the nucleus, cartilage, fragmented apophyseal bone, annular tissue, or any combination thereof. Laser surgery is one of the treatment modalities for treating patients with lumbar disc herniation. This study aims to examine the effect of Percutaneous Laser Disc Decompression (PLDD) in patients with lumbar disc herniation. **Materials and Methods:** This study was conducted on 58 patients who underwent PLDD (optical fiber inserted through an 18G needle, 8 joules, and 8 watts). Individuals were monitored before and after treatment using the comparing visual analog scale (VAS) pain score (from 0 [no pain] to 10 [severe pain]). **Results:** The mean age of participants was 63.19±13.48 years. Regarding gender, 24 patients (41.4%) were female. The mean VAS score before surgery was 8.73±1.29, and VAS score after surgery was 55.2±2.71, which means pain was significantly reduced (P<0.001). **Conclusion:** The patients' post-PLDD pain may decrease; hence, PLDD can use as an appropriate method for treating lumbar disc herniation. **[GMJ.2022;11:e2382]** DOI:10.31661/gmj.v11i0.2382

Keywords: Lumbar Disc Herniation; Pain; Percutaneous Laser Disc Decompression

Introduction

Low back pain (LBP) is one of the most common disorders that any individual experiences in their life and clinicians believe it is one of the most challenging and difficult to treat the pain of their career [1]. One of the most common sources of pain considers being as spinal disc herniation. Patients are often asymptomatic; however, by aging, they start to experience LBP, pain in the buttock, radiation of electric-like pain in the

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legs, and among severe cases, radiculopathy and neuropathy [2]. The preferred initial modality to assess the patient's complaint in symptomatic patients is magnetic resonance imaging (MRI) [3]. Studies showed that 16% to 33% of asymptomatic patients revealed disk herniation; however, in symptomatic patients, it was higher and ranged from 50% to 70%, which on the other hand, indicates the importance of the patient's symptoms [4-8].

Patient's presentations vary from LBP, radiculopathy, and sciatica to severe bladder dysfunction; still, sciatica is reported to be one of the common symptoms [9]. Although the definite sciatica proportion ranged from 3% to 4% of the population, about 40% of the adult population had experienced sciatica at least once in their life [9]. Also, the most common location of the disc herniation, especially disc protrusion, is L5-S1, followed by L4-L5 [10]. The primary approach for asymptomatic patients is using anti-inflammatory drugs, physiotherapy, and in general, non-surgical procedure [10].

In contrast, the gold standard and accepted approach remain surgery in symptomatic patients [10]. In addition to the surgery, supplementary methods in LBP patients include corticosteroid injection in the facet joints and/or intrathecal, radiofrequency denervation, local thermal therapy, and trigger point injection [10]. Regarding patients' satisfaction and avoidance of invasive methods, non-invasive techniques emerged, and percutaneous procedures in the treatment of disk herniation were introduced [10].

In 1975, a percutaneous discectomy was performed by Hijikata *et al*. [11], and later on, other percutaneous techniques were performed; one of them is percutaneous stands laser disc decompression (PLDD) [12, 13]. PLDD has been used for over 20 years; it was first performed in 1986 for disc herniation and radiculopathy [14, 15].

PLDD is a method performed by inserting laser fibers throughout the skin, often in the posterolateral approach to transmit the generated energy to the nucleus pulpous to change the essence of it and consequently to shrink the area and decrease the volume and reduction of the pressure on the nerve root [16].

The advantages of the PLDD include being less invasive, shorter hospitalization and faster recovery compared to conventional surgery [16, 17]. Surgeons have recommended PLDD for patients with disk protrusion, and due to its advantages, patients are more willing to experience it [16, 17].

PLDD is a simple operation with low complications, and it has a lower risk for injuries and operation side effects. In contrast to conventional surgery, the patients' symptoms are reduced immediately after the operation. The patient feels the relief of the pain after the procedure; hence, it is more satisfactory and practical [17].

To date, some evidence has shown that using the PLDD method was effective and contained good outcomes; however, few have been studied and followed for a long time [18-20]. This study aims to evaluate the clinical outcome of PLDD in patients with lumbar disc herniation.

Materials and Methods

Study Population and Settings

This quasi-experimental pilot study was performed on 58 patients who candied for PLDD that were referred to Shariati Hospital from 2019 to 2021.

Ethical Considerations

The authors have entirely observed the ethical issues, including plagiarism, data fabrication, and double publication. Human rights were respected according to the Helsinki Declaration 1975, as revised in 1983. All patients were informed about treatment options and objectives of the study and gave written informed consent before inclusion in the study sample; they were also told that they could refrain from the study at any stage and there would be no punishment or disadvantage if they did so. The study was approved by the ethics committee of AJA University of Medical Sciences (ethical code: IR.AJAUMS.REC.1399.125).

Inclusion and Exclusion Criteria

Eligible patients were over 18 years of age with radiologic findings suggesting a

disc herniation, and lumbosacral radicular syndrome lasted for 6-8 weeks, or the herniated segment should be less than 1/3 of the spinal canal based on the patient's MRI and or computed tomography scans.

Also, we excluded all the patients with a history of Cauda Equina syndrome, previous spine surgery at the same disk level, spondylolisthesis, spinal stenosis, pregnancy, and severe physical and mental illness over the past year [17, 21, 22].

PLDD Procedure

Microdiscectomy was performed using an ipsilateral approach by retracting the mid-line paravertebral muscles without and/or with minimal bone removal and displacement of the herniated disc through the transflavum.

The procedure was performed with local anesthesia without the need for an anesthesiologist. Eventually, as the disc's nucleus drained, the pressure on the nerve was reduced. The patients were first located in the prone position. The patients were prepared after prepping and draping, and under the C-arm X-ray machines (Ziehm 8000, Germany) guide from the lateral Scottish dog to the desired level of the symptomatic side, needle gauge 18 was entered as the tunnel view.

After discography and control at the anteroposterior and lateral aspects and ensuring that the needle was in the middle of the disc, the fiber (980 nm wavelength and 240-400 µm diode laser) entered through the needle. After that, laser Beams (Ceralas E 980 nm Laser System, Biolitec Inc., Germany) were emitted by an optical fiber through the needle.

Then, the Y connector was closed, the device was set to 8 joules, and the settings were adjusted to 0.6-second radiation and 1.2 seconds pause.

Also, we set the device to 8 watts in active

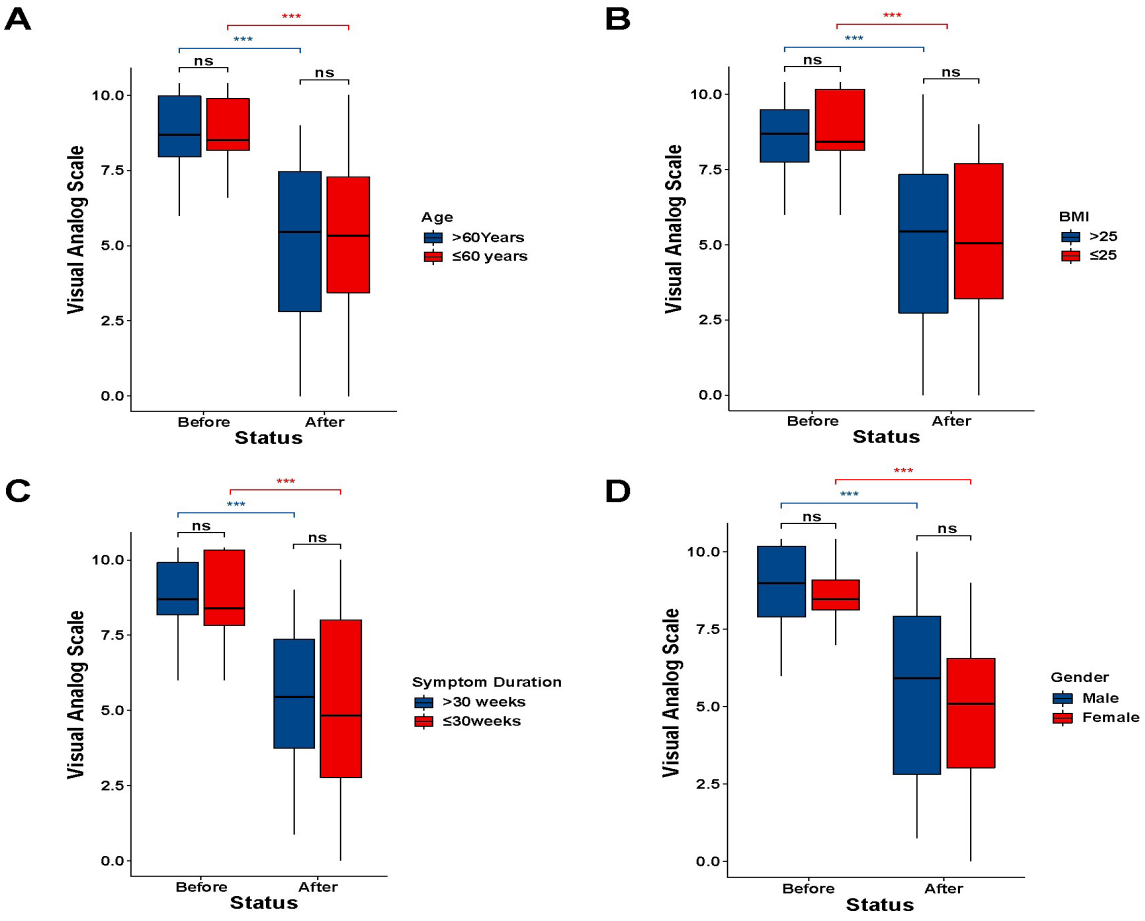

Figure 1. Comparison of pain score with age **(A)**, BMI **(B)**, duration of symptoms **(C)**, and gender **(D)** ns: not significant, ***P< 0.001

mode; then, we pressed the pedal and irradiated from 800 to 1400 joules depending on the size of the disc and its level. Usually, at every 300 joules, the needles are pulled up to 2 mm backward or forward to create a larger quadrant [23].

In the cases that the patient has been radicular pain, the needle was moved under the C-arm guide. It is normal to experience mild lumbar pain (measuring the pain using the pain score scale).

The patient must be alert and conscious at all stages of the procedure and was slightly sedated when asked to move their feet during surgery [24, 25].

Data Collection

Baseline characteristics of patients include age, gender, body mass index (BMI) were recorded. The pain was assessed through Visual Analog Scales (VAS). The measurement was considered using a 10-point VAS with endpoint anchors of no pain (0 points) and severe pain (10 points) before and after the procedure. Also, we compared the VAS based on age, gender, and BMI.

Statistical Analysis

Independent Samples Kolmogorov-Smirnov test was used to determine the normality of data. Paired t-test was applied for compared the VAS score before and after PLDD. Also, Independent T-test and chi-square were used to determine differences between study subcategories. The SPSS software (version 16, SPSS Inc., Chicago, IL, USA) was used to perform all statistical analyses, and statistically significant differences were considered values of P less than 0.05.

Results

The study population consisted of 58 patients, among which 58.6% were male. The mean age of the participants was 63.19±13.48 years (Table-1). The mean BMI of the participants was 29.09±6.51 Kg/m2.

The participants suffered from symptoms associated with disc herniation for an average of 30.44±5.01 weeks, and 55.2% had symptoms for more than 30 weeks.

The mean VAS score before and after surgery was 8.73±1.29 and 5.22±2.7, respectively, which showed marked reduction ($P<0.001$). Assessing the contributing factors on the patients' pain level, we found no significant association between VAS and gender, age, BMI, and symptom duration (Figure-1).

Discussion

Lumbar disc herniation is one of the most common causes of LBP and radiculopathy [26], and it is usually treated with a conservative approach. However, surgical intervention is used for patients who do not benefit from medication [27]. Surgical and minimally invasive techniques have been shown to improve clinical outcomes in patients with herniated discs who fail to significantly reduce symptoms despite three months of appropriate conservative therapy [28]. The main shortcoming to conventional open surgery, which has been performed since 1934, is that it further weakens the posterior wall of the already damaged disc complex, so such surgery may not benefit patients with herniated discs [29].

Therefore, for a patient who becomes unresponsive to conservative therapy, minimally invasive treatment should be considered before using conventional open surgery [30]. The advantages of all minimally invasive surgery are small incisions, less damage to muscles and ligaments, no general anesthesia, and shorter hospital stays.

The principle of PLDD processing relies on closed hydraulic system theory [25]. Laser energy is intended to relieve pressure on the nucleus pulposus and peripheral tissues by causing evaporation in the nucleus pulposus [25].

In experimental studies, a decrease in disc volume of only 1.0 ml reduces pressure (a decrease of 312 kPa) [25]. Central decompression causes the disc to recede into the fracture [31]. Animal studies in 2012 showed a volume-reducing effect of nucleation on the lumbar spinal nucleus of an animal model [32].

PLDD's current indications are radicular pain, lumbar spinal stenosis, and disc herniation

Table 1. Comparison of Pain Scores Regards to Patients' Characteristics

Variables	Baseline		After PLDD		P-value
	Mean	SD	Mean	SD	
Gender					
Male	8.81	1.41	5.46	2.86	<0.001
Female	8.61	1.10	4.88	2.51	<0.001
P-value	0.564		0.429		
Age (years)					
>60	8.67	1.37	5.11	2.74	<0.001
≤60	8.82	1.16	5.40	2.71	<0.001
P-value	0.686		0.694		
BMI (Kg/m^2)					
>25	8.63	1.29	5.16	2.78	<0.001
≤25	8.94	1.29	5.36	2.62	<0.001
P-value	0.401		0.802		
Symptom duration					
>30 weeks	8.78	1.16	5.35	2.33	<0.001
≤30 weeks	8.66	1.44	5.07	3.16	<0.001
P-value	0.711		0.705		

[33-36].

A literature review reported success rates in large studies that fluctuated between 75% and 87% [17]. PLDD has been shown to improve the clinical outcome of contained lumbar herniated discs. In our study, patients experienced a mean of 3.5±1.5 points reduction in their pain. Erbas *et al*. studied 197 patients and revealed that PLDD was a safe and effective treatment of discogenic pain, but it was not an alternative to open surgery [13]. In a review study, Ong *et al*. [37] showed that PLDD effectively treats lumbar radicular pain with a low incidence of complications based only on a few observational studies. There is increasing evidence showing nucleoplasty could be effective in selected patients but have a flat rate of serious adverse events [13]. Most of the studies considered extruded or sequestrated disc hernias as exclusion criteria [25, 38].

As a result, few studies have examined ripped lumbar disc hernias treatment by PLDD [38]. Choy [38] used PLDD in 2001 to treat extruded but not sequestrated lumbar disc hernias and achieved good pain relief in patients.

However, PLDD appears to benefit patients with intact disc hernias more. Lee and Kang [39] concluded that proper patient selection was one of the most critical factors that can affect the success rate of PLDD.

They also said that the ND-YAG laser had positive results [39]. Therefore, before considering PLDD as a management option, selecting the patient and using appropriate conservative therapy is crucial [35, 36].

The PLDD patient selection criteria are described in the literature as leg pain is worse than LBP, herniated disc on MRI, chronic LBP lasting more than three months, non-invasive treatment failure, no evidence of neurological deficiency, segmental instability, preservation of more than 75% of the disc height, and no sign of psychogenic component [40].

These criteria are essential for achieving better clinical results. In the current study, we included patients with criteria similar to the study of van den Akker *et al*. and Rahimzadeh *et al*. [21, 22].

Although PLDD could be useful in some patients, it lacked the information needed for other methods. In other words, this

procedure is not useful for all patients, and the individual's condition is a primary determinant of the therapeutic outcome [41]. Some studies have also shown that PLDD was not the best treatment for patients. In the study by Fan Feng *et al.* [40], 29 randomized clinical trials, including 3,146 participants, were investigated.

Their meta-analysis provided hierarchies of these seven interventions. For the success rate, the rank probability (from best to worst) comprised percutaneous endoscopic lumbar discectomy, standard open discectomy, standard open microsurgical discectomy, chemonucleolysis, microendoscopic discectomy, PLDD, and automated percutaneous lumbar discectomy. The rank probability (from best to worst) for the complication rates were percutaneous endoscopic lumbar discectomy and automated percutaneous lumbar discectomy, respectively [42].

A retrospective study that addressed the effects of PLDD in selected patients reported a 70% success rate over a 5-year follow-up period with no complications [31]. PLDD has been implemented in more than 50,000 patients to date. Gronemeyer [43] was successful in 74% of the cases over a 4-year follow-up of 200 patients. The ND-YAG laser was primarily used by Choy in 1986 and showed a 75% success rate [44].

After that, laser technology was developed, and ion resonance, excimer, and argon (Apparent) laser were developed [44]. The Apparent laser is well absorbed by hemoglobin and works through it. This effect causes apoptosis by activating oxygen in the cell nucleus [44]. Ultraviolet lasers block molecular connections without generating heat [21].

Application period and PLDD energy requirements depend on the wavelength of the laser used in the procedure [15, 17]. In the current study, we used a diode laser with a wavelength of 980 nm and 240-400 µm, which was similar to the study of Momenzadeh *et al*., and the results were identical [45].

For procedures that may act as an intermediate intervention between conservative treatment and surgery, the timing of PLDD after the onset of symptoms is very likely to affect the outcome.

The mean duration of symptoms in our study was about 30 weeks, and the outcome was not associated with it. A clinical trial found that PLDD was less invasive and cost-effective in treating lumbar discs in patients with less disk herniation [21]. A retrospective review study found that PLDD as a part of treatment in eligible patients could be helpful but not an ideal substitute for surgical procedures [22].

Another study found that PLDD helped reduce pain in patients [30]. Despite some controversial studies, considering the benefits of the PLDD approach, such as no need for general anesthesia, performing as outpatient procedure especially for heart patients who cannot be anesthetized, no complications of the surgical wound and nosocomial infection, no complications of anatomy manipulation and nerve damage, decreasing recovery time and early discharge of the patient, and reducing patient costs; notion that PLDD could be considered a better method for lumbar disc surgery [42]. However, further studies and investigations are recommended about the procedure and its efficacy.

Limitations

There were two main limitations in our study. There was no control group, and the follow-up period was relatively short.

Conclusions

The patients' post-PLDD pain can be reduced. Hence, PLDD can be considered an appropriate method for treating lumbar disc herniation in carefully selected patients.

Conflict of Interest

The authors declare that they have no competing interests.

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