Short Communication

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Percutaneous laser disc decompression: a minimally invasive procedure for the treatment of intervertebral disc prolapse – the Bangladesh perspective

Abstract

Objective: The purpose of this paper is to assess the clinical effectiveness of percutaneous laser disc decompression (PLDD) for patients with radicular pain due to intervertebral disc hernia and to describe our experience in this field in Bangladesh.

Background: PLDD is a procedure in which herniated intervertebral discs are treated by the reduction of intradiscal pressure by laser energy. This is introduced by a needle inserted into the nucleus pulposus under local anesthesia and fluoroscopic monitoring. Small volume nucleus vaporization results in a sharp fall in intradiscal pressure, with the consequent migration of herniation away from the nerve root. PLDD has been reported to be a safe, effective, minimally invasive treatment option for patients with a herniated disc.

Materials and methods: This observational random prospective analysis was carried out during the period from November 2007 to December 2011. PLDD was performed on 4622 herniated discs of 2580 patients (1420, male; 1160, female), whose age ranged between 18 and 85 years. A total of 47 cases were failed back surgery syndrome (FBSS). All patients were followed up (ranging from 1 month to 36 months, with a median of 12 months) and were evaluated according to MacNab criteria.

Results: Amongst the 2580 patients, 2296 (89.0%) reported immediate pain relief, 230 (8.9%) patients were uncertain and the remaining 54 (2.1%) did not have immediate pain relief. In the subsequent follow up, according to MacNab criteria a good response was seen in 1935 (75.0%) cases and a fair response in 335 (13.0%) cases. The response to the treatment was poor in 310 patients (12.0%). A second session of PLDD was performed on 292 (11.3%) patients made up of 162 patients (6.3%) due to multi-level (>2 discs) prolapse, 102 patients (3.9%) due to an extensive prolapse of one or two discs and 28 patients (1.0%) because of a relapse. In two cases of a prolapsed dorsal spine (T7-T8 & T8-9), a good response was obtained without any complications. All cases of FBSS showed a good and fair response.

Conclusion: PLDD is an effective and minimally invasive procedure which has almost no side effects or complications, can be performed under local anesthesia, results in no scarring or spinal instability, and still does not hinder the scope of open surgery in failed cases. PLDD is also effective in cases of FBSS.

Keywords: PLID; PLDD; disc herniation; laser evaporation; back and neck pain; failed back surgery syndrome (FBSS).

Zusammenfassung


Hintergrund: Die PLDD ist ein Verfahren, bei dem der Bandscheibenvorfall durch Reduktion des intradiskalen Drucks mittels Laserenergie behandelt wird. Hierbei wird unter Lokalanästhesie und fluoroskopischer Kontrolle eine Laserfaser durch eine Kanüle in den Gallerkern der Bandscheibe vorgeschoben. Die thermische Verdampfung des kleinen Kernvolumens führt zu einer deutlichen Reduzierung des intradiskalen Druckes und somit zu...
einem Rückzug der vorgewölbten Bandscheibe weg von der betroffenen Nervenwurzel. Die PLDD wird als sichere, effektive und minimal-invasive Behandlung für Patienten mit Bandscheibenvorfall beschrieben.


**Ergebnisse:** Von den insgesamt 2580 Patienten be richteten 2296 (89,0%) von einer sofortigen Schmerzlinderung, 230 (8,9%) Patienten waren unsicher und die restlichen 54 (2,1%) hatten keine sofortige Schmerzlinderung. Entsprechend der MacNab-Kriterien wurde die Behandlungserfolg in 1935 (75,0%) Fällen als gut und in 335 (13,0%) Fällen als zufriedenstellend eingestuft. Bei 310 Patienten (12,0%) war das Ansprechen auf die Behandlung schlecht. Eine zweite PLDD-Sitzung wurde bei 292 (11,3%) Patienten durchgeführt. Bei 162 Patienten (6,3%) wurden von einem Multi-Level- (>2 Bandscheiben) Prolaps, bei 102 Patienten (3,9%) aufgrund eines umfangreichen Prolaps von ein oder zwei Bandscheiben und bei 28 Patienten (1,0%) wegen eines Rückfalls. In zwei Fällen eines Bandscheibenvorfalls im Bereich T₇₈ und T₈₉ konnte ein gutes Ansprechen ohne Komplikationen erreicht werden. Alle Fälle von FBSS zeigte gute und zufriedenstellende Therapieerfolge.

**Fazit:** Die PLDD ist ein effektives und minimal-invasives Verfahren, welches fast keine Nebenwirkungen oder Komplikationen hat. Es kann unter örtlicher Betäubung durchgeführt werden, führt zu keiner Narbenbildung oder Instabilität der Wirbelsäule, und schließt eine offene Chirurgie in gescheiterten Fällen nicht aus. PLDD ist auch wirksam bei FBSS.

**Schlüsselwörter:** PLID; PLDD; Bandscheibenvorfall; Laservaporisation; Rücken- und Nackenschmerzen; Postdiskotomiesyndrom (failed back surgery syndrome, FBSS).

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1 Introduction

Acute or chronic back and neck pain is a major social, economic and healthcare issue in all communities. Nearly 80% of the population experiences backache during their life-time and for the vast majority of back and neck pain sufferers, discogenic pain is the main culprit. In 1934, Mixter and Barr [1] first described that herniation of lumbar disc is a cause of lower backache. Lower back pain is now increasing in the younger population due to misdirected spinal kinetics secondary to improper posture, heavy load lifting and motorbike driving.

Treatment is aimed at the removal of the portion of herniated disc which is compressing upon the nerve root or spinal cord. Another way of decompressing the nerve root is by inducing a negative pressure in the intervertebral disc by removal of tissue. Percutaneous laser disc decompression (PLDD) is a modality in which laser energy is delivered through a needle to the nucleus pulposus by means of an optical fiber [2].

The principle of PLDD is based on the law of physics that applies to an intact, enclosed hydraulic space. As water is non-compressible, a small change in volume will result in a disproportionately large change in pressure. It is well-known that the water content of the nucleus pulposus ranges from 50 to 89% and is age-dependent, decreasing with advancing years. Pressure reduction creates a pressure gradient leading to migration of the herniated portion of the disc away from the affected nerve root or spinal cord [3].

2 Background

PLDD was first performed by Choy and Ascher in 1986 using a Nd:YAG laser at the lumbar level [3]. In Europe the first cervical level was performed by J. Hellinger in 1991 [4]. Later, the holmium:YAG laser was found to be safer and more efficient at the cervical level as described by Siebert in 1993 [5].

PLDD is a procedure in which the herniated intervertebral discs are treated by reduction of intradiscal pressure with laser energy. This laser energy is delivered through a needle inserted into the nucleus pulposus under local anesthesia and fluoroscopic monitoring. A small volume
of nucleus vaporization results in a sharp fall in the intradiscal pressure, with consequent migration of herniation away from the nerve root. PLDD has been reported to be a safe, effective, and minimally invasive treatment option for patients with a herniated disc [6–10].

The treatment principle of PLDD is based on the concept of the intervertebral disc being a closed hydraulic system. This system consists of the nucleus pulposus, containing a large amount of water, surrounded by the inelastic annulus fibrosus. An increase in water content of the nucleus pulposus leads to a disproportional increase in the intradiscal pressure. In vitro experiments have shown that an increase of intradiscal volume of only 1.0 ml causes the intradiscal pressure to rise by as much as 312 kPa (2340 mm Hg) [3]. Similarly a decrease in the intradiscal volume would cause a disproportionately large decrease in intradiscal pressure. The radicular pain, that characteristically accompanies disc herniation, is the result of nerve root compression by the herniated portion of nucleus pulposus. A reduction of intradiscal pressure causes the herniated disc material to recede toward the center of the disc, thus leading to reduction of nerve root compression, and relief of radicular pain. In PLDD, this mechanism is exploited by application of laser energy to evaporate water in the nucleus pulposus. Apart from evaporation of water, the increase in temperature also causes protein denaturation and subsequent renaturation. This causes a structural change of the nucleus pulposus, limiting its capability to attract water and therefore leading to a permanent reduction of intradiscal pressure by 57% [11, 12].

3 Subjects and methods

This observational random prospective analysis was done during the period from November 2007 to December 2011. PLDD was performed in 4622 herniated discs of 2580 patients, 1420 of them male, 1160 female. The age range was from 18 to 85 years. All patients were selected from outpatient source of our private medical practices. All patients were briefed about laser and PLDD procedure. Those who did not fulfill the selection criteria or refused the PLDD procedure were selected for open surgical techniques. Initially the procedures were done in different hospitals but at a later date they were performed selectively at the Institute of Laser Surgery and Hospital, Dhaka, Bangladesh. The same surgical team, made up of the authors, operated from the beginning until the study was finished. All post-operative patients were kept in the hospital for 3–7 days for post laser physiotherapy and close observation. All patients were followed-up and evaluated according to MacNab criteria [13].

3.1 Criteria for patient selection

The patient selection criteria of Choy et al. [14] were followed but some modification was done in this study.

3.1.1 Inclusion criteria

- Patients reporting lower back or neck pain, with or without radiation to either only one or both lower or upper limbs.
- Patients who failed to get any pain relief within at least 6 weeks of conservative management with bed rest, physiotherapy, muscle relaxants and anti-inflammatory agents.
- Patients with magnetic resonance imaging (MRI) documentation of a contained, non-sequestered herniation of the disc and clinical symptoms of pain corresponding to the level of disc involvement.
- Patients with failed back surgery syndrome (FBSS), who had been operated at an earlier date for disc herniation (laminectomy/fenestration and discectomy).

3.1.2 Exclusion criteria

- The presence of sequestered discs,
- Hemorrhagic diathesis,
- Pregnancy,
- Severe spondylolisthesis,
- Severe scoliosis,
- Metastatic cancer,
- Vertebral compression fracture.

3.2 Equipment/material used

- Fluoroscopy unit (Siemens, Germany)
- Fluoroscopy compatible operating table (Siemens, Germany)
- Surgical laser (970 nm diode laser, type: LAKHTA-MILON; Milon Group, St-Petersburg, Russia)
- Spinal needle 18G, 88 mm (Spinocan; B Braun, Germany) or 16G, 90 mm (made in China)
- Sterile WF 400/440/465P Polimid with SMA-905 connector optical fiber for delivering laser energy (made in Russia)
3.3 Technique

The procedure was explained to the selected patients in detail to ensure total patient cooperation during the procedure under local anesthesia. Informed consent was also obtained. For lumbar PLDD, the patients were placed on the table in prone position for the procedure. Those who felt discomfort or were unable to lie in a prone position were placed in the lateral position. After cleaning and draping, 2% lidocaine was infiltrated about 8–10 cm from the midline on the affected side. Then, under fluoroscopic control, an 18G×88 mm or 16G×90 mm needle was inserted into the disc with posterolateral approach at an angle of 45° with the midline. The needle was positioned midway between the two endplates and inserted until the tip was 1 cm posterior to the center. A near parallel position of the needle to the endplates (Figure 1) was achieved to avoid thermal injury to the endplates. This was followed by insertion of 400 μm optical fiber through the needle with the tip 1 cm beyond the needle tip (to avoid blockage to the passage of vapor through the needle which may result in pain).

The energy, delivered with a 970 nm diode surgical laser, was initiated at 30 W for 3–5 pulses of 1 s duration. Then lasing procedure was completed at 20–24 W with 2–3 s pulse duration until a total energy of 1650–2350 J had been delivered.

After the PLDD procedure all the patients were prescribed bed rest for 3–7 days to avoid weight-bearing activity, and regular physiotherapy to strengthen the back muscles.

For cervical PLDD an anterior approach was adopted. Having the patient in supine position, the neck being extended with sand bag under the shoulder blades, the needle was advanced vertically through the space between trachea and the neurovascular bundle till the tip reaches the anterolateral angle of the cervical disc. Then it was angled a little and advanced further to reach the center of the disc (Figure 2). Lasing was initiated with

Figure 1  Fluoroscopic lateral (A) and posteroanterior (B) view of the needle inserted into the lumbar disc.

Figure 2  Fluoroscopic lateral (A) and anteroposterior (B) view of the needle inserted into the cervical disc.
26 W and 3–5 pulses of 1 s duration, then it was completed with 20–22 W with pulses of 1–2 s duration, until a total energy of 650–1250 J was delivered.

### 4 Results

We performed the first case of lumbar PLDD in Bangladesh on November 17, 2007, and we did the first cervical PLDD about 1 year later. From November 2007 to December 2011 we have performed PLDD in 4622 herniated discs of 2580 patients of which 1420 (55.0%) were male and 1160 (45.0%) were female. Of these patients 4189 lumbar (90.6%), 431 cervical (9.3%) and two thoracic (0.1%) discs were treated. PLDD performed on discs at different levels are shown in Table 1. Forty-seven cases of FBSS were also treated. The patients were evaluated postoperatively according to MacNab criteria. Of the 2580 patients, 2296 (89.0%) reported immediate pain relief, 230 (8.9%) patients were uncertain and the remaining 54 (2.1%) did not have immediate pain relief. In the subsequent follow-up, according to MacNab criteria, a good response was seen in 1935 patients (75.0%) and fair response in 335 (13.0%) patients However, the response to the treatment was poor in 310 (12.0%) of the cases (Table 2). Two or more sessions of PLDD were required in 292 (11.3%) patients: in 162 patients (6.3%) because of multi-level (>2 discs) prolapse, in 102 patients (3.9%) because of extensive prolapse of one or two discs and in 28 patients (1.0%) because of relapse. In two cases of prolapsed dorsal spine (T7–8 & T8–9) a good response was attained without any complications. All 47 cases of FBSS showed good or fair response.

### 5 Discussion

Since its innovation in 1986 by Choy and Ascher, PLDD has gained in popularity all over the world. It is being performed in almost every nation in Western Europe, in the UK, in South and Central America, Cuba, Japan, China, India, Korea, and the US. By May 2002, some 35,000 cases had been treated worldwide, with some 10,000 cases in the US alone. The reported success rates according to the MacNab criteria from laser spine surgeons around the world average at 75–85%, with a complication rate of 1%. PLDD received the US Food and Drug Administration approval in 1991 and was awarded a Current Procedural Terminology (CPT) code by the American Medical Association in January 2000 [3].

In Bangladesh, our success rate is 89.0% with 12.2% minor complications (paraspinal muscle spasm, sacroiliitis), and 0.7% major complications such as discitis (Table 3). All minor complications were dealt with conservatively with physiotherapy. Fourteen cases of discitis were treated with combined antibiotic therapy and three cases were diagnosed as tubercular discitis and improved with antitubercular regimen. Poor results (12.0%) were seen mostly in the initial cases of our series due to technical error and improper case selection (co-existing spinal canal stenosis due to other causes, facet joint arthritis and other spondyloarthropathies. We observed 28 (1.1%) cases of relapse which were mostly traumatic.

Although no cases of FBSS were included in the selection criteria in earlier literature, we have performed PLDD in 47 cases who were operated (laminectomy/fenestration and discectomy) earlier for disc herniation and all of them showed a good and fair response.
6 Conclusion

The PLDD is a safe, simple and more effective method to treat patients with herniation of lumbar, cervical or thoracic intervertebral discs. The advantages of PLDD are manifested by shorter surgeries, better success, shorter postsurgical stay in a hospital, and a very small number of postsurgical complications, together with the patients’ quicker return to normal daily activities. PLDD can be done repetitively and it does not preclude future surgery. This evidence for laser discectomy comes from multiple observational studies [6–10, 15–19]. Our overall long-term success rate of 89.0% by MacNab’s criteria is comparable to that reported by the pioneers Choy et al.[20] in 1992 and Gangi et al.[21] in 1996.

As a result we can recommend PLDD because it is safe, effective, and minimally invasive. Also it can be performed under local anesthesia, it results in no scarring or spinal instability, can be repeated, and in unsuccessful cases, still does not hinder the scope of open surgery. Finally PLDD is also effective in cases of FBSS.

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References