

## Original Article

# Outcome of patients with lumbar spinal canal stenosis due to discogenic under percutaneous laser disc decompression

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**Abstract:** Background: The Percutaneous laser disc decompression (PLDD) method was first described by Daniel Choy in Australia in 1987. Therefore, in this study, we examined the clinical signs and symptoms of patients with spinal canal stenosis due to disc protrusion after PLDD surgery. Methods: In this clinical trial study, 43 patients with spinal canal stenosis due to lumbar disks who referred to Kashani and Zahra Marzieh educational hospitals from 2006 to 2016 were entered the study. The patients were divided into two groups as discogenic canal stenosis (3 females and 9 males) and complex degenerative disorder (canal stenosis due to discogenic and ligamentos) (16 females and 15 males). Patients underwent PLDD surgery and the clinical manifestations such as back and radicular pain, claudication, and complications of the surgery (hematoma, reoperation, and neurological symptoms) in patients were evaluated until one year after the operation. Results: After one year of surgery, the mean of back and radicular pains significantly decreased in both groups ( $P < 0.05$ ). All patients with claudication in the discogenic group improved and 35.5% of patients with complex degenerative disorder were not claudication after one year of surgery. The outcomes of treatment in patients with discogenic canal stenosis were 91.7% excellent, and 8.3% fair and in the complex degenerative disorder group were 64.5% excellent, 19.4% good and 16.1% fair ( $P = 0.16$ ). None of the patients had new neurological symptoms, and 12.9% of the complex degenerative disorder group patients needed reoperation. Conclusion: The PLDD method is a better procedure for discogenic canal stenosis than complex degenerative disorder. Therefore, more studies are required in this field for long time.

**Keywords:** Percutaneous laser disc decompression, nucleotomy, lumbar canal stenosis, pain

## Introduction

The narrowing of the lower part of the spinal canal is called spinal canal stenosis which is in various forms and degrees [1, 2]. Spinal canal stenosis often occurs in middle ages and due to degenerative changes. One of the most important causes of spinal canal stenosis is disc herniation which is one of the most common and important causes of low back pain in various societies and has a relatively high prevalence [3, 4]. The most common type of canal stenosis is the intervertebral disc bulging toward the spinal canal, leading to reduced spinal canal space and narrowing of the canal (discogenic canal stenosis). Another cause of spinal canal stenosis is the thickening of vari-

ous ligaments and bones around the spinal cord (especially ligamentum flavum) [5].

In most cases, there is a combination of these two types, which is called complex degenerative disorder. Signs of spinal canal stenosis can vary from lack of symptom to paralysis of the lower extremities, and even incontinence of the urine and feces, and, depending on the severity of the stenosis, various symptoms develop in most patients. The most common symptoms of spinal canal stenosis include back and radicular pain in the lower extremities, pelvic pain, and paresthesia of the lower limbs. The hallmark symptom is intermittent neurogenic claudication [6]. The spinal canal stenosis is diagnosed by clinical suspicion, examinations, and

imaging. The imaging method used in these cases is Magnetic resonance imaging (MRI) [7]. Various studies have been conducted on the treatment of patients with spinal stenosis, in which a variety of surgical and medical treatments have been investigated. Non-surgical treatments include rest, weight loss and physiotherapy and in case of non-response to such treatments and patient's severe dissatisfaction and disability, surgical treatment is indicated which is usually in the form of decompression of the spinal canal and remove the elements which formation cause compression on the nerve roots [8]. As mentioned, these include osteophytes, hypertrophic ligaments, bone lesions, fibrosis, or intervertebral disc.

Decompression surgery in the spinal stenosis is usually done by removing medial one-third of the upper facet and, if necessary, the lower facet of the spine [9]. These procedures are the cause of instability in some of the patients that necessitates to fusion and instrumentation. Despite the increasing growth of science and the emergence of different surgical methods, nucleotomy method is used as an effective method with less pain and complications than other methods. This type of surgical procedure requires less time than other methods, and complications such as bleeding, prolonged hospitalization, and infection are less frequently observed in this method [10]. Nucleotomy has been considered as an effective way of treating herniated discs, but few studies have been conducted on its effect on the treatment of spinal canal stenosis. One of the techniques for nucleotomy is the Percutaneous laser disc decompression (PLDD), during which the pressure inside the disk has been greatly changed by laser decompression and by doing this. This method leads to the burning of a part of the nucleus. As a result of this, the bulged part of the nucleus has been embedded in the cavity created by the laser, and the compressive effect of the annulus has been removed from the spinal elements that, this method can be effective in opening the spinal canal [11]. Considering the importance of spinal canal stenosis and its relatively high prevalence among societies, and also considering the various methods for treatment, in this study, we decided to measure the effect of the PLDD as a method for the treatment of spinal canal stenosis caused by intervertebral disc herniation and study the symptoms, clinical

signs and imaging of these patients after surgery.

### **Materials and methods**

#### *Study design and setting*

In this clinical trial study, 43 patients with spinal canal stenosis due to lumbar disks who referred to Kashani and Zahra Marzieh educational hospitals from 2006 to 2016 entered the study.

The inclusion criteria included patients with spinal canal stenosis due to the lumbar disk, according to the evidence and findings of MRI (presence of a block in the lumbosacral MRI MI) with informed consent, also patients with complex degenerative disorder (canal stenosis due to lumbar disc and ligament thickness) were enrolled into study. However, exclusion criteria included patients with canal stenosis due to congenital reduction of spinal canal diameter, metastatic disease of the spine, calcified disc, previous spine surgery, sphincter disorder or Spondylolisthesis, foraminal stenosis, severe scoliosis, cauda equine syndrome, unstable neurological deficits, hard disk bony spinal stenosis, previous spinal fracture, hemorrhagic disease, pregnancy, psychosis, and drug dependence. Exclusion criteria included patients who were not followed up.

After approving the proposal and obtaining a license from the University's Medical Ethics Committee, patients with spinal canal stenosis due to lumbar disc herniation who were eligible to study and who were willing to undergo PLDD surgery were justified about the treatment and patients who wanted to be treated with this method were included in the study. After the admission of the patient in the operating room, they were operated with PLDD method.

#### *Surgical procedure*

PLDD: was first performed by Dr. Choy in Australia in 1987 and was licensed by the FDA in 1991 as a less invasive approach for treating some of the herniated discs, and according to relevant positive results, it was widely accepted and by the year 2002, 35000 PLDD surgery was performed worldwide. In several studies, the application of this method has been used in some cases of lumbar canal stenosis, which

# Spinal canal stenosis

**Table 1.** Demographic characteristics of patients based on canal stenosis types

Variables	discogenic canal stenosis	Complex degenerative disorder	P-value
Gender			
Male	3 (15.8%)	15 (62.5%)	0.11*
Female	9 (37.5%)	16 (84.2%)	
Age (year) (mean $\pm$ SD)	41.91 $\pm$ 15.51	52.32 $\pm$ 14.66	0.78**

\*Chi square. \*\*Independent t test.

is the primary cause of disc protrusion and has caused clinical symptoms of canal stenosis [12, 13]. In the PLDD method, different kind of lasers has been used. In our PLDD method, the laser needle (18 G) is inserted into the center of the disk through the posterolateral section of the spinal column guided by C-arm fluoroscopy or CT, and the center of the nucleus is burned circular and evaporated with about 1500 j of total energy. The diode laser 980 nm (Biolitec-AG, Diode laser 980 nm) used in this method brings the laser beam into the nucleus 1-1.5 centimeters and burns it. As a result of decreased intra-discal pressure, the pressure applied to the neural elements decreases and reduced or heals the pain and symptoms of the patient. In many cases, over time, the protruded disk section with the vacuum phenomenon moves toward the disk space.

## Assesment

All patients were discharged from the hospital on the day after surgery and they were followed up in 14 days; three months, six months and one year after the operation and, during the follow-up period, patients were evaluated for improvement of claudication, back pain, lower extremity pain, and complications of surgery including discitis and new neurological deficit. For each patient, the severity and quality of back pain and lower limbs, as well as periodic claudication, were evaluated and recorded at the intervals of 2 weeks, 3 months, 6 months, and one year based on NPS and Macnab criteria. One year after surgery, patients underwent MRI again, and the findings were compared with pre-operative MRI findings. The patients divided regarding the cause of canal stenosis that was included discogenic canal stenosis and complex degenerative disorder (discogenic and ligamentos). The treatment recovery was evaluated with Macnab criteria that the outcome was classified into four levels of excellent (no pain, no restriction of

activity), good (pain in the severe activity with normal function), fair (normal activity with intermittent pain) and poor (no improvement).

## Statistical analysis

The sample size of this study was calculated by using the sample size estimation formula to compare the mean values, taking into account the confidence level of 95%, test power of 80% and the standard deviation of pain intensity in patients with spinal canal stenosis estimated to be 1.17. The least significant difference was observed in the pain intensity before and after the treatment, which was 0.5, and the sample size was 43 patients [14]. Data were collected by a computer and analyzed by SPSS version 23 software. The analyses were carried out in two descriptive and analytical sections. In the descriptive part, the reports were presented as the mean (standard deviation) for quantitative variables and percent (number) for qualitative variables. In the analytical part, the comparisons before and after the surgery were performed using Chi-Square, Fisher's exact test, Mann-Whitney U, and repeated measure ANOVA based on the type of variables used. All analyses with the error rate of 5% were performed using SPSS 20 software.

## Results

### Demographical

The patients were divided into the discogenic (3 males and 9 females) and complex degenerative disorder (15 males and 16 females) groups. There was no significant difference between groups based on gender ( $P=0.11$ ) and the age of patients ( $P=0.78$ ) (**Table 1**).

### Pain intensity

Results of pain score of VAS scale for back pain (**Table 2**) and radicular pain (**Table 3**) sh-

## Spinal canal stenosis

**Table 2.** The mean of Back pain based on the canal stenosis types

Times	discogenic canal stenosis	Complex degenerative disorder	P-value*
Before surgery	4.45 ± 3.55	6.16 ± 3.14	0.17
14 days after surgery	2.44 ± 2.60	3.14 ± 2.10	0.29
3 months after surgery	2.77 ± 2.87	3.29 ± 2.40	0.54
6 months after surgery	2.77 ± 2.86	3.29 ± 2.39	0.49
One year after surgery	2.77 ± 2.86	3.16 ± 2.49	0.64
Repeated measure ANOVA	P <sub>groups</sub>	0.44	
	P <sub>times</sub>	<0.001	

\*Mann Whitney U.

**Table 3.** Frequency of radicular pain based on the canal stenosis types

Times	discogenic canal stenosis	complex degenerative disorder	P-value*
Before surgery	6.72 ± 4.22	6.45 ± 3.37	0.35
14 days after surgery	2.70 ± 2.40	2.65 ± 2.38	0.95
3 months after surgery	2.20 ± 2.09	3.01 ± 2.75	0.59
6 months after surgery	1.80 ± 2.04	3.11 ± 2.77	0.22
One year after surgery	1.80 ± 2.04	2.95 ± 2.85	0.32
Repeated measure ANOVA	P <sub>groups</sub>	0.63	
	P <sub>times</sub>	<0.001	

\*Mann Whitney U.

**Table 4.** Claudication based on the canal stenosis types

Times	discogenic canal stenosis	complex degenerative disorder	P-value*
Before surgery	11 (91.7%)	28 (90.3%)	0.69
14 days after surgery	1 (8.3%)	21 (67.7%)	0.001
3 months after surgery	0	19 (61.3%)	<0.001
6 months after surgery	0	18 (58.1%)	<0.001
One year after surgery	0	17 (54.8%)	0.001

\*Chi square.

**Table 5.** Treatment outcome in the both group

Outcome	discogenic canal stenosis	complex degenerative disorder	P-value*
Excellent	11 (91.7%)	20 (64.5%)	0.16
Good	0	6 (19.4%)	
Fair	1 (8.3%)	5 (16.1%)	

\*Chi Square.

owed that there was no significant difference between groups based on back and radicular pains before surgery, 14 days, 3 and 6 months, and one year after surgery ( $P > 0.05$ ). However, based on repeated measure ANOVA, changing back and radicular pains in these times were significant ( $P < 0.001$ ), and also the back and radicular pains were decreased significantly in both groups, postoperatively ( $P < 0.05$ ).

### Claudication

There was no significant difference between the group based on the frequency of claudication before surgery ( $P = 0.69$ ) but after surgery, all patients with claudication in the discogenic group improved and 35.5% of patients with claudication in the complex degenerative disorder group improved that this difference was significant ( $P < 0.05$ ) (Table 4).

### Treatment outcome

The outcomes of treatment in patients with discogenic canal stenosis were 91.7% excellent, and 8.3% fair and in the complex degenerative disorder group were 64.5% excellent, 19.4% good and 16.1% fair ( $P = 0.16$ ) (Table 5).

### Complications

In our study, hematoma and neurological symptoms did not occur at any time in any patient.

## Spinal canal stenosis

**Table 6.** Incidence of hematoma, reoperation and neurological symptoms

Complication	discogenic canal stenosis	complex degenerative disorder	P-value*
hematoma	0	0	-
Reoperation	0	4 (12.9%)	0.25
neurological symptoms	0	0	-

\*Fisher's Exact test.

Reoperation was observed in four subjects (12.9%) of the complex degenerative disorder group, and, finally, no significant difference was observed between groups based on reoperation ( $P=0.25$ ) (Table 6).

### Discussion

The surgical procedure of spinal canal stenosis usually has some complications, and in some cases, these complications may be irreversible [15]. Some years ago, a laser method called PLDD was proposed to eliminate spinal canal stenosis. The PLDD method is a technique in which laser energy is transmitted by fiber to the nucleus pulposus. This fiber inserted through a thin needle from the posterolateral of the spinal column into the disc space under local anesthesia. Then, in this method, the energy of the laser causes the evaporation of the water and burning inside the nucleus pulposus and decreases its volume and pressure on the nerve is removed [16, 17]. Choy and Ascher first introduced this method in 1987 [1]. This method is a minimally invasive method that reduces the risk of damage to muscle, bone, ligaments, and nerves. In this method, the pain rate in patients is reduced and, the patient's hospitalization rate has decreased and the duration of this procedure is less than surgery and supportive care [17].

In a study by Choy and Jefferey in which 35 patients of both genders and all ages who had symptoms of canal stenosis and, in the lumbosacral MRI, who has the evidence of canal stenosis and intervertebral disk bulging (protruded disc herniation) were subjected to PLDD. In a follow-up after the procedure, 69% of patients had good to the excellent improvement of symptoms (intermittent claudication, back pain, or radicular pain). In this study, it was concluded that in the discoge-

nic lumbar canal stenosis, the PLDD, is a favorable technique compared to the open surgery [18].

In the other study, the PLDD procedure had 80% improvement of sciatica pain symptom and 75% of discogenic pain after 3 months. Also, the PLDD considered a safe and effective treatment for discogenic and sciatica pains. Also, this technique had no complication, such as infection or neurological symptoms [19].

Zhao et al. [20] conducted that PLDD is a safe and effective procedure for pain relief in the treatment of lumbar disc herniation and stenosis with high success rate and few complications.

In the study by Brouwer, open surgery was more effective and better than PLDD [21].

In a study conducted by Sang Hyun Kim et al. in 2012, 46 patients with radiculopathy and MRI evidence of a lumbar disc protrusion in the lumbar region were subjected to PLDD. The mean VAS Score for radiculopathy before the procedure was decreased to  $7.4 \pm 1.4$  and after the procedure decreased to  $1.4 \pm 0.7$  that, 89% of the patients had good to excellent improvement [22]. In our study, patients who underwent PLDD surgery, back pain, and radicular pain were significantly reduced in patients after 1 year. On the other hand, new neurological symptoms didn't occur in the patients. Before operation in our patients, 90.7% had claudication, but after 1 year, all patients with discogenic canal stenosis improved, and 35.5% of complex degenerative disorder improved. In a study conducted by Renl et al., 21 patients had intermittent claudication and negative SLR, and they had central herniated discs in the MRI and then they were subjected to PLDD which 66.7% of patients had good to excellent improvements one year after the procedure [23]. In our study, the PLDD method showed a significant reduction in radicular pain and back pain in postoperative patients. Also, four patients with complex degenerative disorder needed reoperation. The limitations of this study were not using control group, double-blinded and randomized, noting follow up in long time, and not comparing with open surgery technique.

## Conclusion

According to our results, PLDD method was an innovative method, and was with successful outcomes in cases of discogenic canal stenosis without the ligament hypertrophy. Therefore, it seems that this method could be a good procedure with few complication to improve the symptoms of patients. In addition we need more study with higher sample size, long follow up (more than one year), and comparing with open surgery to evaluate effect of PLDD in discogenic canal stenosis.

## Disclosure of conflict of interest

None.

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## Spinal canal stenosis

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