

# TREATMENT OF HERNIATED LUMBAR DISC WITH LASER DISCECTOMY \*

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## ABSTRACT :

*Percutaneous intradiscal laser nucleotomy is a safe, minimally invasive and short procedure for treatment of a selected group of patients with herniated lumbar intervertebral disc disease. We have been using this technique since March 1993. We operated 283 cases until August 1995. Among these, 132 patients whose follow-up periods were longer than one year was included in this study. Patients seemed to be favoured better in the early postoperative period when compared with the late follow-up. Although 87.3% of the cases had negative Laseque test, the rate for complete relief of complaints were 68.9%. 5% of the cases were reoperated with laser nucleotomy, but two of them didn't favour and underwent to laminotomy and disc removal. Open surgery have been proposed in 26 (19.6%) and 16 of them were operated. Overall improvement in minor motor, sensorial and deep tendon reflex deficits were 70.9%, 67.6% and 48.8%, respectively. We recommend laser nucleotomy as an effective treatment modality, and it can be performed with a very low complication rate, especially, if the preoperative computerized tomographic scans showing the coordinates for the trajectory of the needle, are available.*

**Key Words:** *Intervertebral disc, laser, low back pain, percutaneous nucleotomy.*

## INTRODUCTION

There are a number of percutaneous procedures for lumbar disc herniation as an alternative to conventional surgical methods, such as laminectomy disc removal, or others (14). Among these, chemonucleolysis with chemonucleolysis prevented is usage. But in the late 1980s, percutaneous nucleotomy with a punch or automated nucleotome has been performed more commonly (8, 9). However, the difficulty in approaching to disc space via a cannula with a diameter more than 3 mm and the resultant tissue damage were their disadvantages (14). Since 1986, Nd-YAG laser has been introduced as a new advance in the treatment of herniated disc disease (2, 3). Using laser for decompressing the affected disc has the following advantages; 1) because the output power can be easily controlled, it can be used safely; 2) since high energy can be transmitted through thin flexible fibers, minimal invasive therapy is possible; 3) there are no chemical complications; and 4) there are minor technical problems in using a small-diameter needle (3, 14). We began to use Nd-YAG laser in the treatment of herniated discs since 1993 and in this report, we present our experiences in 132 patients.

## MATERIALS AND METHODS

Since March 1993, we have been performing PILN in selected patients with lumbar disc herniation. The decisions for laser nucleotomy were given in patients having the following criteria:

1. Symptom of radicular pain corresponding to the level of non-sequestered disc herniations which were observed on computerized tomography or magnetic resonance imaging.
2. Failure in adequate conservative therapy,
3. No osseous pathologies such as vertebral stenosis, facet impingement, lateral recess stenosis, advanced degenerative disc disease or spondylolisthesis,
4. No advanced neurological deficit,
5. No hemorrhagic diathesis.

283 patients having these criteria underwent laser nucleotomy. But, 132 of them could have been followed at least one year, postoperatively. Among them 69 were female. Mean age was  $44.24 \pm 13.19$  years (ranging from 21 to 87 years). The mean period for their complaints was  $44.77 \pm 39.94$  months (ranging from 1 to 132 months). In 64 cases left radicular symptoms were present. The preoperative examination revealed motor deficits in 107 (81%), sensorial deficits in 71 (53.7%) and deep tendon reflex deficits in 43 (32.5%) cases. Laseque test was negative in 13, and positive in 119 (90.1%) cases. The degree where Laseque test had been positive, was lower than  $45^\circ$  in 45 cases, and higher than  $45^\circ$  in 74 cases. In 5 cases

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with borderline discal herniations, because there were high risks for general anesthesia, PILN was tried. No complication was observed during or after the surgery.

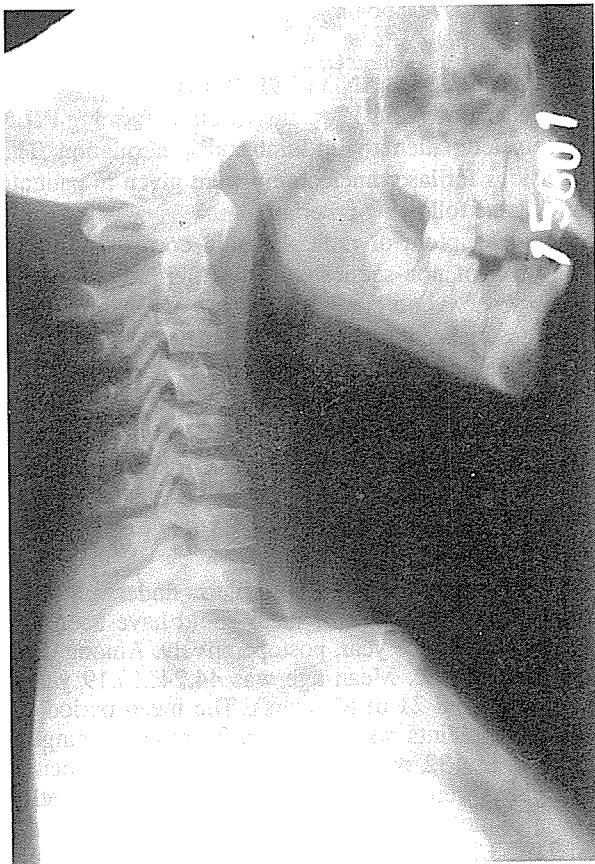
Among these patients, 106 (80.3% were operated for a single, 24 (18.1%) for a double, and 1 for a triple level of disc herniation. 157 herniated discs, of which 2 were pure L3-4, 81 (51.5%) were pure L4-5, 23 were pure L5-S1, 20 were L3-4 + L4-5, 24 (15.2%) were L4-5 + L5-S1, 4 were L3-4 + L5-S1 and 3 were L3-4 + L4-5 + L5-S1, were punctured.

Each patient had a CT scan in which the appropriate distance from the midline for puncturing the skin to approach the center of the disc, was measured (Figure 1). The procedure was done with local anesthetic infiltration under fluoroscopic control while the patient was placed in the lateral recumbent position with the radicular pain side up. The related disc space was punctured via a posterolateral approach as reported by

Choy (3). Nd: YAG 1.06 Mm laser was delivered via a sterile 400 Mm core optical fiber through a 20 cm, 18 gauge needle. The standart irradiation condition that we preferred for a lumbar disc was; the output power of 15 watts with an interval of 1 second, and repetition times of 100 pulses (1500 joules). The pauses between pulses were 1 second, unless patients would have any complaint. Although some modifications were done on these parameters during the procedure according to the intraoperative complaints of patients, we never exceeded 1500 joules. All patients were hospitalized one night with their knees bent on a pillow and discharged on the day after the procedure. An oral antibiotic was given for one week, and medical therapy with analgesic, antiinflammatory and myorelaxant drugs, continued 15 days, postoperatively. Patients were examined immediately after the procedure, at the first month and then every three months. Mean period for follow-up was  $18.73 \pm 4.00$  months (ranging from 12 to 27 months).

## RESULTS

Among 132 patients, 10 were operated with open surgery before PILN. While seven underwent PILN for the same previously removed disc space, three were operated for another herniated discs. We modified the irradiation conditions in 67 (50.7%) patients during the procedures since they were complaining about the increased low back or ipsilateral leg pain or burning. But only 30 of them had severe discomfort. There was a close relationship between the decompressive effect of PILN and the clinical findings. In 111 (84.1%) cases, we achieved relief of pain immediately after the operation. However, in 10 cases pain reduced and in 11 cases remained the same. Most of the patients had minor complaints localized on the lumbar region where the puncture was performed. This backache lasted about one or two days. Minor motor deficits which were observed in 107 patients before PILN, disappeared in 49 (45.7%), improved in 39, and remained the same in 19 patients in the immediate postoperative examination. Sensorial deficits were present in 71 cases in their preoperative examination, and in 33 (46.4) of them sensorial deficits disappeared in the early postoperative period. Deep tendon reflex deficits of the lower extremities were observed in 43 patients before PILN, and in 9 (20.9%) of them improved in their immediate postoperative examination. In the early postoperative period, straight leg raising test



**Figure 1 :** A patient's preoperative CT scan demonstrating the coordinates for trajectory of needle to approach the appropriate location in the disc.

was negative in 13 cases whose preoperative tests were also negative. This test was negative in 67 of 74 cases whose preoperative tests were positive above 45°, and was positive above 45° in the remaining seven cases, too. Straight leg raising test was negative in 31, positive above 45° in 12, and positive below 45° in 2 patients whose preoperative tests were positive under 45°.

During postoperative follow-up period, 7 (5.3%) patients were reoperated with PILN because of the persistence of their radicular symptoms (Table 2). Later two of these seven cases didn't favour and operated with open surgery. Open surgery after PILN, was indicated in 26 (19.6%) cases. Among them, 16 (12.1%) were operated with one of the conventional surgical technics (two patients who were reoperated with laser are included). Three had an extruded disc on their postoperative CT scans, and free fragments compressing the related nerve root was removed during their surgery. The disc tissues had a dark brown color and it was not easy to remove the disc stuck to end-plates without excessive curetting. Other 10 patients are still waiting favour from the medical therapy.

In the late postoperative follow-up, the number of patients with minor motor deficits decreased from 58 to 32 when compared with the early postoperative examinations. Overall improvement for the minor motor deficits was 73/107 (70.9%). Sensorial deficits were still remaining in 23 of the 38 patients who had senso-

rial deficits in the early postoperative period. Overall improvement in sensorial deficits was 48/71 (67.6%). Lower extremity deep tendon reflex deficits disappeared in 12 of the 34 patients whose early postoperative examinations revealed deficits. Overall improvement in deep tendon reflex deficits was 21/43 (48.8%). Laseque was negative in 95, positive above 45° in 14, and positive below 45° in 2 of 111 cases whose early postoperative tests were negative. Among 19 patients whose early postoperative Laseque tests were positive above 45°, 9 had negative, 8 had positive test above 45° and 2 below 45°. This test was also positive below 45° in 2 of the cases whose early postoperative tests were positive under 45°. Overall success rate for disappearance of straight leg raising test was 104/119 (87.3%). When we investigated the satisfaction of the patients from PILN, we observed favourable results in 91 (68.9%) cases. But 31 cases didn't favour, and the other 10 (7.5%) were completely unsatisfied (Table 1). We have not faced with any complication during the procedures. Patients had no septic complication in their follow-up periods.

## DISCUSSION

Previous experimental studies provide that PILN may reduce the pressure exerted on nerve root by the herniated disc (1, 4, 6, 7). The shrinkage and vaporization of a small volume of nucleus pulposus may allow a reduction in intradiscal pressure which result as a decrease in the herniation. It is true that PILN and other

percutaneous procedures do not substitute for conventional surgical methods completely, because they can not remove a herniated mass. But in selected patients having the appropriate criteria, relief of the symptoms may be achieved with this safe and relatively noninvasive modality (3).

The success rates, in terms of pain relief and return of normal func-

Table 1: Summary of clinical response after PILN.

preoperative		early postoperative				late follow-up			
deficits		state of deficits			deficits	state of deficits			
	cases	abs.	imp.	same		cases	abs.	same	recov.
MOTOR	107	49	39	19	MOTOR	58	26	32	70.9%
SENSORY	71	33	-	38	SENSORY	38	15	23	67.6%
DTR	43	-	9	34	DTR	34	12	22	48.8%
LASEQUE		(-)	>45°	<45°	LASEQUE		(-)	>45°	<45°
(-)	13	13	-	-	(-)	111	95	14	2
>45°	74	67	7	-	>45°	19	9	8	2
<45°	45	31	12	2	<45°	2	-	-	2
		abs.	imp.	same			abs.	imp + same	recov.
PAIN	132	111	10	11	PAIN	132	91	41	68.9%

The changing of the neurological deficits and straight leg raising tests are shown according to the findings observed during the immediate and late postoperative periods. Abbreviations: abs. (absent), imp. (improved), recov. (recovery rate), DTR (deep tendon reflex).

**Table 2:** Summary of therapeutic approaches.

	cases	favoured	repeat PILN	open surg. proposal	performed open surg.	medical therapy
First PILN	132	88	7	23	14	23
Repeat PILN	7	3		3	2	2
TOTAL		91 (68.9%)		26 (19.6%)	16 (12.1%)	25 (18.9%)

The repeating of PILN was performed in 5.3% of all cases, but more than half of these cases did not favour and open surgery was proposed later. Open surgery was indicated in 26 patients. Only 16 of them could be operated. But the other 10 patients didn't accept open surgery and they have been still waiting favour from conservative and medical therapy. Abbreviation: surg. (surgery).

tion for open discectomy, microdiscectomy (13), nucleotome discectomy (5) and chymopapain chemonucleolysis (10) are 60-80%, and 70-80%, respectively. The rate of good results after PILN was found 78.4% by Choy in his 333 patients. Among our patients, 68.9% had complete relief of their symptoms and when the fair results were added, this rate was increasing to 76.5%. Straight leg raising test had the best respond to PILN. Positive tests disappeared in 87.3% of the cases with preoperative positive tests. Patients with preoperative positive tests above 45°, seemed favouring better.

The immediate relief of pain after PILN (84.1%) and disappearance of positive laseque tests in the early postoperative examination (82.3%) may prove the ability of the procedure in decreasing the pressure on the affected nerve root during the acute stage. This effect seemed lasting also in the late follow-up period. Improvement of the minor motor, sensorial, and deep tendon reflex deficits were 70.9%, 67.6% and 48.8%, respectively and these results predicted the effectiveness of laser nucleotomy in selected cases.

During the procedure, it was possible to see the steam draining from the hole of the needle. When the smoke is entrapped in the denaturated disc by the carbonized tissue which closes the tip of the needle, the intradiscal pressure may increase. Patients usually express this situation as a sense of straining on the lumbar area. But this sense often resolves by allowing its drainage and opening the lumen with the mandrin. Also patients usually have some complaints during the puncture of the annulus. This may be due to an increase in the intradiscal pressure that leads to further compression on the nerve root. These two conditions may explain why we found free fragments which had not been seen on the preoperative neuroradiological

investigations in three cases. We modified the laser irradiation conditions in 67 (50.7%) patients who had severe burning sense or pain on lumbar area or ipsilateral leg during the procedure. Our aim was to reduce the heat generated on nerve roots.

They actually tolerated the procedure easily after the modifications.

Choy avoids laser nucleotomy of a disc which has been treated with a previous open discectomy (3). But we vaporized the discs which had been treated by open discectomy in seven cases. We punctured these discs via a posterolateral approach contralateral to the previous laminotomy side. Our purpose in changing the puncture site was to exclude the fibrotic tissue from the trajectory of the needle. In two patients, we were not able to puncture the L5-S1 disc since one had a very high iliac crest, and the other had a hypertrophic facet joint. In cases with high iliac crests, it was not possible to place the tip of the needle in the center of the disc every time. In such cases tip, also tip of the laser probe was close to the superior end-plate of first sacral vertebra and denaturation of nucleus pulposus seemed unsatisfactory. But we believe that in cases with hypertrophic facet joints of L5-S1 disc space, it is not possible to move the needle forward between the ilium and the facet joint, and it is apparent that the risk of root damage will increase. So we recommend CT scans including the measurements of the puncture site on skin for approaching the center of the disc via a trajectory lateral to the facet joint and medial to iliac bone. If we see an interference of this trajectory by any of these two structures, we do not propose PILN.

We believe that PILN with a low complication rate, is a safe, minimal invasive and short lasting procedure for effective treatment of nonsequetered herniated lumbar intervertebral disc disease. This technique may also be preferred in cases whose discal herniations are borderline for PILN when there are high risks for general anesthesia.

## REFERENCES

1. Adams MA, Hutton WC. Mechanics of intervertebral disc. *The Biology of the intervertebral Disc*. Vols 1, 2. Edited by P Ghosh. Boca Raton, Florida, CRC press 1989.
2. Ascher PW. Application of the laser in Neurosurgery. *Lasers Surg. Med.* 2: 91-97, 1986.
3. Choy SJD, Ascher PW, Saddekni S et al. Percutaneous Laser Disc Decompression: A new Therapeutic Modality. *Spine* 17: 949-956, 1992.
4. Gropper GR, Robertson JH, Mc Clellan G et al. Comparative histological and radiographic effects of CO2 laser versus standard surgical anterior cervical discectomy in the dog. *Neurosurgery* 1:42-47, 1984.
5. Maroon JC, Onik G. Percutaneous automated discectomy; a new method for lumbar disc removal. *J Neurosurg* 66: 143-146, 1987.
6. Nachemson A. Lumbar intradiscal pressure; experimental studies on post-mortem material. *Acta Orthop Scand (Suppl)* pp. 43, 1960.
7. Nachemson A. The lumbar spine; An orthopaedic challenge. *Spine* 1: 59-71, 1976.
8. Onik G, Helms CA, Ginsberg L et al. Percutaneous lumbar discectomy using a new aspiration probe. *AJNR* 6: 290-293, 1975.
9. Onik G, Helms CA, Ginsberg L et al. Percutaneous lateral discectomy using a new aspiration probe: Porcine and cadaver model. *Radiology* 155: 251-252, 1985.
10. Onofrio BM. Injection of chymopapain into intervertebral discs; Preliminary report on 72 patients with symptoms of disc disease. *J Neurosurg* 42: 384-388, 1975.
11. Smith L. Enzyme dissolution of nucleus pulposus in humans. *JAMA* 187: 137-149, 1964.
12. Watts C. Complications of chemonucleolysis for human disc disease. *Neurosurgery* 1: 2-5, 1977.
13. Williams RW. Microlumbar discectomy: A surgical alternative for initial disc herniation. In: Cauthen JC ed. *Lumbar Spine Surgery*. Baltimore, Williams&Wilkins, 85-98, 1983.
14. Yonezawa T, Onomura T, Kosaka R et al. The System and Procedures of Percutaneous Intradiscal Laser Nucleotomy. *Spine* 15: 1175-1185, 1990.