

## **ORIGINAL ARTICLE**

# **Automated percutaneous lumbar discectomy in patients suffering from prolapsed intervertebral disc: a prospective study**

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## **ABSTRACT**

**Background:** A variety of minimally invasive techniques (chemonucleolysis, laser, automated percutaneous discectomy, percutaneous manual nucleotomy) have been invented over the years, as treatment of low back pain related to disc disease. Automated percutaneous lumbar discectomy (APLD), being one of these techniques, is a modality in which removal of nucleus pulposus, reduces intradiscal pressure thus relieves the nerve root compression and subsequently reduces radicular pain. This technique was introduced by Onik in 1985, referred to as 'automated' since it involves a mechanical probe, working by a 'suction and cutting action for removal of the nucleus pulposus.

**Methodology:** After meeting the inclusion criteria, minimal invasive procedure - APLD, performed in between 2012 to 2015 on 120 patients on outdoor basis. Radicular discogenic pain was confirmed by MRI and clinical finding, procedure is being performed using nucleotome under fluoroscopic guidance.

**Result:** Based on patient satisfaction, 72 (60%) patients had excellent pain relief (75 – 100%), 34 (28.3%) had good pain relief (51–74%) whereas 14 (11.7%) patients had poor pain relief. Two (1.6%) patient developed discitis, which was the only complication and it resolved within fifteen days without sequelae.

**Conclusion:** Percutaneous decompression (APLD) techniques for intervertebral disc herniation are safe and cost-effective techniques with significant and long lasting results concerning pain reduction and mobility improvement. They can be proposed as initial treatment or attractive alternatives prior to major surgery.

**Key words:** Lumbar Prolapsed Intervertebral Disc; Nucleotome; discectomy; Intradiscal pressure; Lumbar radicular pain.

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## **INTRODUCTION**

Back pain or radiculopathy related to herniated discs is an extremely common and a frequent cause of chronic disability. Symptoms of lumbar disc herniation (LDH) may start as low back pain (LBP),

which then develops to radicular pain. A variety of minimally invasive techniques have been invented over the years as treatment of low back pain related to disc disease. Automated Percutaneous Lumbar Discectomy (APLD), being one of these techniques,

## lumbar discectomy in prolapsed intervertebral disc

is a modality in which removal of nucleus pulposus reduces intradiscal pressure and relieves the nerve root compression, subsequently reduce radicular pain. However, Maroon and Allen [1] stated that the removal of an average of 2.5 grams of nucleus pulposus material from the disc ranging from one gram to 8 grams with no correlation with the outcomes. Percutaneous lumbar discectomy (PELD) was first described by Hijikata [2] in 1975 and represented a revolutionary concept in the semi-invasive treatment of vertebral pain. APLD is an attractive method of treatment because of the minimally-invasive nature and therefore the assumed decrease in risk of structural damage to the nerves, muscles, bone, and ligaments. Hence the patients are expected to have day care procedure, less back pain, cost-effectiveness, minimal or no blood loss, and a shorter convalescence period than with conventional surgery. The actual relief of low back and radicular pain, might take more time slightly longer period to full recovery than after conventional.

### METHODOLOGY

After approval of institutional research ethical, this prospective, descriptive study was conducted at a Pain Medicine Clinic, Department of Anesthesia, Institute of Medical Science, BHU, Varanasi, India, from February 2012 to May 2015.

The patients were first treated with conservative management, including medications and physical therapy. When conservative treatment proved unsuccessful, they were recommended treatment of APLD. Patients who met the inclusion criteria signed and informed written consent were taken from one hundred twenty patients with radicular and axial pain were included in this prospective, single-arm, observational study. Patient presenting with low back ache of discogenic origin to our Department were enrolled in the study. We included patients between 20 years to 65 years of age, presenting with low backache of discogenic origin with evidence on MRI, with disc protrusion < 6 mm. Other criteria were the axial back pain, radicular leg pain and lack of response to conservative management including medications and/or physical therapy.

Patients with spondylolisthesis and spinal fractures, infections or tumors, and for open discectomy, patients having sequestered disc having bladder and bowel involvement, with decreased height of disc ( $\leq 50\%$ ) on x-ray, patient having pain of other origin (including tuberculosis, facet joint arthropathy and severe bony stenosis, disc protrusion > 5 mm or

sequestration, unstable spinal fracture or spinal instability, were also excluded. Other exclusion criteria were; pregnancy, infection at the injection site, coagulopathy and patients unable to provide informed consent.

All patients underwent magnetic resonance imaging (MRI) of the lumbosacral spine.

The procedure was monitored fluoroscopically, with the use of a C-arm. Once confirmed, the trocar can be safely advanced into the center of the disc using this anteroposterior view. The fluoroscope was then repositioned to obtain a lateral view, allowing the surgeon to confirm that the trocar's tip is correctly placed on both anteroposterior and lateral views. Once the trocar is in the correct position, the dilator and cannula are placed over the trocar and advanced until the annulus was reached. The dilator was then removed, and the cannula was pushed the extra few millimeters to rest on the annulus. The nucleotome was then placed into the disc. Once the aspiration probe was seen to be in the correct position in anteroposterior and lateral views, the port of the instrument was rotated toward the area of the herniation, the nucleotome console (Figure 1) was turned on, the footswitch pressed, and the disc aspiration was initiated (Figure 2).

Since the disc was avascular, the fluid flowing from the aspiration line should not be bloody. If the fluid has a red tinge, the most likely explanation was the presence of a gap between the cannula and the annulus that allows blood to be sucked into the disc from the surrounding soft tissues. It was likely the good results of APLD for discogenic pain are achieved by lowering the pressure within the disc. Duration of aspiration averages 15–20 minutes, and was stopped when the amount of nuclear material coming from the probe clearly decreases or when a blood-tinged material starts coming, indicate that the vascularized discovertebral cartilage was denuded. Probe was withdrawn into the cannula once no more material can be aspirated and injected 20 mg methylprednisolone acetate and 1 ml bupivacaine 0.5% within the disc through 22 G aspiration needle. Patient will be followed for immediate and long term relief of pain, straight leg raising test, spinal tenderness, and improvement in neurological deficit if any. Patient will also be followed for immediate and long term complication including discitis, neurological deficit, bladder and bowel involvement. Technique-related complications include nerve root injury, osteomyelitis, cellulitis, uncontrolled bleeding, dural puncture, annular injury, and vertebral



Figure 1: Nucleotome console

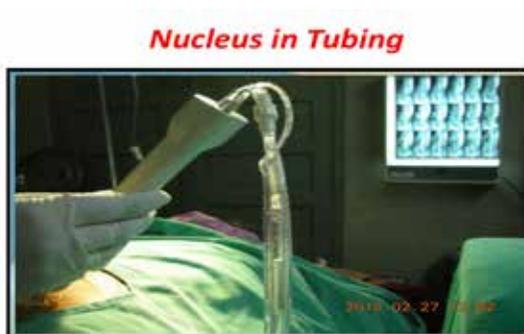


Figure 2: Intraoperative images taken after insertion of nucleotome, nucleus pulposus within tube

endplate injury were noted.

**Postoperative care:** After procedure patients remained under observation for 3-4 hours then sent back home with prescription of nonsteroidal anti-inflammatory agent, and gabapentin at bedtime for 2 weeks and encouraged to move, stand, and walk for few step on day five. Repetitive forward flexion/backward extension, prolonged car driving, prolonged sitting, and lifting heavy weights was prohibited for 3-4 weeks. Limb pain resolution may take weeks, owing to remodeling of the disc and regression of inflammation at the surgical site. Progressive return to heavy activities or sports is usually possible at 5-6 week.

## RESULTS

Out of 120 patients, 75-85% patients were satisfied with this procedure. Blood loss was very minimal or no loss. Patients were operated as day care cases and discharge after 3-4 hrs of post discectomy. The patients were observed for immediate and long term relief of pain and complications. In present study, all degrees of pain relief is shown in Table 1.

The mean pain score was  $6.53 \pm 1.112$ , in immediate post procedure period a slight decrease in mean pain score by 1.09 was observed on day one, but as the time passed a consistent decrease in pain scores, visual analogue score (VAS) was observed and at 6 months interval mean pain score was  $2.10 \pm 1.998$  as compared to  $6.53 \pm 1.112$  pre procedure which was statistically significant ( $p < 0.001$ ) (Table 2).

Seventy five percent patients in younger age group (20 – 29 years) showed excellent relief as compared to 40% patients in 30 – 49 years age group and 31.2% patients in  $\geq 50$  years age group as shown in Table 3.

The patients presenting with acute pain ( $\leq 3$  months duration) showed excellent pain relief in 71.4% patients as compared to 24% patients presenting with chronic pain ( $\geq 3$  months duration) as shown in Table 3.

Best results were seen in patients with protruded central disc, as 65% (52 out of 80) patients showed excellent pain relief, whereas patients presenting with extruded disc with wide neck showed poor results, as 6 patients out of 36 (16.7%) could only demonstrate excellent relief. Substantial relief of pain ( $\geq 75\%$ ) was present in nearly 90% of patients with protruded disc as compared to 66.7% of patients with extruded disc (Table 3).

The influence of number of disc undergoing discectomy on pain relief is shown in Table 6. Best results (substantial pain relief) 96.77% were seen in patients with disc prolapse at one level

Table 1: Showing overall relief of pain

Pain relief	N (%)
Excellent (75 – 100 %)	72 (60)
Good (51 – 74%)	34 (28.3)
Poor ( $\leq 50\%$ )	14 (11.7)
Total	120 (100)

Table 2: Comparison of VAS at different time interval

Time interval	Mean $\pm$ SD	Median (IQR)	p-value
Pre procedure	$6.53 \pm 1.112$	7 (6-7)	-
Post procedure	$5.44 \pm 1.027$	6 (5-6)	$< 0.001$
Day 1	$4.68 \pm 1.376$	5 (4-6)	$< 0.001$
Day 15	$4.06 \pm 1.657$	4 (3-5)	$< 0.001$
1 month	$3.45 \pm 1.660$	4 (2.5-4.5)	$< 0.001$
3 month	$2.60 \pm 1.429$	3 (2-3)	$< 0.001$
6 month	$2.10 \pm 1.998$	2 (0-3)	$< 0.001$

Fischer Exact test:  $p = 0.0249$ .

**Table 3: Influence of different factors on pain relief achieved**

	Parameter	Excellent n (%)	Good n (%)	Poor n (%)	Total n=120
<b>Age</b>	20-29	36 (75)	12 (25)	0 (0)	48
	30-49	16 (40)	18 (45)	6 (15)	40
	≥50	10 (31.2)	6 (18.8)	16 (50)	32
<b>Chronicity</b>	Acute(≤ 3 months)	50 (71.4)	16 (22.8)	4 (5.7)	70
	Chronic(≥ 3 months)	12 (24)	18 (36)	20 (40)	50
<b>MRI findings</b>	Protruded central	52 (65)	20 (25)	8 (10)	80
	Protruded paracentral	2 (50)	2 (50)	0 (0)	4
	Extruded wide neck	6 (16.7)	18 (50)	12 (33.3)	36
<b>No. of lumbar vertebral levels involved</b>	1	40 (64.5)	20 (32.2)	2 (3.2)	62
	2	26 (56.5)	14 (30.4)	6 (13)	46
	> 2	4 (33.3)	0	8 (66.7)	12
<b>Biopsy findings</b>	Normal	46 (85.2)	6 (11.1)	2 (3.7)	54
	Degenerated	14 (21.2)	20 (30.3)	32 (48.5)	66

as compared to 86.96% at two levels and worst 66.67% in patients with disc prolapse at more than two levels (Table 3).

Histopathology revealed degenerated disc in 66 patients contains fibrosed tissue, infiltrated WBCs and macrophages without evidence of infections and in remaining 54 patients disc was normal (Figures 3 & 4).

Patients with normal disc demonstrated excellent relief in 85.2% patients as compared to 21.2% patients with degenerated disc as shown in Table 3.

Oswestry disability index (ODI) showed a statistically significant ( $p < 0.001$ ) decrease from its pre procedure level as shown in Table 4 at 3 months interval.

The incidence of discitis following APLD was observed in 2 (1.7%) patient, which responded to rest and antibiotic therapy (cap amoxycillin 500 mg 8 hourly for 2 weeks). Bladder dysfunction as



**Figure 3: Normal disc on histopathological examination**

**Table 4: Comparison of pre- and post-procedure (3 months) Oswestry disability index.**

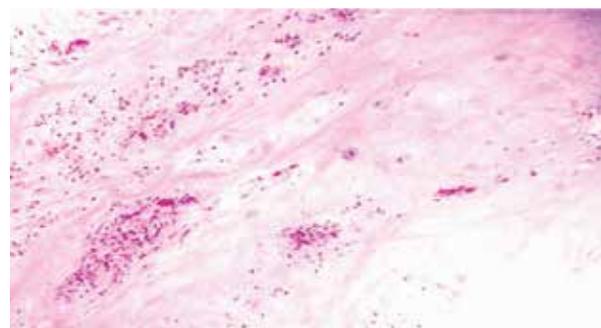
Period	ODI (Mean ± SD)	p-value
Preoperative	38.55 ± 11.57	< 0.001
Postoperative (3 months)	19.60 ± 7.66	

Fischer Exact test:  $p = 0.0249$ .

evidenced by retention of urine was observed in 4 patients with L5/S1 extruded disc following APLD, which was recovered within three weeks after conservative treatment.

## DISCUSSION

Often Patients respond well to non operative management with acute lumbar disc herniation with the help of bed rest, analgesics, anti inflammatory drugs, muscle relaxants.<sup>5</sup> Those Patients who do not respond to conservative treatment or who have frequent recurrences that severely affect



**Figure. 4: Degenerated Disc with fibrosed tissue and infiltrated WBCs on histopathological examination**

their quality of life are considered for surgical intervention like elective lumbar discectomy. The surgical technique is associated with high risk for developing approach-related complications. The overall results of standard discectomy range from 60 to 95% in different series.<sup>4</sup> More than 3,00,000 lumbar discectomy procedures and 70,000 spinal fusion procedures are performed in the United States annually. The costs associated with the management of patients with various lumbar disorders have been estimated to exceed £16 Million per year in UK.<sup>5-6</sup> Researchers all over the world are investigating and developing an alternate solutions, for example disc arthroplasty, nucleus pulposus replacement and biological therapies. There are several percutaneous options to remove disc material like APLD, nucleoplasty, RF discectomy, hydrodiscectomy and laser/endoscopy discectomy. The specific surgical goals are: to maintain a minimal annulotomy, to reach as many zones of the disc as possible and getting as much nuclear material out as possible and to avoid damage to the bony endplates, nerve, ligaments, and taking too much annulus fibrosus tissue.

The present study was done on 120 patients of either sex suffering from low backache of discogenic origin requiring automated percutaneous lumbar discectomy (APLD). The patients were followed for immediate and long term relief of pain and complications. The influence of various factors affecting the ultimate outcome like age, chronicity and duration of pain, neurological symptoms, radiological features and histopathology of disc were studied.

In this study overall substantial relief of pain was observed in 88.3% of patients undergoing APLD and was similar to other workers<sup>7-9</sup> where relief of pain ranges from 75% - 85% as shown in Table 1. It is clearly evident from these observations that the APLD when used in selected patients results in relief of pain in more than four fifth of patients, with minimal or no complications. However, some of the earlier workers<sup>10,11</sup> reported a poor success rate [29% - 37%] following APLD, but these reports of poor outcomes has been criticized especially for poor patient's selection and becoming biased to the APLD procedures. The poor outcome might correlate poorly with the volume of disc material aspirated, and that failure is more likely with larger disc herniations. On the other hand Teng et al<sup>12</sup> and Maroon & Allen<sup>1</sup> reported more than 80% of substantial pain relief.

A statistically significant ( $p < 0.001$ ) pain relief

as evidenced by decrease in VAS score from pre-procedure level at 6 months interval was observed following APLD. Similar observations were observed by earlier worker Alò KM<sup>13</sup> who reported a mean reduction of VAS score by 60.2% at 6 month interval. Oswestry Disability Index (ODI) showed (Table 4) significantly decreases ( $19.60 \pm 7.66$ ) at 3 months interval from its pre procedure level ( $38.55 \pm 11.57$ ) which was better than observed by Grevitt et al<sup>14</sup> at 55 months interval, this discrepancy in the observation may be because of longer follow up of 55 months as compared to 6 months in our study.

Patients in age group of  $< 50$  years reported 93.1% pain relief as compared to 50% pain relief in elderly patients ( $\geq 50$  years) which was statistically significant ( $p < 0.0249$ ). The increasing age results in poor outcome which was also reported by Teng et al,<sup>12</sup> Maroon and Allen,<sup>1</sup> Bernd et al<sup>15</sup> and Bonaldi et al.<sup>8</sup> However, Marks<sup>16</sup> failed to observe a significant influence of age in pain relief which contradicts our observations.

There is definite influence of chronicity of pain in patients with low back ache of discogenic origin undergoing APLD (Table 3). Nearly 94.3% of patients showed substantial relief of pain with acute or subacute onset ( $< 3$  months) as compared to 60% of the patients having pain of chronic onset ( $\geq 3$  months) and the difference was statistically significant ( $p < 0.072$ ).

The pathogenesis of low back ache as evidenced on radiology (MRI) and histopathology of disc certainly influence the outcome. Patients with protruded disc showed 90.5% pain relief as compared to 66.7% with extruded disc. Similar observations were also made by Teng et al<sup>12</sup> who reported 86% success rate in protruded disc as compared to 72% in extruded disc patients. From these observations it seems that the protruded disc is definitely an indication for APLD. In this series two third of patients with extruded disc with wider neck demonstrated substantial pain relief. If the number of disc involved is  $\geq 2$  the outcome is poor (33.3% pain relief) in comparison to 96% pain relief when one disc is involved and the difference was statistically significant ( $p < 0.020$ ). The degenerated disc as evidenced by histopathology were associated with poor outcome (51.5% pain relief) as compared to patients having normal disc (96.3% pain relief) which was statistically significant ( $p < 0.001$ ).

In our series two (1.7%) patients reported discitis following APLD, which responded to rest and antibiotic therapy and was similar to observations reported by earlier worker.<sup>17,18</sup> However, Teng et

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al<sup>12</sup> reported 0.06% incidence of discitis following APLD which is definitely less than that observed in our series. Bladder dysfunction as evidenced by retention of urine was observed in four patients with L5/S1 extruded disc following APLD which was recovered within three week. None of the patients in this series had hematoma as compared to 0.2% by Onik et al<sup>7</sup> and 0.09% by Maroon & Allen<sup>1</sup> which was primarily related to technique.

**Limitations of study:** First, this study incorporates a prospective design and study should be randomized double blind manner. Sample size was very small and this technique can't be applied in any type of lumbar disc herniations. Additionally, this is relatively a short-term follow-up study. We need further studies with long-term follow-up.

## CONCLUSION

In our case series, this technique was shown to be safe and cost effective, low morbidity and can be

performed under local anesthesia on an outpatient basis. Patients returned to work significantly sooner after percutaneous discectomy than after microdiscectomy or laminectomy. The operating time was significantly shorter and there were no approach-related complications, such as dural tear and/or permanent nerve root injury. Automated percutaneous lumbar discectomy is an effective minimally invasive surgical treatment alternative in patients with symptomatic contained disc herniations.

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**Conflict of Interest:** None.

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**Authors' contribution:** All of the authors took part in the conduction of the study, data search and manuscript preparation.

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