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ORIGINAL RESEARCH

Clinical Outcomes and Efficacy of Percutaneous Transforaminal Endoscopic Discectomy for Lumbar Disc Herniation

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ABSTRACT

Background: Lumbar disc herniation (LDH) represents the major cause of low back pain and sciatica among the population. Percutaneous transforaminal endoscopic discectomy (PTED) is a minimally invasive technique that has recently gained growing interest. The purpose of this study was to report authors' experience with a series of patients who underwent PTED with symptomatic disc herniation and to evaluate PTED efficacy in the treatment of LDH.
Methods: Seventy patients suffering from sciatica due to LDH were treated by PTED. Patient demographic characteristics as well as quality of life measures, Oswestry disability index (ODI), visual analogue scale (VAS), and outcome of MacNab's response were collected preoperatively, 6 weeks after surgery, and 12 months postoperatively.
Results: Mean age of the study group was 33.12±8.8 years. The most common level of LDH was L4-L5 (61.4%) and L5-S1 (27%). Conversion to open microdiscectomy was required in 6 (8.3%) patients. VAS score and ODI demonstrated significant difference at 6-week and 12-month follow-up. MacNab criteria revealed a significant improvement at 6 weeks, but not at 12 month follow-up.
Conclusion: PTED in the lumbar spine demonstrates comparable rates of satisfaction to microdiscectomy, and it requires shorter hospitalization and revalidations period.
Level of Evidence: II; Prospective case series.
Keywords: Lumbar disc herniation; Lumbar discectomy; Transforaminal endoscopic discectomy.

INTRODUCTION

Lumbar disc herniation (LDH) represents the major cause of low back pain and sciatica among the population [1]. The most important and common symptom is lumbosacral radicular leg pain commonly accompanied with muscle weakness and numbness [2,3]. Symptomatic LDH can be managed variably. Conservative therapy by interventional pain treatment (analgesics, physical therapy) is the first line of treatment; however, surgical treatment should be considered if symptoms persist, worsen, or reduce the quality of the patient's life [4].

Surgery for LDH can be classified into 2 broad categories: open or minimally

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invasive surgery and posterior versus posterolateral approach. Currently, open microdiscectomy is the gold standard for treating LDH [5]. The technique is associated with good results; however, some damage is caused to the surrounding musculoskeletal structure [6]. Percutaneous transforaminal endoscopic discectomy (PTED) is a minimally invasive technique that has recently gained a growing interest. The concept of PTED is to provide surgical options that optimally address disc pathology and repair, avoiding iatrogenic morbidity associated with open surgical procedures [7].

The purpose of this study was to report our experience on a series of patients who underwent PTED with symptomatic disc herniation and to evaluate PTED efficacy in the treatment of LDH.

MATERIALS & METHODS

Between January 2011 and March 2015, after receiving appropriate IRB approval, 280 patients examined at the authors' outpatient clinic suffering from sciatica due to LDH were evaluated. Of those, 70 were treated by means of PTED by a single surgeon. All patients initially received conservative treatment. If symptoms persisted, MRI of the lumbar spine was requested and evaluated. When surgery was indicated, written informed consent was obtained.

The demographic characteristics of the patients' group were recorded including sex, age, duration of low back pain and leg pain, straight leg raising test, and neurologic status were recorded. Quality of life measures Oswestry disability index (ODI), visual analogue scale (VAS), and outcome of MacNab's response were collected preoperatively, 6 weeks, and 12 months postoperatively at the outpatient clinic or through phone interviews. MRI and X-rays of lumbar spine were performed on all patients. In case of recurrent or persistent radiculopathy, a postoperative MRI was performed to identify the underlying pathology.

The inclusion criteria to our study were contained disc protrusion on preoperative MRI, motor weakness, sensory changes, straight leg test positive, and presence of abnormal reflex due to LDH, unsuccessful conservative treatment for at least 6 weeks, age 20-60 years, and the absence of previous lumbar surgery on the same disc level. Patients with severe spinal stenosis and spondylolisthesis were excluded from our study.

Surgical Procedure

Surgery was carried out with the patient in the prone position under general anesthesia, with the back mildly flexed. The optimal skin entry point was more lateral (8–14 cm from the midline). An 18-gauge spinal needle was gently introduced laterally under fluoroscopic guidance, through a triangular working zone into the intervertebral disc to touch the annular surface. This zone is formed (on lateral view) posteriorly by the superior facet joint, inferiorly by the upper endplate of the caudal vertebrae, and superiorly and anteriorly by the nerve root exiting the neural foramen. The superior facet joint was used as an anatomic landmark to avoid puncturing injuries and compressions to the existing nerve root. Following spinal needle puncture of the targeted disc, a guide wire was inserted via the needle, and the needle was then removed. Next, 2 conical rods were introduced over the guidewire to stretch the soft tissue. After dilation, a 4-mm drill and then, successively, a 6-mm drill and an 8-mm drill were used to enlarge the safe caudal part of the neuroforamen,

also known as Kambin's triangle [8], while keeping the guidewire in place. The working cannula was introduced over the second dilatator until the tip was located on the disc herniation, close to the posterior longitudinal ligament. The endoscope together with working and irrigation channels were introduced, and the herniated disc material was removed in 1 part, or piecemeal, with disc forceps. The decompression was considered sufficient if the nerve showed pulsations similar to the heart rate and the amount of removed disc material approximately matched the amount seen on the MRI. The skin was closed with 2 nylon stitches. The blood loss associated with this procedure was minimal (less than 1-5 mL), although no objective measurements could be performed.

Clinical Evaluation

Self-evaluation questionnaires including ODI [9], VAS score [10], and MacNab criteria [11] were used as indices of clinical outcome. This evaluation included recurrence of symptoms, complications, subsequent surgical treatment, duration of hospitalization, and time to returning to work. All data were recorded through initial records, telephone calls, emails, and follow-up visits at our outpatient clinic. The evaluation was performed in all patients preoperatively, as well as 6 weeks, and 12 months postoperatively.

Statistical Analysis

Data analysis was performed by IBM SPSS ver. 20.0. Descriptive statistics were used to analyze demographic data. Comparison between subgroups was made with rank sum test, paired-sample t-tests, Fisher exact tests, and $p<0.05$ was considered statistically significant.

RESULTS

Seventy patients underwent PTED due to LDH by 1 surgeon. Conversion to open microdiscectomy was required in 6 (8.3%) patients. At the 12-month follow-up, all patients were available for evaluation. Mean age of the study group was 33.12± 8.8 years. The most common level of LDH was L4-L5 (61.4%) and L5-S1 (27%). Preoperatively, 6 weeks and 12 months post-operatively VAS score, ODI, and MacNab criteria were recorded.

Mean VAS score for lower back and leg pain was 8.08 (range 6-9). Six weeks postoperatively, the mean VAS score was 1.18 (range 0-7) (Table 1). Statistically significant difference was encountered ($p<0.001$) between preoperative and 6 weeks postoperative VAS score (mean 6.9; $p<0.001$). Twelve months postoperatively mean VAS score was 0.45 (range 0-4). Between 6 weeks and 12 months postoperatively, a significant decrease of the score (mean 0.728, $p<0.001$) was detected (Table 2).

Table 1. VAS preoperative, and at 6-weeks and 12-months postoperative follow-ups.

Period	N	Min	Max	Mean	STD
Preoperative	70	6.0	9.0	8.08	0.77
Postoperative 6 weeks	70	0.0	7.0	1.18	1.71
Postoperative 12 weeks	70	0.0	4.0	0.45	0.93

Table 2. VAS in preoperative to 6-weeks and 6-weeks to 12-months follow-ups.

	Paired Differences				t	df	P value
	Mean	STD	SE	95%CI			
Preoperative to 6 weeks	6.9	1.80	0.22	6.47 - 7.33	32.02	69	<0.0001
6 weeks to 12 months	0.73	1.06	0.13	0.48 - 0.98	5.74	69	<0.0001

Preoperative, 6 weeks, and 12 months postoperative ODI scores were measured and compared with rank sum test. Preoperatively, 62.9% of the patients had severe disability (ODI=81-100) and 37.1% disability (ODI=61-80). Six weeks postoperatively, 80% of the patients demonstrated no disability (ODI=0-20), 14.3% minimal disability (ODI=21-40), 4.3% (ODI=41-60), and 1.4% of the patient with 61-80% disability. Finally, 12 months postoperatively, 91.4% of the patients had no disability (ODI=0-20) and 8.6% had minor disability (ODI=21-40). The preoperative ODI score demonstrated a significant decrease compared to 6 weeks postoperative follow-up (statistically significant Z=-7,452, p<0.005). A comparison of ODI between 6 weeks and 12 months postoperatively indicated a statistically significant improvement (Z=-3,357, p=0.001) (Table 3).

Table 3. ODI scores at preoperative, 6-weeks, and 12-months follow-ups.

ODI	0-20	21-40	41-60	61-80	81-100
Preoperative	0%	0%	0%	37.1%	62.9%
Postoperative 6 weeks	80%	14.3%	4.3%	1.4%	0%
Postoperative 12 weeks	91.4%	8.6%	0%	0%	0%

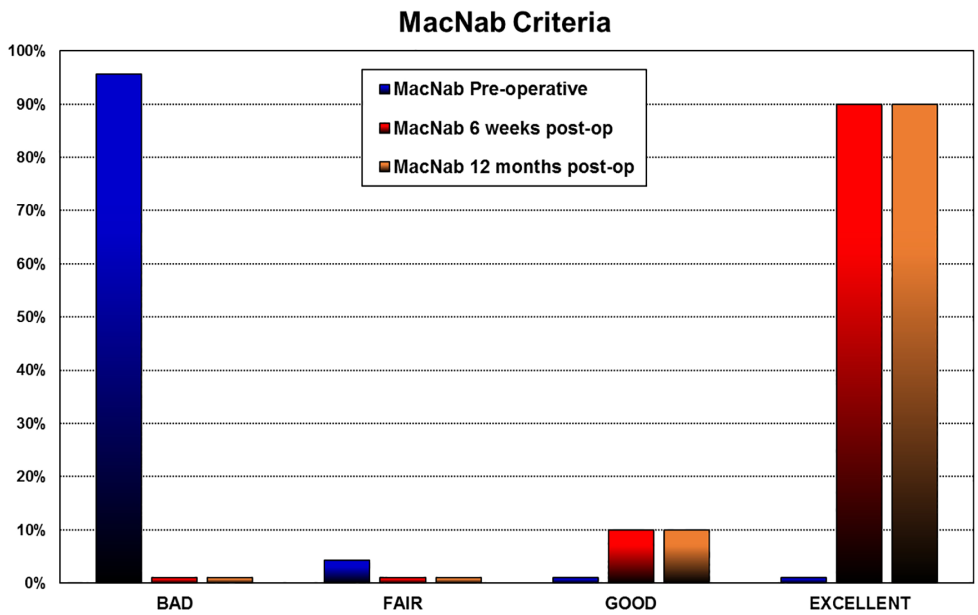

Figure 1. MacNab criteria, preoperatively and at 6-weeks and 12-months follow-ups.

The analysis of MacNab criteria demonstrated that preoperatively 95.7% of patients had poor quality and 4.3% fair quality of life. At 6 weeks postoperatively, 10% of patients had good results and 90% excellent results. At 12 weeks postoperatively, the percentage remained the same. A statistically significant improvement was found between preoperative and 6 weeks postoperative follow-up (Z=-7,909, p<0.05). However, no statistical difference between 6 weeks and 12 months postoperative follow-ups (Z=0, p=1,000) was demonstrated (Figure 1).

Further data analysis revealed a positive linear correlation between age and alteration of patients' VAS score (Pearson correlation r=0.363, p=0.002) in the pre- and postoperative periods.

DISCUSSION

LDH is the most common pathology of the lumbar spine associated with lower back pain frequently radiating to the extremities [1]. Minimally invasive surgery, such as PTED, has recently attracted growing attention. The advantages of PTED include preservation of normal posterior and paraspinal structures, less postoperative pain, reduction of hospitalization, and a shorter period of recovery as well as returning to work [12-15].

The results of this study showed statistically significant improvement of lower back and leg pain in the short term, even in patients that initially felt irritation mainly in the lower back over the long term. In this case series, 90% (63 patients) had excellent results at 12 month follow-up, according to MacNab criteria and VAS score. Literature data reveal comparable rates of satisfaction following PTED [7,12]. Nellendteijn et al. published a systematic review on 8 trials where no statistically significant difference in leg pain between transforaminal endoscopic surgery group (89%) and open microdiscectomy group (87%) was encountered. Overall improvement was 84% (versus 78% of MD), reoperation rate 6.8% (versus 4.7%), and complication rate 1.5% (versus 1%) [7]. Sinkemani et al. performed a retrospective study and reported that 94.4% of the patients that underwent PTED showed excellent and good results according to MacNab criteria [16]. Turk et al. showed that 90.4% (95/105 patients) of those who underwent PTED presented with pain relief (good and excellent results) 12 months postoperatively [15]. Gadjradj et al. performed a prospective case series study with 166 patients who underwent PTED for 167 LDH treatment and the results showed significant improvement on the lower back and leg pain in the short term and further improvement over the long term [13]. Yeung & Tsou reported an 89.3% satisfactory rate in a retrospective review involving 307 patients who underwent endoscopic discectomy [17]. Jasper et al. achieved pain relief in 83.9% and 69.7% of their patients with single- and multilevel disc involvement, respectively. The overall average rate reported by Jasper et al. was 71.7%, and VAS scores improved from 8.8 to 2.6 at 6 months [18].

The recurrence rate of LDH and need of reoperation was 8.3% (6 patients) within the first 12 months postoperatively in this case series. In the observational studies, the median reoperation rate was 7% (0–27%), according to Nellendteijn et al. [7]. Sencer et al. publishing the short-term clinical results of 163 patients undergoing either PTED or percutaneous interlaminar endoscopic discectomy, reported a recurrence rate of LDH of only 2.8%, which is the

lowest published in the literature for PTED so far [19]. In the study of Gadjradj et al., 12 patients (7.2%) required additional surgical procedures due to recurrence of LDH, 11 at the same level, and 1 at a different level [13]. In a large single-center retrospective review of 10,228 cases, Choi et al. showed that failure of PTED was mostly due to incomplete removal of herniated disc material [20]. Wang et al published a retrospective review on 350 patients that underwent PTED and retrieved 36 patients with recurrence LDH (10.3%) [21]. Older patients, elderly patients, and patients with diabetes were at increased risk of PTED failure, specifically in the early years of the procedure's use. In this study, 4 patients had a recurrence in the first 2 years this technique was performed. Adequate removal of LDH, careful patient selection for surgery, and surgeon's experience are the most important elements for avoiding recurrence following PTED. In this study, the positive linear correlation between age and VAS score improvement proves that younger patients have better outcomes after PTED due to the fact that their LDH is recent and softer, and as a result it can be removed easily endoscopically. On the other hand, for older patients (>60 years), LDH is usually hard, and bony stenosis is usually encountered [21].

Literature reveals comparable rates of satisfaction following PTED and microdiscectomy in lumbar spine [6,22-24]. Cong et al. published a meta-analysis that compares endoscopic discectomy and open microdiscectomy and found a significantly higher satisfaction rate in patients that underwent endoscopic discectomy. Furthermore, the authors reported that endoscopic discectomy is associated with less blood loss and earlier hospital discharge [25]. Sinkemani et al. conducted a retrospective case control evaluation of 86 patients who underwent microendoscopic discectomy (MED) or PTED and showed no significant difference between the techniques' clinical outcomes [16].

In our series, all patients were discharged from the hospital 24 hours following PTED and returned to work after a mean of 4 weeks. Three randomized control trials reported similar results on PTED with reduced hospital stay and faster return to work, compared to microdiscectomy [14,26-28]. The short hospitalization, shorter revalidation period, and earlier return to work may result in an economic advantage for PTED. Further studies should be performed alongside these trials to assess the cost-effectiveness and cost utility of transforaminal endoscopic surgery.

More high-quality, randomized control trials with sufficiently large sample sizes and the assessment of cost effectiveness of PTED compared to open microdiscectomy need to be performed in order to establish PTED as the gold standard for lumbar disc herniation.

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