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Results of transforaminal endoscopic discectomy for lumbosacral disc herniation added by nucleoplasty

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Introduction Herniated disks are very common. Percutaneous endoscopic lumbar spine surgery for the lumbar disc herniation facilitates minimalized access ports to the operating site with decreased risk of infection, reduced blood loss and less tissue dissection and muscle trauma. The **goal** was to compare the results of standard transforaminal endoscopic discectomy for lumbosacral herniation and outcomes of the procedure added by nucleoplasty. **Material and methods** Percutaneous transforaminal endoscopic discectomy was performed for 92 patients and added by nucleoplasty in 43 patients of group I. Preoperative and postoperative evaluation was produced with the Visual Analog Pain Scale (VAS), the Oswestry Low Back Pain Disability Questionnaire (ODI) and the MacNab clinical outcome score. Complication and recurrence rate was reviewed. Microsoft Office Excell and Statistica 8.0 were used to complete data analysis reports. **Results** VAS scores decreased from 7.9 to 3.1 showing 2.5-fold decrease ($p < 0.05$), and ODI scores decreased from 71.09 to 18.58) ($p < 0.001$) demonstrating fourfold decrease at one-year follow-up. There were no significant differences in VAS and ODI scores between the groups preoperatively and postoperatively ($p > 0.05$). The majority of patients of group I (41.86 %) rated their health status as excellent on the MacNab scale, and the majority of patients of group II (53.06 %) rated their health status as good. Postoperative complication rate was 11.63% in group I and 12.24 % in group II ($p > 0.05$). There was no recurrence in group I with the recurrence rate of 6.1 % ($p < 0.001$) in group II. **Conclusion** Endoscopic discectomy for lumbosacral herniation supplemented with nucleoplasty can reduce the recurrence rate.

Keywords: degenerative disc disease, recurrent disc herniation, endoscopic discectomy, nucleoplasty

INTRODUCTION

A spinal disc herniation is protrusion of disc content beyond the vertebral body endplates or the prolapsed disc or ruptured disc material entering the spinal canal [1]. Herniated discs can often be the result of degenerative disc disease and affect people of any age in 54-79 % of cases [2, 3]. Herniated discs are more common in the lower back and more than 90 % of all lumbar disc herniations occur at levels L4/5 and L5/S1 of the lower lumbar spine [1, 4, 5]. The true frequency and accepted definition of disc damage has changed with increasing MRI availability. The prevalence of intervertebral disc degeneration is difficult to identify in asymptomatic population. With the lack of uniformity in the definitions of disc degeneration and disc herniation, actual prevalence of the disease can be difficult to assess in multiple studies [6–9]. The conditions of some patients are resistant to conservative therapy and the focus is on improvement of surgical approaches and technqiues. The various surgical techniques are available for the management of the pathology with modern surgical interventions, implants and scientific developments providing new therapeutic options. Recently, percutaneous endoscopic lumbar discectomy is also commonly performed for lumbar disc herniation for its various strong points compared to open lumbar discectomy such as minimal surgical incision, less damage to surrounding muscles and bone structures, and length of hospital stay [10, 11]. The choice of operative procedure depends on the clinical characteristics of each patient, the resources available, local expertise and patient preference.

There is some controversy concerning the best treatment and prevention of lumbar disc herniation [12–15], and a personalized approach is recommended with studies being conducted to evaluate the effectiveness of various methods. Percutaneous transforaminal endoscopic discectomy is a widely used minimal invasive surgical procedure for lumbar disc herniation with a lateral transforaminal access path. The surgeon provides access to the spinal canal laterally through the intervertebral foramen, and the nerve root can be visualized with the herniation removed [16]. With this access, there is no need for the nerve root traction with the approach providing good endoscopic visualization.

Endoscopic surgery is usually performed as an outpatient or inpatient procedure with the use of local or general anesthesia. The main advantages of percutaneous endoscopic lumbar discectomy include minimized structural and clinical impact of surgical access. With minimal surgical incision, the approach

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is associated with minimal soft tissue trauma, lower risk of infection and reduced intraoperative blood loss. The structural integrity, innervation of the paraspinal muscles and decrease in epidural scars facilitate postoperative movements, improved functional results and patient satisfaction. These factors combined with reduced operating time and local anesthesia result in a shorter length of hospital stay and less costs involved [17, 18]. The advantages of the percutaneous endoscopic lumbar discectomy over MD are reported to include such parameters as intraoperative blood loss, operating time, inpatient stay and the duration of the rehabilitation period. However, more studies are needed to explore the severity of postoperative pain, MacNab's outcome criteria, complication, recurrence and re-operation rates.

The **goal** of the study was to compare the results of standard transforaminal endoscopic discectomy for lumbosacral herniation and outcomes of the procedure added by nucleoplasty.

MATERIAL AND METHODS

A pro-/retrospective monocenter case-control study was performed between 2018 and 2020 and 92 patients were involved in the study design. The inclusion criterion was a surgical intervention performed for a primary single-level lumbosacral intervertebral disc herniation at the L4–L5 or L5–S1 level. Exclusion criteria included spinal deformity, degenerative spinal stenosis, spondylolisthesis, instability of the spinal motion segment.

Group I included 43 patients with intervertebral disc herniation (IDH) of lumbar spine, who underwent percutaneous endoscopic lumbar discectomy (PELD) and additional nucleoplasty. The mean age of the patients was 31.62 ± 1.58 years. There were 20 (45.0 %) male and 23 (55.0 %) female patients. Group II was represented by the findings of a retrospective review of 49 patients who underwent percutaneous endoscopic lumbar discectomy performed by the same surgeon in 2018–2019. The mean age of patients in Group II was 31.63 ± 1.58 years. There were 21 (41.7 %) male and 28 (58.3 %) female patients.

Medical records and preoperative MRI were used to evaluate the type and location of IDH as interpreted by the American Association of Neuroradiology [19], degeneration of the intervertebral disc classified with Pfirrmann grading system [20], the types of degenerative changes in bone tissue in the operated and adjacent segments as identified by Modic M. T. [21] and lumbar foraminal stenosis evaluated with a new grading system developed by Lee S. [22]. All patients underwent surgical treatment. Indications to surgery included chronic pain of at least the last 3 months (VAS > 4 points and / or ODI > 30 %), radicular pain syndrome and sensitivity disorders, ineffective conservative therapy and motor disorders (muscle strength of 3 or less).

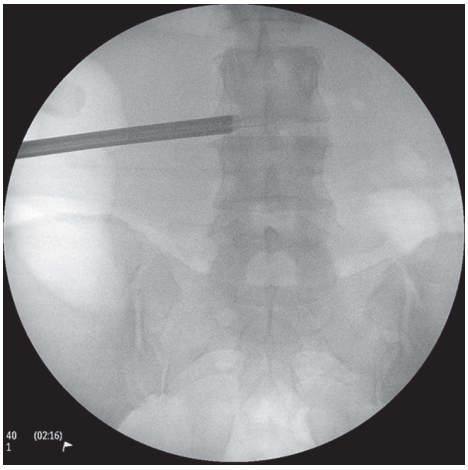


Fig. 1 Endoscopic technique of surgical intervention

Preoperative and postoperative evaluation was produced with the Visual Analog Pain Scale (VAS), the Oswestry Low Back Pain Disability Questionnaire (ODI) and the MacNab clinical outcome score. Complication and recurrence rate was reviewed. The study received a favorable opinion from the relevant research ethics committee. Written informed consent was obtained from all patients for publication of the findings without identifying details. Microsoft Office Excell and Statistica 8.0 (StatSoft Inc.) were used to complete data analysis reports. Mann-Whitney test was used. Two-tailed Fisher's exact test (a contingency table) was applied to identify associations between the groups. Repeated changes were analyzed with the Wilcoxon rank-sum test. $P < 0.05$ was considered statistically significant.

RESULTS

Table 1 demonstrates demographic characteristics of the patients and preoperative measurements. IDH located at the L4–L5 level was identified in 58.14 % and 61.22 % of groups I and II, respectively, at the L5/S level in 41.86 % and 38.78 % of groups I and II, respectively. There were 55.81 % cases of posterolateral IDH in group I and 57.14 % in group II, and 20.93 % and 24.49 % cases of foraminal IDH in group I and group II, respectively. The majority of patients had Phirrman grades III and IV intervertebral disc degeneration. Phirrman grades III and IV were detected in 41.86 % and 34.88 % cases of group I,

respectively, and in 44.19 % and 34.69 % of cases in group II. MRI was used to assess changes in the vertebral bodies being adjacent to the involved discs. Modic type I signal intensity changes were detected in 16.28 % of patients in group I and 18.37 % in group II, and Modic type II changes II diagnosed in 27.91 % and 26.53 % cases of groups I and II, respectively. Lumbar foraminal stenosis evaluated with the Lee grading system was detected in 18.60 % of cases in group I and in 18.37 % of patients in group II.

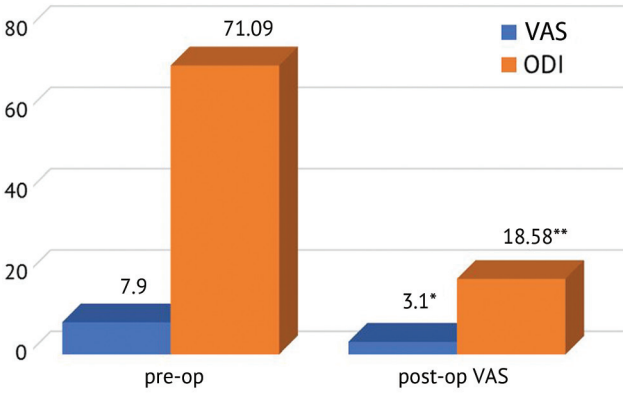
A statistically significant decrease in the parameters was revealed in the groups postopertaively ($p < 0.001$). No significant differences in the outcomes of surgical treatment were detected between the groups ($p > 0.05$). No significant correlation was found in the factors having an impact on the final results of surgical treatment. VAS (M ± SD) and ODI (M ± SD) scores measured preoperatively and postopertaively in patients of the two groups are shown in Figure 2. The measurements indicate to significant improvements in the VAS and ODI scores in the groups ($p < 0.05$; $p < 0.001$) and are presented in Figure 3. The MacNab clinical outcome score measured in the groups is shown in Figure 4.

Table 1

Preoperative demographic and clinical characteristics of patients

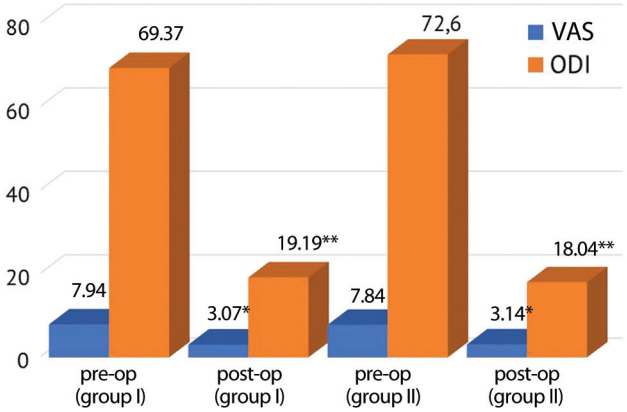
Description	Group I	Group II	P*
Participants including	43	49	> 0.05
males	20 (46.5 %)	21 (42.9 %)	
females	23 (53.5 %)	28 (57.1 %)	
Age M ± SD, years	31.62 ± 1.58	31.63 ± 1.58	> 0.05
Range of age, years	25.0–55.0	25.0–55.0	
Body mass index M ± SD	35.1 ± 4.9	30.3 ± 10.2	0.05
ODI M ± SD	60.4 ± 9.5	51.4 ± 10.3	0.05
VAS M ± SD	6.9 ± 0.9	7.1 ± 0.6	> 0.05
Level of surgical intervention			
L4/L5 level	25 (58.14 %)	30 (61.22 %)	0.05
L5/S1 level	18 (41.86 %)	19 (38.78 %)	> 0.05
Types of IDH			
Median	5 (11.63 %)	5 (10.20 %)	> 0.05
Posterolateral	24 (55.81 %)	28 (57.14 %)	> 0.05
Foraminal	9 (20.93 %)	12 (24.49 %)	0.05
Extraforaminal	5 (11.63 %)	4 (8.16 %)	0.05
Pfirrman grading of intervertebral disc degeneration			
I	3 (6.98 %)	4 (8.16 %)	> 0.05
II	4 (9.30 %)	5 (11.63 %)	> 0.05
III	18 (41.86 %)	19 (44.19 %)	0.05
IV	15 (34.88 %)	17 (34.69 %)	> 0.05
V	3 (6.98 %)	4 (9.30 %)	> 0.05
Modic type I	7 (16.28 %)	9 (18.37 %)	> 0.05
Modic type II	12 (27.91 %)	13 (26.53 %)	> 0.05
Lumbar foraminal stenosis evaluated with the Lee grading system	8 (18.60 %)	9 (18.37 %)	> 0.05

*significant differences identified with Mann-Whitney U test



*p < 0.05, preoperative and postoperative statistical significance;
**p < 0.001, preoperative and postoperative statistical significance

Fig. 2 VAS and ODI scores measured preoperatively and postoperatively in patients of both groups (in the quantitative ratio)



*p < 0.05, preoperative and postoperative statistical significance;
**p < 0.001, preoperative and postoperative statistical significance

Fig. 3 Comparative characterization of VAS and ODI scores measured preoperatively and postoperatively in patients of groups I and II (in the quantitative ratio)

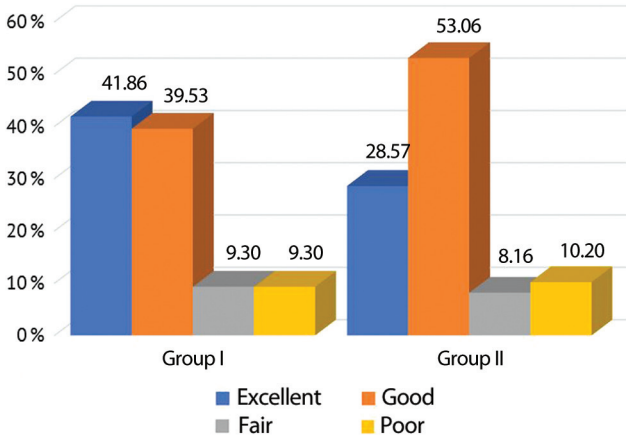


Fig. 4 Comparative characterization of the MacNab clinical outcome scores measured in patients of groups I and II (as a percentage)

The majority of patients of group I (41.86 %) rated their health status as excellent on the MacNab scale, and the majority of patients of group II (n = 26; 53.06 %) rated their health status as good. A small number of patients, correlated between the groups, rated the results of treatment as poor (9.3 % in Group I and 10.2 % in Group II) due to a reduced sensitivity threshold, co-morbid conditions or psychological implications. The comparative characteristics of complications and recurrences encountered in patients of both groups are presented in Table 2. No complications were seen in 88.37 % patients of Group I and 87.76 % cases of Group II.

Table 2

Comparative characteristics of complications and recurrences encountered in patients of both groups

Complication/ recurrence	Group I (n = 43)		Group II (n = 49)	
	abs.	%	abs.	%
Injury to dura mater	3	6.98	2	4.08
Injury to the nerve root	2	4.65	1	2.04
Re-operation	0	0.00	3	6.12
No adverse event	38	88.37	43	87.76

DISCUSSION

Microdiscectomy is known as the most effective method for IDH. The widespread introduction of high-tech minimally invasive methods has significantly reduced the disability rate worldwide and, thus, contributed to the solution of the social problem associated with the condition. However, the growing number of microdiscectomies is directly proportional to the number of patients who undergo re-operations due to recurrences or heniations at the adjacent level which creates a problem of postdiscectomy syndrome. Recurrences can also occur as a surgical failure with compression not addressed intraoperatively [23–25]. Specific approaches to diagnosis and primary surgical treatment, neurological symptoms, structural and morphological changes at the level of the operated vertebral motion segment at different follow-up periods and differentiated surgical practice can be helpful in prevention of re-operations.

Endoscopic technologies have become popular in the treatment of IDH [26, 27]. For the last 5 years, PELD with the THESSYS system has been used in our country. The main advantage with the method is reduced surgical trauma with the skin incision of 5–7 mm. Surgical intervention is performed using an endoscopic portal with a diameter of 7 mm which minimizes injury to the soft tissues. The surgical procedure is aimed to treat nerve root or spinal cord compression by decompressing the spinal cord and nerve roots of the lumbar spine with a discectomy. The instruments used have working surfaces of 2–3 mm which minimizes the impact on the nerve structures during the operation [28–31]. This study explored the effectiveness of PELD combined with nucleoplasty. Subjective evaluation criteria evaluated included the level of pain and the extent of impaired vital activity. All patients (n = 98) reported improved pain and the parameters of vital activity postoperatively. VAS scores decreased from 7.9 to 3.1 and showed a 2.5 time reduction ($p < 0.05$) at one-year follow-up. ODI scores demonstrated almost a 4 time decrease (from 71.09 to 18.58) ($p < 0.001$). Comparative analysis of VAS and ODI scores showed no significant differences in patients of the groups preoperatively and postoperatively ($p > 0.05$).

Postoperative complication rate was 11.63 % in group I and 12.24 % in group II ($p > 0.05$). An injury to dura mater that did not result in any pathology was detected in 6.98 % of patients of Group I and 4.08 % of Group II, and an injury to the nerve roots was seen in 4.65 % and 2.04 % in Groups I and II, respectively. The results obtained are comparable to the outcomes reported in other series [5, 7, 32, 33]. The complications were rather associated with the endoscopic stage of the intervention rather than with nucleoplasty. The combination of transforaminal endoscopic discectomy and cold plasma nucleoplasty is reported to demonstrate significant advantages in comparison with transforaminal endoscopic discectomy alone including a reduction in the time of postoperative recovery, the length of inpatient stay and reduced recurrence rate [34, 35]. Gabechia G.V.

(2019) reported the mean IDH recurrence rate of 2.6 % in the main group and 10 % in controls [35]. There was no recurrence in group I of our series with the recurrence rate of 6.1 % ($p < 0.001$) in group II.

CONCLUSION

PELD combined with nucleoplasty was shown to be an effective and safe method of surgical treatment for IDH with a) minimal injury to soft tissues and minimal contact with nerve structures; b) rapid postoperative recovery and reduced days of disability; c) use of local anesthesia, which is essential for elder people and comorbidities; d) good visualization of intracanal structures under optical magnification reducing the risk of the nerve root injury; e) direct access to the extrusion through the natural foraminal opening; f) minimal risk of infection. Endoscopic discectomy for lumbosacral herniation supplemented with nucleoplasty can reduce the recurrence and re-operation rates.

Conflict of interests *The authors declare that there is no conflict of interest.*

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