

## Original article

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## Transforaminal endoscopic microdiscectomy in the treatment of patients with herniated intervertebral discs in the lumbar spine

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More than 800,000 microdiscectomies are performed annually worldwide. According to various authors, good and excellent results are about 85%, with adequate selection of patients for surgical treatment. Nevertheless, up to 40% of patients continue to suffer from pain, motor and sensory disorders, although their intensity decreases after surgery. Therefore, the search for new methods of surgical interventions that will improve the results of treatment of such patients continues.

In the late 90s of the last century, the JOIMAX company (Germany) developed a technique for endoscopic transforaminal microdiscectomy, which used a lateral (transforaminal) rather than a standard interlaminar approach. According to literature data, endoscopic transforaminal microdiscectomy has up to 93% of positive outcomes.

**Objective.** To study the immediate and long-term outcomes of treatment of patients with herniated intervertebral discs in the lumbar spine using the transforaminal endoscopic microdiscectomy method.

**Materials and methods.** The immediate (1st day after surgery) and long-term (6th month postoperatively) outcomes of surgical treatment of 68 patients with herniated intervertebral discs in the lumbar spine were studied. Patients were operated on using the endoscopic transforaminal microdiscectomy method at the «Family Medicine Clinic», Dnipro from 2020 to 2024.

**Results.** There were 52 men and 16 women, the age of the patients ranged from 24 to 68 years (average 44.2 years), the duration of the disease was from 6 months to 12 years. Before the operation, the average pain score according to VAS was 8.7 points. Pain syndrome on the VAS scale on the 1st day after surgery was, on average, 3.5 points, after 6 months - 3 points. After 6 months after surgery, 63 patients (93%) had good treatment outcomes according to the J. MacNab scale. Unsatisfactory results were in 5 patients (7%).

**Conclusions.** Transforaminal endoscopic microdiscectomy is a modern highly effective minimally invasive method of surgical treatment of herniated intervertebral discs in the lumbar spine, which allows to significantly reduce intraoperative trauma, the patient's hospital stay, accelerate the rehabilitation of patients, and improve treatment outcomes.

**Keywords:** transforaminal endoscopic microdiscectomy; minimally invasive treatment methods; outpatient neurosurgery

### Introduction

It is estimated that more than 800,000 microdiscectomies are performed annually worldwide [1]. According to various authors, the rate of good to excellent outcomes reaches approximately 85% when patients are appropriately selected for surgical treatment; however, around 40% of patients continue to experience pain, motor, and sensory disturbances, albeit with reduced intensity postoperatively [1, 2, 4]. Unsatisfactory treatment outcomes are classified under the so-called "failed back surgery syndrome" (FBSS). Postoperative compressive scar-adhesive epiduritis—a reactive productive inflammatory process that invariably develops after surgical interventions (including microdiscectomies)—accounts for about 25%

of FBSS cases [2]. According to different sources, FBSS is responsible for approximately 20% of repeat surgeries. Although microdiscectomy continues to be considered the gold standard, over the past 30 years, numerous new techniques and their modifications have been proposed. The developers of these methods aim to minimize the trauma associated with surgical access while maintaining the radical nature of the operation [1, 2]. The ongoing search for new surgical techniques focuses on reducing intraoperative trauma, shortening hospital stays, decreasing the frequency of postoperative complications, improving treatment outcomes, accelerating patient rehabilitation, and lowering treatment costs.

The predominant trend is the enhancement of the micro-surgical interlaminar approach, particularly

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through the development of retractors that minimize damage to the paravertebral muscles. Additionally, minimally invasive approaches to herniated discs have been proposed that avoid the removal of the ligamentum flavum and additional facetectomy [3-7]. A major drawback of the posterior interlaminar approach is that, after incision or resection of the ligamentum flavum, the surgeon sees the nerve root and dural sac in the wound, while the herniation is typically located posterior to these structures; thus, its removal requires traction of both the nerve root and the dural sac [5, 8-11]. Alongside advancements in microsurgical techniques, endoscopic methods have been introduced to reduce access-related trauma. The most widely used method in the 1990s was endoscopic monoportal or biportal nucleotomy, which was successfully applied not only in the treatment of disc protrusions and small hernias but also in sequestered herniations [4-9]. However, this method lacked the versatility of microdiscectomy and often necessitated repeat surgical interventions.

At the end of the 1990s, the German company "Joimax" developed a technique for endoscopic microdiscectomy that used a lateral (transforaminal) approach instead of the standard interlaminar one. In this procedure, the surgeon enters the spinal canal laterally through the intervertebral foramen. This allows for the herniated disc to be visualized first, followed by the nerve root. With this approach, nerve root traction is not required. The TESSYS (Transforaminal Endoscopic Surgical System) technique has gained widespread adoption across Europe [7-11]. The instruments used in this procedure are continually being refined, thereby expanding the capabilities of the technique. Numerous studies by international authors indicate the high efficacy of endoscopic transforaminal microdiscectomy and a low incidence of failures and complications. According to published data, endoscopic transforaminal microdiscectomy achieves approximately 93% positive outcomes, which is comparable to the efficacy of traditional "open" microdiscectomy [10-17]. Endoscopic transforaminal microdiscectomy offers several important advantages: the skin incision is only 5 mm long and typically heals without any cosmetic defect; muscles and aponeuroses are not incised but rather gently separated using tubular dilators; the maximum port diameter is 7.5 mm; and the absence of oxygen exposure reduces the risk of postoperative compressive scar-adhesive epiduritis. Hospitalization time does not exceed 12-20 hours, and the patient is mobilized three hours after surgery. These features qualify the technique as a form of "ambulatory neurosurgery", as a significant number of patients are discharged on the same day the operation is performed. The rehabilitation period is three times shorter than that following conventional microdiscectomy. However, some authors argue that the method is insufficiently radical and not universally applicable [11-15, 19].

**Objective:** To investigate the short- and long-term outcomes of treating patients with lumbar intervertebral disc herniation using transforaminal endoscopic microdiscectomy.

## Materials and Methods

### Study design

A single-center retrospective and prospective controlled study was conducted involving 68 patients. The medical records of 52 patients who underwent transforaminal endoscopic microdiscectomy between 2020 and 2024 were analyzed. The prospective arm of the study, comprising 16 patients, was conducted in 2024.

### Study participants

The participants were patients with lumbar intervertebral disc herniations who underwent surgery at the "Family Medicine Clinic" (Dnipro, Ukraine).

The study was approved by the Biomedical Ethics Committee of Kherson State University (Minutes No. 7 dated June 30, 2024).

### Inclusion Criteria

Patients with foraminal, posterolateral, or paramedian herniations in the lumbar spine who had completed a 4-week course of conservative therapy without positive effect.

### Exclusion Criteria

Pre-defined limitations of the method included central disc herniations, foraminal stenosis, nerve root exit through the inferior aspect of the foramen, cranial migration of L5-S1 herniation, and life-threatening contraindications.

### Analyzed parameters

Sex and age of the patient, duration of the disease, level, size, and location of the herniation, evaluation of outcomes using the Visual Analog Scale (VAS) and the modified J. MacNab scale.

### Surgical technique

The procedure was performed under intravenous anesthesia with local potentiation. Muscle relaxant solutions were not used, which is essential for this type of surgery. The patient was placed in a prone position. The level of surgical intervention was verified using intraoperative radiography. The surgical approach is crucial to the success of the procedure; depending on the level of intervention, the distance from the midline increases in the caudal direction (**Fig. 1**). The operation can be conventionally divided into three stages:

a) Entry point – determined using specific anatomical landmarks (**Fig. 2**);

b) Surgical access – achieved using dilators and reamers, followed by placement of the endoscopic port (**Fig. 3 and 4**) into Kambin's triangle;

c) Main stage – herniation removal – the assistant or surgical nurse monitors the muscles of the corresponding myotome (beginning from the stage of foraminal opening expansion), which prevents nerve root injury, as any compression is immediately indicated by muscle twitching. Therefore, muscle relaxants are not used.

After the operation is completed, one or two sutures are applied to the skin.

### Statistical analysis

Statistical processing of the research data was performed using Python v3.9.5 (<https://www.python.org/downloads/>) in the JupyterLab development environment (<https://jupyter.org/install>). Comparisons between independent groups were conducted using Fisher's exact test. The error threshold was set at  $p <$

*This article contains some figures that are displayed in color online but in black and white in the print edition.*



**Fig. 1.** Indentation from the midline depending on the level of intervention



**Fig. 2.** Entry point for endoscope port placement



**Fig. 3.** Endoscope port placement



**Fig. 4.** Endoscope photo

0.0001. A value of  $p < 0.0001$  was considered critically significant for all types of analysis performed.

## Results and discussion

### Patient characteristics

The short-term (first postoperative day) and long-term (6 months after surgery) outcomes of surgical treatment were studied in 68 patients with lumbar intervertebral disc herniation. The patient was examined either upon discharge from the hospital or during wound dressing (for those discharged on the day of surgery), and again during a scheduled follow-up consultation six months later. Surgical outcomes were evaluated using the VAS and the modified J. MacNab

scale. This methodology is routinely used at the "Family Medicine Clinic" (Dnipro) for the removal of paramedian, posterolateral, and foraminal hernias in the lumbar spine.

Among the patients, there were 52 men and 16 women aged 24 to 68 years (mean age – 44.2 years). The duration of the disease ranged from 6 months to 12 years. In all cases, conservative treatment methods, including physiotherapy and sanatorium-resort therapy for a period of no less than 4 weeks, failed to yield the desired results. All patients underwent magnetic resonance imaging (MRI) during the preoperative period.

Indications for surgical intervention included persistent lumbosciatic syndrome, sensory disturbances, moderate to severe motor deficits, and reflex

impairments, combined with ineffective conservative therapy lasting at least 4 weeks and confirmed by morphological signs such as MRI-proven disc herniation. Surgical interventions were performed in the presence of neurocompressive syndromes caused by paramedian, posterolateral, or foraminal hernias (median hernias and L5-S1 hernias with cranial migration were removed as previously described).

The size of the foraminal opening and the location where the nerve root exits through it (**Fig. 5**) [18] are of crucial importance. To enlarge the foramen and place the endoscopic port, it is necessary to preserve the anatomical structure of the foraminal opening. If the nerve root exits through its upper portion, and the lower part, even in the presence of stenosis, still has space for placing a guidewire, the intervention can be successfully performed. However, if the root exits through the lower portion of the foramen or there is significant stenosis due to spondyloarthritis, developmental anomalies, or pronounced spondylolisthesis, the operation will be unsuccessful—except in cases of foraminal hernias, where foramen opening is not required.

Herniated discs at the L2-L3 level were detected in 5 patients (7%), at L3-L4 in 2 patients (3%), at L4-L5 in 35 patients (52%), and at L5-S1 in 26 patients (38%). Paramedian hernias were diagnosed in 21 cases (31%), posterolateral in - 39 cases (57%), and foraminal - in 8 cases (12%) (**Table 1**).

According to MRI data, in 32 cases (47%) the hernias measured up to 8 mm, while in 36 cases (53%) they exceeded 8 mm.

#### **Treatment outcomes**

Before surgery, the average pain score on the VAS was 8.7 points. On the first day after surgery, it decreased to 3.5 points, and six months later, it was 3.0 points ( $p < 0.0001$  compared to the preoperative score).

Six months after the surgical intervention, 63 patients (93%) demonstrated good or satisfactory treatment outcomes according to the J. MacNab scale, while 5 patients (7%) had unsatisfactory results (**Table 2**).

#### **Clinical Case**

Patient H., a 53-year-old female, was hospitalized at the "Family Medicine Clinic" Medical Center on

May 27, 2024, with the diagnosis of a posterolateral intervertebral disc herniation at the L4-L5 level with a foraminal component, L5 right-sided radiculopathy, and pronounced pain and muscle-tonic syndromes.

Upon admission, the patient complained of intense lower back pain radiating along the lateral surface of the right lower limb.

She has been suffering from this condition for several years; however, during the last month, the pain syndrome significantly worsened (9 points on the VAS). She associates the onset of the condition with the physical nature of her occupational activities.

She previously underwent conservative treatment involving physiotherapeutic procedures and sanatorium-resort therapy. However, during the last three weeks, despite the treatment, the pain in her leg intensified markedly.

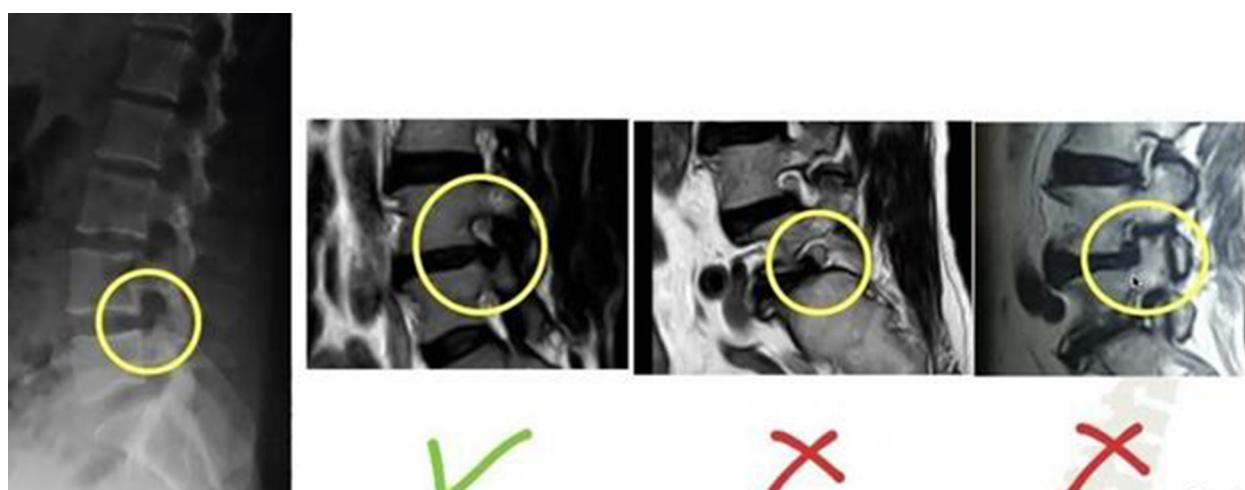
Objective examination revealed pronounced tenderness upon palpation of the spinous processes of the L4 and L5 vertebrae, hypoesthesia along the L5 dermatome on the right, and a sharply positive Lasegue's sign on the right.

MRI revealed a posterolateral intervertebral disc herniation at L4-L5 with a right-sided foraminal component and severe compression of the right L5 nerve root (**Fig. 6**).

A transforaminal endoscopic microdiscectomy of the L4-L5 intervertebral disc on the right was performed.

**Fig. 7** shows fluoroscopic guidance of the endoscope port placement in the specified area of the L4-L5 intervertebral space on the right.

Immediately after the surgery, the patient reported complete regression of the pain syndrome. She was mobilized 3 hours postoperatively. Since she resides in another city, she remained in the hospital overnight. She was discharged the following morning in satisfactory condition. Two weeks later, she reported feeling well, with no complaints and a postoperative scar showing no signs of inflammation (**Fig. 8**). One and a half weeks after surgery, the patient resumed her regular professional activities.



**Fig. 5.** Possibility of intervention depending on the size of the foraminal opening and the location of the nerve root (<https://doi.org/10.1002/ca.22286>)

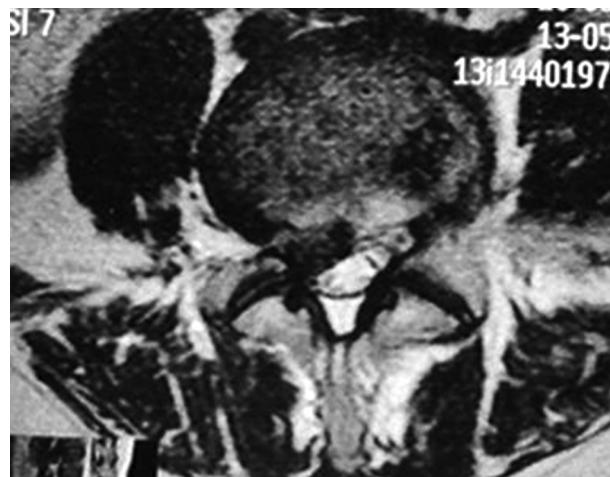
**Table 1.** Distribution of cases according to type and level of herniation

Level	Type of hernia			Total
	Paramedian	Posterolateral	Foraminal	
L2-L3	0	2 (3,0%)	3 (4,0%)	5 (7,0%)
L3-L4	0	1 (1,5%)	1 (1,5%)	2 (3,0%)
L4-L5	12 (18,0%)	21 (31,0%)	2 (3,0%)	35 (52,0%)
L5-S1	9 (13,0%)	15 (22,0%)	2 (3,0%)	26 (38,0%)

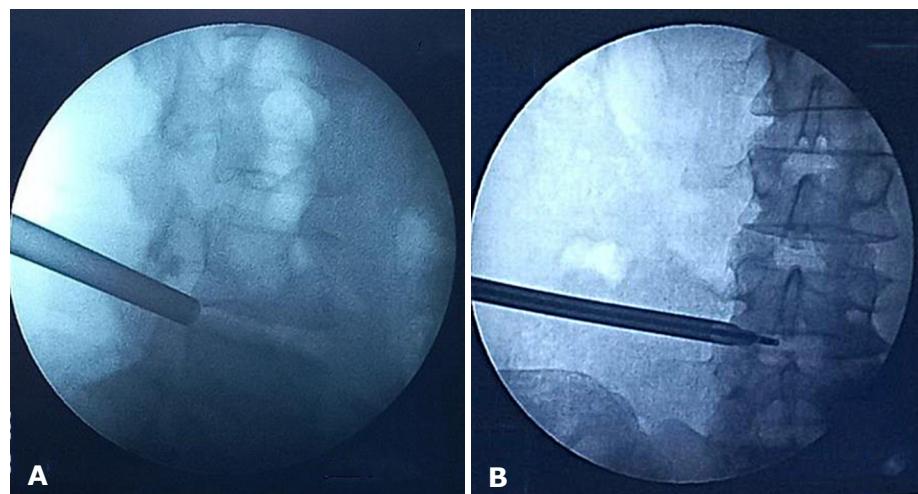
**Table 2.** Evaluation of treatment outcomes using the J. MacNab scale six months after surgery

Results	Number of observations	
	Abs.	%
Good	51*	75
Satisfactory	12	18
Unsatisfactory	5	7
Total	68	100

Note. \* – The difference is statistically significant ( $p < 0.0001$ ) compared to the indicator in patients with an unsatisfactory outcome.



**Рис. 6.** MRT scan. Posterolateral herniation of the L4-L5 intervertebral disc with a right foraminal component



**Fig. 7.** Port placement: A – lateral projection; B – straight projection



**Fig. 8.** Postoperative scar two weeks after surgery

### Discussion

X. Tao et al. (2018) [19] conducted a randomized study assessing treatment outcomes in 462 patients (231 patients in the traditional microdiscectomy group and 231 in the endoscopic transforaminal microdiscectomy group), using the VAS and the modified J. MacNab scale at 1 day, 1 month, 3 months, and 6 months postoperatively. It was found that the TESSYS technique significantly reduces the duration of surgery, intraoperative blood loss, surgical trauma, and length of hospital stay, while accelerating rehabilitation and improving treatment outcomes. The rate of good results according to the modified J. MacNab scale was 87.88% with TESSYS and 84.85% with traditional microdiscectomy.

According to Shenghua He et al. (2018), the success rate with TESSYS reached 98% one year after surgery [20]; data from Chao Yuan et al. (2020) [21] indicate a success rate of 95%.

### Future research prospects

TESSYS is a modern, highly effective, minimally invasive technique for the removal of lumbar intervertebral disc herniations. Like other surgical methods, it has its advantages and disadvantages. The primary advantage is its minimally invasive nature combined with adequate radicality when compared to traditional microdiscectomy. However, a notable disadvantage is its insufficient universality.

According to the author, future research should focus on improving the visualization of herniated discs and the planning of interventions — in particular through the use of artificial intelligence. This is especially relevant for determining the entry point, which is currently calculated in a highly subjective manner and may contribute to unsuccessful surgical outcomes. Additional research should address the "safe" placement of the endoscope port along an optimal trajectory to avoid damage to neural and vascular structures, ensure complete herniation removal, and achieve full decompression of the compressed nerve root and/or dural sac.

### Conclusions

1. Transforaminal endoscopic microdiscectomy is a modern, highly effective, minimally invasive surgical method for the treatment of lumbar intervertebral disc herniations.
2. Transforaminal endoscopic microdiscectomy enables positive outcomes in 93% of cases.
3. According to various authors, the TESSYS technique significantly reduces intraoperative trauma, intraoperative blood loss, length of hospital stay, accelerates rehabilitation, and improves treatment outcomes.

### Disclosure

#### *Conflict of interest*

The author declares no conflict of interest.

#### *Ethical standards*

All procedures performed on patients during the study complied with the ethical standards of the institutional and national research ethics committees and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

#### *Informed Consent*

Informed consent was obtained from each individual patient.

#### *Funding*

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