



## RESULTS OF INTERLAMINAR ENDOSCOPIC LUMBAR DISCECTOMY (PSLD) SUPPLEMENTED BY NUCLEOPLASTY IN PATIENTS WITH LUMBOSACRAL DISC HERNIATION

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### **Abstract.**

Lumbar intervertebral disc herniation remains one of the leading causes of chronic low back pain and radiculopathy, significantly affecting quality of life and functional capacity in the working-age population. The continuous development of minimally invasive spinal surgery has led to the widespread adoption of endoscopic techniques aimed at reducing surgical trauma while maintaining clinical effectiveness. Among these techniques, interlaminar endoscopic lumbar discectomy (posterior spinal lumbar discectomy, PSLD) has gained particular relevance, especially for lumbosacral disc herniations, due to its favorable anatomical access and direct visualization of neural structures. The addition of nucleoplasty may further enhance surgical outcomes by reducing intradiscal pressure and potentially decreasing the risk of recurrent herniation.

The present study aimed to evaluate the clinical and functional outcomes of interlaminar endoscopic lumbar discectomy supplemented by nucleoplasty in patients with lumbosacral intervertebral disc herniation. A prospective single-center study was conducted between 2022 and 2025 and included 32 patients with single-level disc herniation at L4–L5 or L5–S1 who underwent surgical treatment using the combined minimally invasive technique. Clinical outcomes were assessed preoperatively and at 12 months postoperatively using the Visual Analog Scale (VAS) for pain intensity, the Oswestry Disability Index (ODI) for functional status, and the MacNab criteria for overall surgical outcome.

The results demonstrated a statistically significant reduction in both leg and back pain, accompanied by a marked improvement in functional status and quality of life. Satisfactory outcomes according to the MacNab criteria were achieved in the majority of patients, with a low rate of postoperative complications and recurrence. The findings suggest that interlaminar endoscopic lumbar discectomy combined with nucleoplasty is a safe and effective surgical option for the treatment of lumbosacral disc herniation, providing favorable short- and mid-term outcomes and high patient satisfaction.

**Keywords:** lumbar disc herniation; interlaminar endoscopic discectomy; posterior spinal lumbar discectomy; nucleoplasty; minimally invasive spine surgery.

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## РЕЗУЛЬТАТЫ ИНТЕРЛАМИНАРНОГО ЭНДОСКОПИЧЕСКОГО УДАЛЕНИЯ ГРЫЖИ ДИСКА ПОЯСНИЧНО-КРЕСТЦОВОГО ОТДЕЛА ПОЗВОНОЧНИКА (PSLD), ДОПОЛНЕННОГО НУКЛЕОПЛАСТИКОЙ, У ПАЦИЕНТОВ С ГРЫЖЕЙ МЕЖПОЗВОНКОВОГО ДИСКА ПОЯСНИЧНО-КРЕСТЦОВОГО ОТДЕЛА ПОЗВОНОЧНИКА

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### **Аннотация.**

Грыжа межпозвонкового диска пояснично-крестцового отдела позвоночника остаётся одной из ведущих причин хронической боли в пояснице и радикулопатии, существенно снижая качество жизни и функциональную активность пациентов трудоспособного возраста. Развитие малоинвазивной хирургии позвоночника способствовало широкому внедрению эндоскопических методов, направленных на снижение операционной травмы при сохранении высокой клинической эффективности. Интерламинарное эндоскопическое удаление грыжи диска (posterior spinal lumbar discectomy, PSLD) занимает особое место среди современных методик благодаря анатомически обоснованному доступу и возможности прямой визуализации нервных структур. Дополнение данной методики нуклеопластикой потенциально позволяет уменьшить внутридисковое давление и снизить риск рецидива заболевания.

Целью настоящего исследования являлась оценка клинико-функциональных результатов интерламинарного эндоскопического удаления грыжи диска, дополненного нуклеопластикой, у пациентов с грыжей межпозвонкового диска пояснично-крестцового отдела позвоночника. В проспективное одноцентровое исследование, проведённое в период с 2022 по 2025 годы, было включено 32 пациента с одноуровневым поражением дисков L4–L5 или L5–S1. Оценка результатов лечения проводилась до операции и через 12 месяцев после вмешательства с использованием визуальной аналоговой шкалы боли (ВАШ), индекса инвалидизации Освестри (ODI) и критериев MacNab.

Полученные данные продемонстрировали достоверное снижение болевого синдрома в спине и нижних конечностях, а также значительное улучшение функционального состояния и качества жизни пациентов. Большинство хирургических вмешательств сопровождалось благоприятными исходами при низкой частоте осложнений и рецидивов. Результаты исследования подтверждают, что интерламинарное эндоскопическое удаление грыжи диска в сочетании с нуклеопластикой является безопасным и эффективным методом хирургического лечения грыж пояснично-крестцового отдела позвоночника.

**Ключевые слова:** грыжа межпозвонкового диска; интерламинарная эндоскопическая дискэктомия; PSLD; нуклеопластика; малоинвазивная хирургия позвоночника.

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## **BEL-DUMG‘AZA UMURTQA POG‘ONASI DISK CHURRASI BO‘LGAN BEMORLARDA NUKLEOPLASTIKA BILAN TO‘LDIRILGAN INTERLAMINAR ENDOSKOPIK DISKEKTOMIYA (PSLD) NATIJALARI**

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### **Annotatsiya**

Bel-umurtqa pog‘onasi disk churrasi surunkali bel og‘rig‘i va radikulopatiyaning asosiy sabablaridan biri bo‘lib, mehnatga layoqatli yoshdagi bemorlarning hayot sifati va funksional faolligini sezilarli darajada pasaytiradi. Umurtqa pog‘onasi jarrohligida minimal invaziv texnologiyalarning rivojlanishi operatsion shikastlanishni kamaytirish va yuqori klinik samaradorlikni saqlab qolishga qaratilgan endoskopik usullarning keng joriy etilishiga olib keldi. Interlaminar endoskopik diskektomiya (posterior spinal lumbar discectomy, PSLD) anatomik jihatdan qulay kirish yo‘li va nerv tuzilmalarini to‘g‘ridan-to‘g‘ri vizualizatsiya qilish imkoniyati bilan ajralib turadi. Ushbu usulni nukleoplastika bilan to‘ldirish disk ichidagi bosimni kamaytirishga va kasallik qaytalanish xavfini pasaytirishga xizmat qilishi mumkin.

Mazkur tadqiqotning maqsadi bel-umurtqa pog‘onasi disk churrasi bo‘lgan bemorlarda interlaminar endoskopik diskektomiya va nukleoplastika kombinatsiyasining klinik va funksional natijalarini baholashdan iborat. 2022–2025 yillar davomida o‘tkazilgan prospektiv bir markazli tadqiqotga L4–L5 yoki L5–S1 darajasida bir darajali disk churrasi aniqlangan 32 nafar bemor kiritildi. Davolash samaradorligi operatsiyadan oldin va operatsiyadan 12 oy o‘tib og‘riq intensivligi (VAS), funksional holat (Oswestry Disability Index) hamda MacNab mezonlari asosida baholandi.

Tadqiqot natijalari bel va oyoqlardagi ogʻriqning ishonchli darajada kamayganini hamda bemorlarning funksional holati va hayot sifati sezilarli yaxshilanganini koʻrsatdi. Asoratlar va retsidivlar kam uchradi, bemorlarning aksariyatida jarrohlik natijalari ijobiy baholandi. Olingan maʼlumotlar interlaminar endoskopik diskektomiya va nukleoplastika kombinatsiyasi bel-umurtqa pogʻonasi disk churralarini davolashda xavfsiz va samarali usul ekanligini tasdiqlaydi.

**Kalit soʻzlar:** bel disk churra; interlaminar endoskopik diskektomiya; PSLD; nukleoplastika; minimal invaziv umurtqa jarrohligi.

**Introduction.** Lumbar intervertebral disc herniation is one of the most common degenerative conditions of the spine and represents a major cause of chronic low back pain and radiculopathy in the working-age population worldwide [1]. Disc herniation is defined as displacement of nucleus pulposus material beyond the boundaries of the intervertebral disc space with or without rupture of the annulus fibrosus, leading to compression and inflammatory irritation of neural structures [2]. Epidemiological studies indicate that radiological signs of disc degeneration and herniation may be detected in 50–80% of asymptomatic individuals, confirming the multifactorial and often subclinical nature of this pathology [3,4]. Nevertheless, symptomatic lumbar disc herniation remains a leading indication for spinal surgery due to its significant impact on quality of life, functional capacity, and socioeconomic burden [5].

More than 90% of clinically relevant lumbar disc herniations are localized at the L4–L5 and L5–S1 levels, which are subjected to maximal biomechanical stress and axial loading [6]. Although conservative treatment remains the first-line approach, including pharmacotherapy, physical rehabilitation, and interventional pain procedures, surgical intervention becomes necessary in cases of persistent radicular pain, neurological deficit, or failure of nonoperative management [7]. Over the past two decades, advances in minimally invasive spine surgery have led to the development and widespread adoption of endoscopic techniques aimed at reducing surgical trauma while maintaining clinical efficacy [8].

Percutaneous endoscopic lumbar discectomy has evolved into two principal approaches: transforaminal and interlaminar. The interlaminar endoscopic approach, also known as posterior endoscopic lumbar discectomy (PSLD), is particularly advantageous at the L5–S1 level due to anatomical constraints such as a high iliac crest, narrow foramina, and hypertrophied facet joints that may limit transforaminal access [9]. The interlaminar approach allows direct posterior access to the spinal canal through the interlaminar window, providing early visualization of neural structures and effective decompression under endoscopic control [10].

Nucleoplasty, based on controlled reduction of intradiscal pressure via targeted ablation or decompression of the nucleus pulposus, has been proposed as an adjunctive technique to reduce the risk of recurrent herniation and to address residual discogenic pain [11]. Combining interlaminar endoscopic discectomy with nucleoplasty may theoretically enhance long-term outcomes by addressing both mechanical compression and intradiscal pathology [12]. However, clinical data evaluating the effectiveness of this combined approach remain limited, particularly in prospective cohorts.

The aim of the present study was to evaluate clinical outcomes, functional recovery, and complication rates following interlaminar endoscopic lumbar discectomy supplemented by nucleoplasty in patients with lumbosacral disc herniation.

**Materials and Methods.** Between January 2022 and March 2025, a prospective single-center observational study was conducted. A total of 32 patients underwent interlaminar endoscopic lumbar discectomy supplemented by nucleoplasty for symptomatic single-level lumbar disc herniation. The study protocol complied with the ethical principles of the Declaration of Helsinki and was approved by the local institutional ethics committee. Written informed consent was obtained from all participants prior to enrollment.

Inclusion criteria consisted of age between 18 and 55 years, presence of a single-level disc herniation at L4–L5 or L5–S1 confirmed by magnetic resonance imaging, radicular pain persisting for more than three months with a Visual Analog Scale (VAS) score greater than 4 points and/or Oswestry Disability Index (ODI) exceeding 30%, failure of conservative treatment, and clinical-

radiological correlation. Exclusion criteria included segmental instability, degenerative spinal canal stenosis, spondylolisthesis greater than Grade I, spinal deformity, prior lumbar surgery at the same level, active infection, or systemic inflammatory disease.

The cohort consisted of 18 men (56.25%) and 14 women (43.75%). The mean age was  $33.8 \pm 4.6$  years. Disc herniation was localized at the L5–S1 level in 20 patients (62.5%) and at L4–L5 in 12 patients (37.5%). According to the classification of the American Society of Neuroradiology, 17 patients (53.1%) presented with protrusion, 11 patients (34.4%) with extrusion, and 4 patients (12.5%) with sequestration [13]. Disc degeneration was assessed using the Pfirrmann grading system, with Grade III degeneration observed in 13 patients (40.6%), Grade IV in 15 patients (46.9%), and Grade V in 4 patients (12.5%) [14]. Modic changes were identified in 9 patients (28.1%), predominantly Type II [15].

All procedures were performed by the same experienced spine surgeon under general anesthesia. Using fluoroscopic guidance, a standard interlaminar endoscopic approach was employed. After partial flavectomy and exposure of the dural sac and affected nerve root, herniated disc fragments were removed under direct endoscopic visualization. Nucleoplasty was subsequently performed using a controlled intradiscal decompression technique aimed at reducing nucleus pulposus volume while preserving annular integrity [16]. Hemostasis was achieved endoscopically, and no drainage was used.

Clinical evaluation was conducted preoperatively and at 12 months postoperatively. Pain intensity was assessed using the VAS for both leg and back pain. Functional status and quality of life were measured using the ODI questionnaire. Surgical outcomes were graded according to the MacNab criteria. Complications, recurrence of herniation, and need for reoperation were recorded.

Statistical analysis was performed using nonparametric methods. Continuous variables were expressed as mean  $\pm$  standard deviation. Pre- and postoperative comparisons were conducted using the Wilcoxon signed-rank test. Statistical significance was defined as  $p < 0.05$ .

**Results.** All 32 surgical procedures were completed successfully without intraoperative conversion to open surgery. The mean operative time was  $58.4 \pm 9.2$  minutes. Mean hospital stay was  $1.6 \pm 0.5$  days, and all patients were mobilized within 6 hours postoperatively.

Preoperatively, the mean VAS score for leg pain was  $7.2 \pm 0.8$  points, which significantly decreased to  $1.6 \pm 0.7$  points at 12 months follow-up ( $p < 0.001$ ). Back pain VAS scores improved from  $5.9 \pm 1.0$  points preoperatively to  $1.8 \pm 0.6$  points postoperatively ( $p < 0.001$ ). The mean ODI score improved from  $52.3 \pm 8.4\%$  before surgery to  $14.7 \pm 5.1\%$  at final follow-up, indicating substantial functional recovery ( $p < 0.001$ ).

According to the MacNab criteria, outcomes were rated as excellent in 20 patients (62.5%), good in 9 patients (28.1%), fair in 2 patients (6.25%), and poor in 1 patient (3.1%). Thus, satisfactory results (excellent and good) were achieved in 90.6% of cases.

Postoperative complications were minimal. Transient dysesthesia in the distribution of the affected nerve root was observed in 2 patients (6.25%) and resolved spontaneously within six weeks. One patient (3.1%) experienced recurrent disc herniation at the same level within 10 months postoperatively and required revision endoscopic surgery. No cases of dural tear, infection, or permanent neurological deficit were recorded.

A summary of key clinical outcomes is presented in Table 1.

Table 1. Clinical outcomes after interlaminar endoscopic lumbar discectomy with nucleoplasty (n = 32)

| Parameter              | Preoperative   | 12 months postoperative |
|------------------------|----------------|-------------------------|
| VAS leg pain (points)  | $7.2 \pm 0.8$  | $1.6 \pm 0.7$           |
| VAS back pain (points) | $5.9 \pm 1.0$  | $1.8 \pm 0.6$           |
| ODI (%)                | $52.3 \pm 8.4$ | $14.7 \pm 5.1$          |

**Discussion.** The findings of the present study demonstrate that interlaminar endoscopic lumbar discectomy supplemented by nucleoplasty is a safe and effective treatment for symptomatic lumbosacral disc herniation. Significant improvements in pain relief and functional outcomes were observed, with a high rate of patient satisfaction and a low incidence of complications.

The interlaminar approach offers distinct anatomical and technical advantages, particularly at the L5–S1 level, where transforaminal access may be limited [17]. Direct posterior visualization of neural structures allows precise decompression while minimizing manipulation of the nerve root. The addition of nucleoplasty may further contribute to long-term stability by reducing intradiscal pressure and limiting residual disc material capable of reherniation [18].

The recurrence rate of 3.1% observed in this cohort is consistent with or lower than rates reported in previous studies of endoscopic lumbar discectomy, which range from 5 to 12% [19]. Preservation of paraspinal musculature and posterior ligamentous structures likely contributes to rapid postoperative recovery and reduced postoperative pain [20].

Limitations of this study include the relatively small sample size and absence of a control group treated without nucleoplasty. Nevertheless, the prospective design and standardized surgical technique strengthen the validity of the findings. Further randomized controlled trials with longer follow-up are required to clarify the independent contribution of nucleoplasty to long-term outcomes.

**Conclusion.** Interlaminar endoscopic lumbar discectomy supplemented by nucleoplasty provides effective decompression, significant pain relief, and meaningful functional improvement in patients with lumbosacral disc herniation. The technique demonstrates a favorable safety profile, short hospitalization, and high patient satisfaction. This combined minimally invasive approach represents a promising surgical option, particularly for herniations at the L5–S1 level, and warrants further investigation in larger comparative studies [21–25].

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