International Journal of Innovative Research in Medical Science (IJIRMS)
Volume 08, Issue 09, September 2023,
https://doi.org/10.23958/ijirms/vol08-i09/1735

Review Article

Revision of Post-Endoscopic Discectomy: A Review

Dr. Yousif Sharaf [*1], Mohamed Alsaif [2], Yakub Sayed [3]

[1]Alsharaf Orthopedic and Spine Center, Manama, Bahrain.
[2]Chief Resident Orthopedic Surgery, Orthopedics Department, Salmaniya Medical Complex, Manama, Bahrain.
[3]Department of Clinical Research, Shifa Clinic, Pune, Maharashtra, India.

*Corresponding Author: Dr. Yousif Sharaf; *dr.yousif.sharaf@gmail.com*

Received 03 August 2023; Accepted 19 August 2023; Published 02 September 2023

Abstract

This review focuses on the recurrence of lumbar disc herniation after percutaneous endoscopic discectomy (PED) and the revision surgery options available for patients who require further treatment. PED is a minimally invasive surgical technique used to treat herniated discs in the lumbar spine. Although PED has many advantages over traditional open decompression and fusion surgery, recurrent herniation is a common complication that can lead to the need for revision surgery. It will provide insights into strategies for minimizing complications and improving outcomes of post-endoscopic revision discectomy. The goal is to assist clinicians in selecting the most appropriate revision surgery option for their patients based on individual risk factors and other relevant factors. Ultimately, the review aimed to improve patient outcomes and reduce the need for repeat surgery in cases of recurrent herniation following PED. Various surgical techniques have been described for revision procedures, including repeated endoscopic discectomy, open discectomy, minimally invasive microdiscectomy, and fusion. The choice of technique depends on the specific indications and individual patient characteristics. The review will discuss common options for revision surgery, including minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF), micro-endoscopic discectomy (MED), and PED. Factors that increase the risk of recurrence after primary PED surgery, such as advanced age, obesity, and Modic changes, will also be discussed. Further research and long-term follow-up studies are warranted to enhance our understanding of the optimal management strategies and outcomes of post-endoscopic discectomy revision.

Keywords: ***Percutaneous; endoscopic; lumbar discectomy; endoscopic discectomy, Recurrent herniation; Revision surgery, complications, outcome.***

Introduction

Endoscopic discectomy is a minimally invasive surgical technique used to treat herniated discs in the lower back (lumbar spine) as an alternative to open surgery [1]. Recently, in some cases, it can also be used to alleviate symptoms associated with lumbar spinal stenosis caused by a herniated disc [2-4].

Percutaneous Endoscopic Discectomy (PED) can be used to remove not only disc herniations but also other spinal conditions such as hyperplastic (enlarged) facet joints, hypertrophic ligamentum flavum, and osteophytes. These conditions can lead to the compression of nerve roots and can cause pain, numbness, and weakness in the legs. Previous evidence showed that PED resulted in clinical outcomes comparable to traditional open decompression and fusion surgery. Additionally, PED has more advantages, including preservation of normal tissue, lower risk of complications (blood loss and degeneration of adjacent segments), speedy recovery time, in addition to lower postoperative care costs [5-7]. However, the recurrence of lumbar disc herniation following PED has raised the concerns of many researchers. Previous studies reported a recurrence rate of lumbar disc herniation after endoscopic discectomy of 3.6% within six months postoperatively and that 9.3% of patients underwent reoperation within eight years postoperatively[8].

When conservative treatment for PED recurrence fails to alleviate pain, revision surgery is often required for the majority of patients. However, there is currently no research to guide the selection of the appropriate revision surgery. Common options for revision surgery in cases of recurrent herniation include Minimally Invasive Transforaminal Lumbar Interbody Fusion (MIS-TLIF), micro-endoscopic discectomy (MED), and PED [9-11]. In this review, we will describe endoscopic lumbar discectomy and its associated complications and attempt to explore some helpful insights into the revision methods used after endoscopic lumbar discectomy.

The aim of this review was to evaluate the current literature on revision surgery following post-endoscopic discectomy (PED) and to provide a comprehensive analysis of the surgical techniques, complications, and outcomes associated with revision surgery.

Methods

The goal of this review article was to evaluate the current literature on revision surgery following post-endoscopic discectomy (PED) and to provide a comprehensive analysis of the surgical techniques, complications, and outcomes associated with revision surgery. Thus, high-quality data that met the study objectives were included. In addition, comprehensive investigations on articles available in renowned databases like Google Scholar, PubMed, Research Gate, and PMC articles were considered for literature review. The key index words or phrases used during the literature search were percutaneous endoscopic lumbar discectomy; lumbar revision; Recurrent herniation; Revision surgery.

Inclusion criteria: Scientific articles addressing the study objectives and written in the English language were included in the literature review.

Exclusion Criteria: literature dated before 2000 were excluded.

Recurrence of lumbar disc herniation (LDH):

PED is a surgical procedure used to remove herniated disc fragments and preserve the normal nucleus pulposus. However, recurrence of herniation can occur due to multiple associated factors such as aging, improper weight-bearing, and others. PED shares some risk factors for recurrence with other discectomy surgeries, such as being male, having a high Body Mass Index (BMI)of more than 25 (obese), being older, having a history of trauma, smoking, diabetes and having a central disc herniation. However, PED also has its unique risk factors for herniation recurrence, such as inexperienced surgeons who have performed fewer than 200 PED procedures and performed the surgery in the early stages of PED development before 2010 [12,13]. In order to minimize the risk of recurrence, surgeons should carefully study imaging examinations and plan the puncture route before surgery. Additionally, postoperative instructions such as lumbar muscle exercises, appropriate weight-bearing, and proper sitting posture can help decrease the risk of herniation recurrence [14].

Clinical presentation: Leg pain in the same distribution that was felt during the index herniation is frequently present in the patient. After the main lumbar discectomy, individuals with rLDH experience a symptom-free interval, as was previously stated. The likelihood that the discomfort is caused by a new disc herniation increases the longer this time of no symptoms. Sometimes the clinical picture is not obvious or simple to diagnose. It's important to distinguish between post-discectomy back discomfort with leg pain transferred from actual radicular pain. In a post-discectomy patient who returns with new symptoms, the differential diagnosis includes scar tissue, epidural fibrosis, arachnoiditis, and infection. Leg discomfort may not be the same for patients with rLDH since the new recurrence herniation may vary in size, location, and migration. Moreover, the surrounding scarring may decrease the nerve root's mobility and modify the experience of pain. The patients might not always exhibit traditional root tension symptoms for similar reasons. It has not been demonstrated that neurological impairments occur more frequently in recurrent disc herniations than in original disc herniations.

Table 1: Risk factors of recurrent Lumber Disc Herniation (LDH)

Personal Factors	Morphological/ Radiological Factors	Surgical Technique
Age, gender	Level and type of herniation	Fragmentectomy vs. aggressive discectomy
Body Mass Index	Size of annular defect	Annular incision
Smoking	Intervertebral disc height	Saline lavage
Diabetes	Lumbar lordosis	Post-operative activity or return
Occupation like weightlifting or carrying heavyweight with extreme forward bending and LDH	Segmental instability Lower Pfirmann degeneration Modic endplate changes	

LDH-Lumbar Disc Herniation

Revision surgery rates and surgical techniques

Patients who do not respond to conservative treatment may require revision surgery. However, there is currently no research to guide the selection of the appropriate revision surgery method for PED recurrence. The surgical technique used in the initial operation can affect the revision strategy. During revision surgery, surgeons must consider the presence of scar tissue and altered anatomical landmarks, such as bony defects. All surgical techniques, including endoscopic, micro- and macro-surgeries with and without fusion procedures, are considered for revision surgery. The choice of technique should be tailored to the surgeon's experience [15].

A previous study conducted by Kim et al. comparing percutaneous discectomy (301 cases in whom 28 experienced reoperations) and Microscopic Discectomy (MD) (614 in whom 38 experienced reoperations) showed that there was no significant difference in reoperation rates between the two groups [16]. According to another study conducted by Cheng et al., the rate of reoperation within six months was highest for endoscopic decompression, followed by MD, and lowest for open surgery and the difference was significant ($P < 0.01$). However, over the course of 1 to 5 years, the rate of reoperation was highest for open surgery, followed by MED, and lowest for PED ($P < 0.01$) [17]. The study's authors concluded that the long-term risk of reoperation after PED was relatively low. Minimally Invasive Transforaminal Lumbar Interbody Fusion (MIS-TLIF), MED, and PED are common surgery methods used for the revision of PELD. More recently, Yao et al. found that these three methods have similar long-term effectiveness. Compared to MIS-TLIF, MED and PED have the advantages of the shorter operation time, shorter hospital stay, and lower cost, but these methods also have a higher risk of recurrence [18]. Regarding clinical outcomes, the authors added that in comparison, MIS-TLIF, MED and PED were linked to greater pain relief one month after surgery. However, this difference was not present three months post-surgery.

Recurrent disc herniations after revision surgery can be difficult to accept. A recent study found that out of the patients who underwent Percutaneous Endoscopic Lumbar Discectomy (PELD), five experienced recurrences after the revision surgery [8]. The recurrence rate was considerably higher in the PELD group compared to the MIS-TLIF group, which had no cases of recurrence. Risk factors such as modic changes, obesity, and advanced age have been found to increase the risk of recurrence after PELD surgery. In the study, all five patients who experienced recurrence were either over the age of 60 or had a BMI greater than 25, indicating a higher risk for recurrent herniation after PELD. Factors that increase the risk of recurrence after the initial surgery can also predict recurrence after revision surgery. The artificial incision made in the annulus fibrosus during the primary PELD surgery may alter the interlaminar shear stress, making the residual nucleus pulposus more likely to prolapse, resulting in recurrence. Surgeons should inform high-risk patients about the possibility of fusion surgery and the risks of recurrent herniation after non-fusion surgery, whether it is the initial or revision surgery.

Table 2: Studies with different modalities of treatment for recurrent LDH and their outcomes

Author	Study design	Sample size	Mean duration of follow up	Type of procedure undergone	Outcome
Ahmed *et al*[19]	Prospective	30	2 years	Transforaminal lumbar interbody fusion (TLIF)	Satisfactory results
Cho *et al*[20]	Retrospective	244	2 years	Fully endoscopic lumbar discectomy (FELD)	The results were comparable to those obtained following FELD for main LDH.

					nonetheless, reported greater incidence of complications for rLDH.
Qiao *et al*[21]	Retrospective	47	Nearly 1 year	Transforaminal lumbar interbody fusion	Lateral Lumbar Interbody Fusion(LLIF) and Posterior lumbar interbody fusion, (PLIF) had comparable results
Kapetanakis *et al*[22]	Prospective	45	1 year	Fully endoscopic lumbar discectomy	With notable improvement rates for physical function, physical pain, and role-emotional factors, FELD is linked to a positive impact.
Li *et al*[23]	Prospective	73	4 years	Transforaminal lumbar interbody fusion	The Japanese Orthopedic Association's average recovery rate was 89%.
Sonmez *et al*[24]	Prospective	20	2 years	Transforaminal lumbar interbody fusion	Similar outcomes

TLIF- Transforaminal lumbar interbody fusion; FELD- Fully endoscopic lumbar discectomy; PLIF- Posterior lumbar interbody fusion; LLIF- Lateral Lumbar Interbody Fusion; LDH- Lumbar Disc Herniation

There are very few accounts of how percutaneous endoscopic discectomy improves quality of life and the capacity to return to work, despite the fact that several researches have demonstrated its effectiveness with favorable clinical results. In assessing neurologic and spinal illnesses, patient-centered health-related quality of life assessments are crucial, especially because they have an impact on the patients' overall wellbeing. Even the idea that standardized health metrics can enhance clinical practice has been floated.

Potential predictors for revision surgery

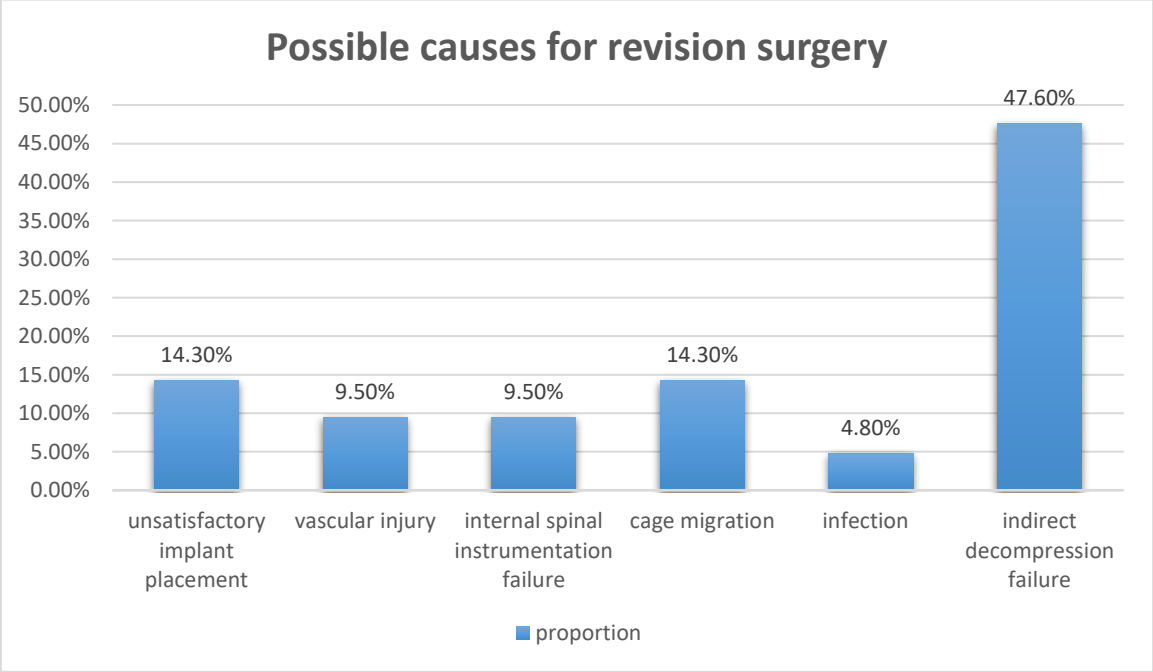

Figure 1: Possible causes for revision surgery [25]

Indirect decompression failure is the leading cause of revision surgery. However, patients' postoperative recovery and satisfaction were not adversely affected by the revision in the long-term follow-up. IDF may occur due to a variety of reasons such as endplate collapse, osteoporosis, severe foraminal stenosis, inadequately restored disc, and bony lateral recess stenosis.

We must select the appropriate revision mode in accordance with the IDF's root causes. Most of the earlier trials used posterior direct decompression as a complement to alleviate neurological problems. Minimally invasive decompression is an alternative to conventional posterior decompression. When the diagnosis is certain, intervertebral foramenoplasty is performed using an endoscope, and the lamina can also be decompressed using a Unilateral Biportal Endoscope (UBE). Moreover, after surgery, posterior pedicle screw fixation can stop additional intervertebral space compression brought on by osteoporosis and endplate damage.

Less trauma, a quicker recovery period, and passage surgery may all contribute to the decreased incidence of infection. Those who are obese or diabetic are more likely to become infected. However, wound infections can be treated conservatively. Infection in the intervertebral space is seldom documented, nevertheless. The gastrointestinal system or blood can both indirectly or directly transmit an intervertebral space infection. Debridement via the first surgical incision is a superior option to stop the infection from spreading to the posterior column of the spine. Implants can be thought of as being conserved in the early stages of infection. Focal debridement, bone grafting, and internal fixation are required when the infection is difficult to treat and the focus of the infection is substantial.

Vascular damage is simple to develop during OLIF if the distance between the psoas major muscle and vascular sheath is relatively small. When suspected vascular damage occurs during surgery, it is imperative to stop the bleeding completely since failing to do so might easily result in prolonged bleeding following the procedure. Early diagnosis is crucial to revision because it allows for the prompt application of appropriate bleeding control techniques once the incision becomes painful and blood pressure begins to decrease quickly.

Obesity, getting out of bed too early, a short interbody fusion cage, aberrant vertebral body form, using the wrong bone graft material, osteoporosis, damage to the bony endplates, and inadequate opening of the contralateral annulus are the primary reasons for cage migration. After SA-LLIF, cage migration often takes place. Early stages of cage migration can be corrected by

adding posterior internal fixation alone because of little displacement and minimal symptoms (Fig. 3a-d). If cage prolapse happens, the protruded intervertebral gap will collapse and result in symptoms in the lower limbs as the prolapsed cage will push on the lumbar plexus. Thus, it is required to change the cage's position from its initial position before applying internal fixing.

Unsatisfactory implant placement can be caused by a variety of circumstances, including a high iliac crest, psoas major hypertrophy, the development of a lumbar bridge, and others. Because it is challenging to straighten the channel, the cage and inferior screws are not perfectly vertical. By moving the implant's location and easing nerve compression with a two-stage procedure, instances with persistent neurological complaints can have positive outcomes. To avoid having to remove the cage in some circumstances where it was used with a fin device during revision, we used posterior decompression or symptomatic side Transforaminal Lumbar Interbody Fusion (TLIF), which eased compression under direct view.

Incorrect surgery or installation choices frequently result in the failure of spinal internal fixation. It is obviously required to repair the internal fixation after removing it from the first posterior incision if it is loose or fractured. To avoid recurrence, revision should also take into account the stress direction and the curvature of the lumbar spine. In order to preserve spinal stability when lateral internal fixation is chosen for one-stage surgery, it is also required to take into account increasing posterior pedicle screw fixation in addition to removing the initial internal fixation.

The stress that the implant can withstand in the body must thus be accurately estimated before surgery, and each implant component's installation method and intended use must be mastered. If a patient has severe osteoporosis, posterior internal fixation should be used to improve the therapy for osteoporosis and give better support.

It is true to say that there is no established standard of care for the surgical management of recurrent disc herniations. A pure re-discectomy is usually adequate and may be carried out safely and successfully with the use of a microscope. In cases of significant preoperative back pain with obvious radiological symptoms of disc degeneration or established instability, a simultaneous fusion with a re-discectomy in the index segment is recommended depending on the clinical and radiological results. In theory, revision indications can lead to effective therapeutic outcomes, but they will be less effective than initial treatments.

Strategies for minimizing complications and improving outcomes

While microdiscectomies for recurrent LDH are now a common and well-accepted treatment option, the development of minimally invasive methods for treating original disc herniations has generated curiosity in how well-suited these methods are for revision discectomies. Isaacs et al. conducted a study on ten patients undergoing Micro Endoscopic D iscectomy (MED) for recurrent herniation. During the mean follow-up of 13.1 months, all patients reported improvement in their sciatica, and 90% had satisfactory or outstanding results, with no significant changes in operating time, blood loss, length of stay, or surgical complications compared to those undergoing initial discectomies. Ahn et al. and Smith et al also reported favorable outcomes in their retrospective studies on 43 and 16 patients, respectively, treated with MED for recurrent herniation, with significant improvements in VAS, ODI, and SF-36 scores. However, the small sample sizes and retrospective nature of these studies make direct comparisons between MED and open techniques challenging.

One approach to minimize complications in Percutaneous Transforaminal Endoscopic Decompression (PERD) is to select appropriate candidates for the surgery carefully. Preoperative evaluation and risk stratification of patients can help identify those who are at a higher risk of complications. Factors such as advanced age, obesity, and Modic changes have been shown to increase the risk of recurrence after primary endoscopic discectomy. Therefore, these patients may benefit from alternative surgical options, such as fusion surgery.

Another strategy to improve outcomes in PERD is to ensure adequate decompression and removal of all herniated disc material. This can be achieved by using advanced imaging techniques, such as intraoperative ultrasound, to identify residual disc fragments. Additionally, the use of more advanced endoscopic tools and techniques, such as laser-assisted endoscopic discectomy, may enhance the ability to achieve complete decompression.

Intraoperative neuromonitoring (IONM) is also an effective strategy for minimizing complications in PERD. IONM can help detect early signs of nerve injury during surgery, allowing for timely intervention and minimizing the risk of permanent damage.

Postoperative rehabilitation and follow-up care are also crucial for improving outcomes in PERD. Patients should undergo structured rehabilitation programs to optimize their recovery and prevent recurrent disc herniation. Long-term follow-up care should also be provided to monitor for potential complications and ensure that patients continue to experience lasting symptom relief.

In summary, minimizing complications and improving outcomes in PERD can be achieved through careful patient selection, advanced imaging techniques, advanced endoscopic tools and techniques, intraoperative neuromonitoring, and structured rehabilitation programs. These strategies can help ensure optimal patient outcomes and reduce the need for further revision surgery.

Future directions for research

Regarding the quantity of recurrent herniations necessary before instrumented fusion at the afflicted level is taken into account, there is currently no clear agreement. Repeat discectomy is the most frequent surgical procedure for first-time recurrence in the absence of low back discomfort or radiological instability. Yet, as recurrent exposure frequently necessitates more extensive facetectomies and dissection for imaging of the neural foramen, the likelihood of introducing or exacerbating segmental lumbar instability grows with each successive operation. As a result, the threshold for including instrumented fusion drops when more herniations occur repeatedly. Mroz et al. used an electronic survey that was distributed to 2560 orthopedic and neurologic doctors across the United States to show this. Regardless of geography, specialty, fellowship training, or style of practice, the majority of surgeons said that they would only do revision microdiscectomy for the first recurrence. With a 69% risk of disagreement amongst surgeons, there was a considerable difference in preferred care for second-time recurrence previously treated with microdiscectomy. In particular, compared to surgeons conducting only 0 to 100 cases per year, those doing 201 to 500 cases per year had 3.47 more chances of selecting to treat using revision microdiscectomy with PLIF/TLIF as opposed to revision microdiscectomy alone.

- ***Effectiveness comparison:*** Further study is required to assess the efficiency of different surgical procedures for revision surgery following endoscopic discectomy, including microdiscectomy, laminectomy, fusion, and repeat endoscopic discectomy.
- ***Long-term effects:*** More study is required to determine the long-term effects of revision surgery following endoscopic discectomy. Examining the effects of revision surgery over time on pain alleviation, functional progress, and quality of life is a part of this.
- ***Results as stated by the patient:*** More study is required to determine the results as reported by the patient following revision surgery following endoscopic discectomy. This involves gauging patient happiness, pain intensity as stated by the patient, and quality of life results.

- ***Danger factors:*** In the future, research may examine elements including patient demographics, comorbidities, and the specifics of the initial herniation as potential risk factors for revision surgery following endoscopic discectomy.
- ***Technological developments:*** The use of robots, navigational systems, and intraoperative imaging can increase vision and accuracy, which can lead to better results and a reduced incidence of complications.
- ***Alternative therapies:*** Patients who need revision surgery following endoscopic discectomy may have more alternatives thanks to the emergence of alternative therapies, including stem cell therapy and other regenerative methods.

Conclusion

Overall, the revision of post-endoscopic discectomy is a complex and challenging procedure that requires a high level of expertise and precision. Successful results include significant pain alleviation, increased functioning, and a satisfying recovery. Suboptimal results include infections, nerve damage, repeated disc herniations, and other surgical problems. Diagnostic tools such as imaging tests can help identify the underlying cause of the patient's symptoms, and treatment options may include a second endoscopic discectomy or a more extensive surgical procedure. By carefully evaluating each patient's individual case and using appropriate surgical techniques, surgeons can help to minimize the risk of complications and the need for revision surgery.

Declarations

Ethics approval and consent to participate

Not applicable

Data Availability

Not applicable

Conflicts of Interest

All authors declare no conflict of interest. There are no conflicting relationships or activities.

Funding Statement

This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

[1] Ruetten S, Komp M, Merk H, Godolias G. Full-endoscopic interlaminar and transforaminal lumbar discectomy versus conventional microsurgical technique: a prospective, randomized, controlled study. Spine (Phila Pa 1976) 2008;33(9):931–9.

[2] Wu B, Tian X, Shi C, Jiang C, Zhang J, Zhan G, et al. Clinical Outcomes of "U" Route Transforaminal Percutaneous Endoscopic Lumbar Discectomy in Chronic Pain Patients with Lumbar Spinal Stenosis Combined with Disc Herniation. Pain Res Manag 2021;2021:6657463.

[3] Song Q, Hai B, Zhao W, Huang X, Liu K, Zhu B, et al. Full-Endoscopic Foraminotomy with a Novel Large Endoscopic Trephine for Severe Degenerative Lumbar Foraminal Stenosis at L5S1 Level: An Advanced Surgical Technique. Orthop Surg 2021;13(2):659–68.

[4] Li H, Ou Y, Xie F, Liang W, Tian G, Li H. Linical efficacy of percutaneous endoscopic lumbar discectomy for the treatment of lumbar spinal stenosis in elderly patients: a retrospective study. J Orthop Surg Res 2020;15:441.

[5] Song Q, Zhu B, Zhao W, Liang C, Hai B, Liu X. Full-Endoscopic Lumbar Decompression versus Open Decompression and Fusion Surgery for the Lumbar Spinal Stenosis: A 3-Year Follow-Up Study. J Pain Res 2021;14:1331–8.

[6] Yin G, Huang B, Wang C, Liu SQ. Therapeutic effects of full endoscopic spine surgery via transforaminal approach in elderly patients with lumbar spinal stenosis: A retrospective clinical study. Acta Orthop Traumatol Turc 2021;55(2):166–70.

[7] Wei FL, Zhou CP, Liu R, Zhu KL, Du MR, Gao HR, et al. Management for lumbar spinal stenosis: A network meta-analysis and systematic review. Int J Surg 2021;85:19–28.

[8] Wang A, Yu Z. Comparison of Percutaneous Endoscopic Lumbar Discectomy with Minimally Invasive Transforaminal Lumbar Interbody Fusion as a Revision Surgery for Recurrent Lumbar Disc Herniation after Percutaneous Endoscopic Lumbar Discectomy. Ther Clin Risk Manag 2020;16:1185–93.

[9] Ahn Y, Lee SH, Park WM, Lee HY, Shin SW, Kang HY. Percutaneous endoscopic lumbar discectomy for recurrent disc herniation: surgical technique, outcome, and prognostic factors of 43 consecutive cases. Spine (Phila Pa 1976) 2004;29(16):E326-332.

[10] Smith JS, Ogden AT, Shafizadeh S, Fessler RG. Clinical outcomes after microendoscopic discectomy for recurrent lumbar disc herniation. J Spinal Disord Tech 2010;23(1):30-4.

[11] Wang J, Zhou Y, Zhang ZF, Li CQ, Zheng WJ, Liu J. Minimally invasive or open transforaminal lumbar interbody fusion as revision surgery for patients previously treated by open discectomy and decompression of the lumbar spine. Eur Spine J 2011;20(4):623-8.

[12] Yao Y, Liu H, Zhang H, Wang H, Zhang C, Zhang Z, et al. Risk Factors for Recurrent Herniation After Percutaneous Endoscopic Lumbar Discectomy. World Neurosurg 2017;100:1-6.

[13] Wang H, Zhou Y, Li C, Liu J, Xiang L. Risk factors for failure of single-level percutaneous endoscopic lumbar discectomy. J Neurosurg Spine 2015;23(3):320-5.

[14] Pan M, Li Q, Li S, Mao H, Meng B, Zhou F, et al. Percutaneous Endoscopic Lumbar Discectomy: Indications and Complications. Pain Physician 2020;23(1):49-56.

[15] Mehren C, Wanke-Jellinek L, Korge A. Revision after failed discectomy. Eur Spine J 2020;29(1):14–21.

[16] Kim MJ, Lee SH, Jung ES, Son BG, Choi ES, Shin JH, et al. Targeted percutaneous transforaminal endoscopic diskectomy in 295 patients: comparison with results of microscopic diskectomy. Surg Neurol 2007;68(6):623-31.

[17] Cheng J, Wang H, Zheng W, Li C, Wang J, Zhang Z, et al. Reoperation after lumbar disc surgery in two hundred and seven patients. Int Orthop 2013;37(8):1511-7.

[18] Yao Y, Zhang H, Wu J, Liu H, Zhang Z, Tang Y, et al. Comparison of Three Minimally Invasive Spine Surgery Methods for Revision Surgery for Recurrent Herniation After Percutaneous Endoscopic Lumbar Discectomy. World Neurosurg 2017;100:641-647.e1.

[19] Ahmed OE, Morad SH, Abdelbar AS. Management of recurrent unilateral lumbar disc herniation in a single level: Unilateral versus bilateral pedicle screws fixation with interbody fusion. Egypt J Neurol Psychiatry Neurosurg 2020;56:28.

[20] Cao J, Huang W, Wu T, Jia J, Cheng X. Percutaneous endoscopic lumbar discectomy for lumbar disc herniation

as day surgery-short-term clinical results of 235 consecutive cases. Medicine (Baltimore) 2019;98:e18064.
[21] Qiao G, Feng M. Revision for endoscopic discectomy: Is lateral lumbar interbody fusion an option? World Neurosurg 2020;133:e26-30.
[22] Kapetanakis S, Gkantsinikoudis N, Charitoudis G. The role of full-endoscopic lumbar discectomy in surgical treatment of recurrent lumbar disc herniation: A health-related quality of life approach. Neurospine 2019;16:96-104.
[23] Li Z, Tang J, Hou S, Ren D, Li L, Lu X, et al. Four-year follow-up results of transforaminal lumbar interbody fusion as revision surgery for recurrent lumbar disc herniation after conventional discectomy. J Clin Neurosci 2015;22:331-7.
[24] Sonmez E, Coven I, Sahinturk F, Yilmaz C, Caner H. Unilateral percutaneous pedicle screw instrumentation with minimally invasive TLIF for the treatment of recurrent lumbar disk disease: 2 years follow-up. Turk Neurosurg 2013;23:372-8.
[25] Wang W, Li J, Xu Y, Luo Y, Ding W, Zhang W. Predictors and tactics for revision surgery in lateral lumbar interbody fusion. BMC Musculoskeletal Disorders 2022;23(1):1101.