



2024

Section: Neurosurgery

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### How to Cite This Article

Barakat, Yosouf; El-Hawary, Magdy Asaad; Shokhaiby, Usama Mohamed El; and Abdou, Ahmed Kamal Abdel-Aaty (2024) "Endoscopic lumbar stenosis decompression through uniportal bilateral approach," *Al-Azhar International Medical Journal*: Vol. 5: Iss. 2, Article 5.

DOI: <https://doi.org/10.58675/2682-339X.2289>

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# Endoscopic Lumbar Stenosis Decompression Through Uniportal Bilateral Approach

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## Abstract

**Background:** Percutaneous endoscopic stenosis lumbar decompression (PESLD) is regarded as a noteworthy therapeutic option for lumbar spinal stenosis (LSS), particularly on the contralateral side, in a satisfactory manner.

**Objective:** To evaluate the efficacy and efficiency of PESLD of LSS through a uniportal–contralateral approach.

**Subjective:** This was a prospective observational study. The patients were admitted to the Neurosurgery Department, Damanhour Educational Hospital, El-Behira Governorate, and Al Hussain Hospital Al Azhar University in Cairo. All patients underwent PESLD through a uniportal–contralateral approach.

**Results:** The preoperative Visual Analogue Scale (VAS) was  $7.3 \pm 0.9$  and decreased significantly postoperative to  $2.4 \pm 1.0$ . Intraoperative data showed that the duration of surgery was  $76.4 \pm 8.7$  min, the blood loss was minimal in 69.6%, mild in 21.7%, and moderate in 8.7%. The postoperative claudication was positive in 43.5%. The incidence of complications was found in six (26.1%) patients, including recurrence, dural tear, and saddle paresthesia. Durotomy was found only in three (13%) patients. The success rate was 73.9%.

**Conclusion:** The initial findings of the uniportal–bilateral PESLD approach exhibit promising outcomes, and the operation demonstrates a relatively safe profile with a tolerable occurrence of potential problems.

**Keywords:** Bilateral lumbar decompression, Endoscopic, Percutaneous, Uniportal

## 1. Introduction

Spinal stenosis can be categorized into two basic classifications: primary stenosis, which is caused by congenital anomalies or disorders that occur during postnatal development, and secondary stenosis (also known as acquired stenosis), which arises from degenerative changes or as a result of local infection or trauma or surgery.<sup>1</sup>

Degenerative lumbar spinal stenosis (LSS), a common pathology in elderly over 60 years old, can anatomically affect several areas, including the central canal, lateral recess, foramina, or a combination thereof. The prevailing symptom associated with lumbar canal stenosis is neurogenic claudication, which is also known as pseudoclaudication. Neurogenic claudication describes leg symptoms involving the buttock, groin, and anterior thigh, and radiates down from the back of the leg to the feet.<sup>2</sup>

Both radicular symptoms and neurogenic claudication are best treated conservatively in the early stages, provided there is no neurological impairment with motor loss and progressive deterioration for the early symptoms or lameness during a short walking test for the latter. In such circumstances, surgical intervention is advised.<sup>3</sup>

The conventional surgical approach for managing LSS involves the utilization of an open, decompressive laminectomy procedure, which may or may not include facetectomy. The utilization of this approach has demonstrated significant efficacy in ameliorating clinical symptoms. However, it is important to note that there is a potential unintended consequence of iatrogenic spinal instability, which may necessitate further surgical intervention to achieve stabilization.<sup>4</sup>

Since several studies have demonstrated comparable outcomes to open laminectomy, minimally

Accepted 24 September 2023.  
Available online 18 April 2024

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<https://doi.org/10.58675/2682-339X.2289>

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invasive spine surgery (MISS) has grown in favor among spine surgeons in recent years. Even though, there is less tissue trauma, a lower risk of complications, less blood loss, a shorter hospital stay, and quicker patient recovery with MISS than with standard surgery. The benefits of low invasiveness must be balanced, nevertheless, against the disadvantages of a constrained vision field and workspace, a challenging learning curve, exposure to radiation, a high cost, and possible drawbacks.<sup>5–7</sup>

Percutaneous endoscopic stenosis lumbar decompression (PESLD) is a MISS that is regarded as an important alternative for surgical approach. PESLD with uniportal–contralateral is a decompression technique that was examined in previous studies, signifying its high efficacy and safety and providing satisfactory results.<sup>8–10</sup> Because the spinous process and ligaments are retained, this approach is linked with reduced muscle injury and enables patients to recover quickly with no iatrogenic instability risk.<sup>8</sup> Applying the uniportal–contralateral approach allows for the decompression of foraminal stenosis, central stenosis, and lateral recess stenosis. Under direct visualization, the uniportal–contralateral PESLD ensures that the spinal segmental motion unit (facet) remains intact by abstaining from facetectomy, even in elderly individuals. This approach additionally enables sufficient visualization of the foramen and lateral recess, particularly on the contralateral side. Finally, this technique offers the advantages of MISS.<sup>9</sup>

Herein, we evaluated the efficacy and efficiency of PESLD of lumbar stenosis through a uniportal–contralateral approach.

## 2. Patients and methods

This study was a prospective observational study for assessing the efficacy of using percutaneous uniportal bilateral lumbar spine decompression as an alternative minimally invasive approach rather than traditional open surgeries. The patients of this study (23 patients) were admitted and operated on between February 2018 and June 2023 in the Neurosurgery Department, Damanshour Educational Hospital, El-Behira Governorate, and the Neurosurgery Department in Al Hussain Hospital Al Azhar University in Cairo.

### 2.1. Inclusion criteria

Secondary degenerative lumbar canal stenosis that involves the central canal, lateral recess, foramina, or any combination of these locations in a single level.

### 2.2. Exclusion criteria

Patients who were represented with primary lumbar canal stenosis, multilevel lumbar canal stenosis, spine instability, e.g., lytic and degenerative spondylolisthesis, secondary nondegenerative lumbar canal stenosis, e.g., after trauma, infection, and surgery, and patients with neurological deficits, e.g., cauda equine or foot drop.

### 2.3. Methods

#### 2.3.1. Preoperative assessment

The personal history of patients and their family history were obtained, encompassing factors such as gender, age, occupation, unique habits, and any concurrent medical issues.

This report aims to provide an overview of historical data pertaining to the occurrence of claudication, radicular pain, nocturnal leg cramps, neurogenic bladder symptoms, as well as sensory issues such as numbness and paresthesia.

#### 2.3.2. Examination

All patients were subjected to general examination, local examination of both lower limbs, and detailed neurological examination.

### 2.4. Radiology

Radiography of the lumbosacral spine in the form of anteroposterior, lateral, oblique (right and left), and dynamic flexion and extension to assess stability, as well as computed tomography (CT) and magnetic resonance imaging (MRI) lumbosacral spine were performed.

### 2.5. Pain assessment

The patient was assessed for preoperative and postoperative pain using the Visual Analog Scale (VAS), modified to inquire about pain on a scale from 0 to 10, 0 means there is no pain, while 10 means ‘worst imaginable pain’.

### 2.6. Intraoperative

The time of surgery, blood loss amount, and dural tear were recorded.

### 2.7. Postoperative

Pain assessment by VAS, hospital stay, CSF leakage, and neurological deficits were reported.

## 2.8. Surgical technique

All surgeries were performed under general anesthesia and in the knee–chest position. After preparation of the surgical site, insertion of a Stienmann pin into the paraspinal musculature was carried out at about 1.5 cm off the midline toward the junction between the facet and the lamina. The site was confirmed using lateral fluoroscopy; thereafter, a 2 cm transverse skin incision was made with the pin in its center; the subcutaneous tissue and lumbar fascia were incised. Microscopic endoscopic tubular retractor system of soft-tissue dilators and tubular retractor of Easy Go system (Karl Storz, Hamburg, Germany) were used. The smallest soft-tissue dilator was inserted over the Stienmann pin, directed toward the inferior edge of the superior lamina, and then the pin was removed.

The next series of dilators were sequentially placed over each other; thereafter, the optimum tubular retractor was placed over the sequential dilators and seated firmly on the bony anatomy; the retractor was then attached to the table by arm assembly.

After exposure was achieved, a small curved curette was used to define the edge of the superior lamina and the facet joint. The muscle fibers that obscure the trajectory were coagulated by bipolar diathermy and removed.

Bone removal with an electric drill or Kerrison Rongeur began on the inferolateral portion of the superior lamina and may proceed to the superolateral portion of the inferior lamina; moreover, partial medial facetectomy may be needed.

This continued until the superior border of the ligamentum flavum (LF) started to appear. After safe dissection from the dura by the dissector, the LF was opened by a dissector and scalpel, and then Kerrison rongeur was used to excise LF until the nerve root was exposed. The root was explored and could be retracted medially either by using a dissector or suction probe; annulotomy was carried out using scalpel blade 11. Free fragments or contained disc herniations were identified and removed in a piecemeal way using disc rongeurs.

Exposure of the contralateral outer boundary of the spinal canal, removal of the contralateral outer layer of LF, exposure of the midline of the LF, removal of the contralateral inner layer of LF, foraminotomy in the cases with foraminal stenosis, removal of the ipsilateral inner layer of LF, and confirmation of the freeness of contralateral and ipsilateral nerve structures were conducted.

Afterward, the nerve root and dural sac were finally checked for complete decompression,

especially in the subligamentous area. Epidural bleeding was controlled with gelfoam. The fascia was then closed by simple interrupted sutures followed by subcutaneous inverted sutures and, finally, the skin was closed with simple or subcuticular sutures. The wound was wiped with betadine and dressed with a sterile dressing. Postoperatively, patients were transferred to the recovery room until full recovery from anesthesia; they were then transferred to the ward and counseled with regard to restart of oral intake and way of mobilization from bed. All patients received intravenous antibiotics and analgesics for 48 h. Patients were discharged as long as there were no complications.

## 2.9. Statistical analysis of the data

Utilizing the IBM SPSS software program, version 24.0, data were input into the computer. Numbers and percentages were used to describe the qualitative data. For properly distributed data, the mean and standard deviation (SD) were used to characterize quantitative data. The 5% level was used to determine the significance of the obtained data.

## 3. Results

**Table 1** demonstrates the demographic data, presenting symptoms and signs, and the level of spinal affection of all patients. The patients' ages ranged from 30 to 70 years with a mean value of  $51.2 \pm 10.4$  years. There were 13 (56.5%) males and 10 females (43.5%). Comorbidities were reported in 12 (52.2%) patients. According to the presenting symptoms, sciatica, lower back pain (LBP), and claudication were observed in 82.6, 82.6, and 78.3%, respectively. Straight leg raising test (SLRT) ranged from 20 to 70° with a mean value of  $45.4 \pm 18.2$ °. Concerning the affected levels, the most affected level was L4–5 in 17 (73.9%) patients.

Concerning the intraoperative data, the time of surgery ranged from 65 to 100 min with a mean value of  $76.4 \pm 8.7$  min. Regarding blood loss, minimal blood loss was higher with 16 (69.6%) followed by mild five (21.7%) and moderate two (8.7%) (**Table 2**).

In terms of postoperative findings, claudication was positive in 43.5%. Complications were found in six (26.1%) patients. Dural tears were higher with three (13.0%), but all 3 cases healed spontaneously without CSF leakage or other complications (meningitis, meningocele). Cases without durotomy were 20 (87%). Two recurrent cases (8.7) underwent open surgeries. One case with saddle paresthesia improved after 2 weeks (**Table 2**).

Table 1. Distribution of the studied cases regarding demographic data, presenting symptoms and signs, and the level of spinal affection of all patients.

Variables	Number (percent)
Age	
<50	9 (39.1)
>50	14 (60.9)
Range	30–70
Mean $\pm$ SD	51.2 $\pm$ 10.4
Sex	
Male	13 (56.5)
Female	10 (43.5)
Comorbidity	
No	11 (47.8)
Yes	12 (52.2)
Diabetes mellitus	4 (17.4)
Hypertension	7 (30.4)
Ischemic heart disease	2 (8.7)
Hepatitis-C virus	1 (4.4)
Presenting symptoms	
Lower back pain	
No	4 (17.4)
Yes	19 (82.6)
Sciatica	
No	4 (17.4)
Yes	19 (82.6)
Claudication	
No	5 (21.7)
Yes	18 (78.3)
Straight leg raising test	
Normal	10 (43.5)
Limited	13 (56.5)
Range	20–70
Mean $\pm$ SD	45.4 $\pm$ 18.2
Levels	
L5–S1	1 (4.3)
L2–3	2 (8.7)
L3–4	3 (13.0)
L4–5	17 (73.9)

Pre- and postoperative VAS scales were assessed. VAS scale significantly reduced after operation ( $P < 0.001$ ) (Table 3).

In our work, the success rate was 73.9%. Fig. 1 represents a female patient in our population with

Table 2. Distribution of the cases regarding the operative data, blood loss, and complications.

Duration of surgery (min)		
<75 min	9	39.1
>75 min	14	60.9
Range	65–100	
Mean $\pm$ SD	76.4 $\pm$ 8.7	
Blood loss		
Minimal	16	69.6
Mild	5	21.7
Moderate	2	8.7
Complication		
No	17	73.9
Yes	6	26.1
Recurrence	2	8.7
Dural tear	3	13.0
Saddle paresthesia	1	4.3

Table 3. Distribution of the studied patients' group regarding Visual Analog Score.

	Preoperative	Postoperative
Visual Analog Score		
Range	6–9	1–5
Mean $\pm$ SD	7.3 $\pm$ 0.9	2.4 $\pm$ 1.0
T-test	5.32	
P-value	0.001*	

preoperative radiological imaging showing disc prolapse and canal stenosis and postoperative radiological imaging showing successful reduction of the prolapse.

#### 4. Discussion

In our study, the preoperative VAS was  $7.3 \pm 0.9$  and decreased significantly postoperative to  $2.4 \pm 1.0$ , indicating promising results concerning pain reduction. Intraoperative data showed that the duration of surgery was  $76.4 \pm 8.7$  min, the blood loss was minimal in 69.6%, mild in 21.7%, and moderate in 8.7%. The postoperative claudication was positive in 43.5%. The incidence of complication was found in six (26.1%) patients, including recurrence, dural tear, and saddle paresthesia. Durotomy was found only in three (13%) patients. The success rate was 73.9%. Overall, our findings showed the efficacy and safety of this approach.

There exist multiple concerns regarding the potential risks associated with PELDS for LSS. Certain surgeons express concerns with the restricted visibility of the dura and nerve roots, alongside the comparatively confined operative area, which may potentially result in dura rips, iatrogenic neurological injuries, and inadequate decompression.

A study found that the overall complication incidence in patients who underwent PELDS was 14.69% and it was comparable to that observed in patients who underwent open laminectomy that was 12.15%. The incidence of revision procedures in the PELDS group was found to be 10.73%, a proportion that did not exhibit a statistically significant difference compared with the open group.<sup>11</sup>

The overall incidence of complications and revision operations was consistent with prior findings. The success rate of PELDS was found to be 86.55%, a comparable figure to that observed for open decompression and fusion surgery. In addition, we conducted PELDS in order to address LSS during its early stages. It is important to note that a lack of expertise and suitable tools may result in an extended surgical intervention, neurological damage, and inadequate decompression. Furthermore, as previously indicated, it is worth noting that

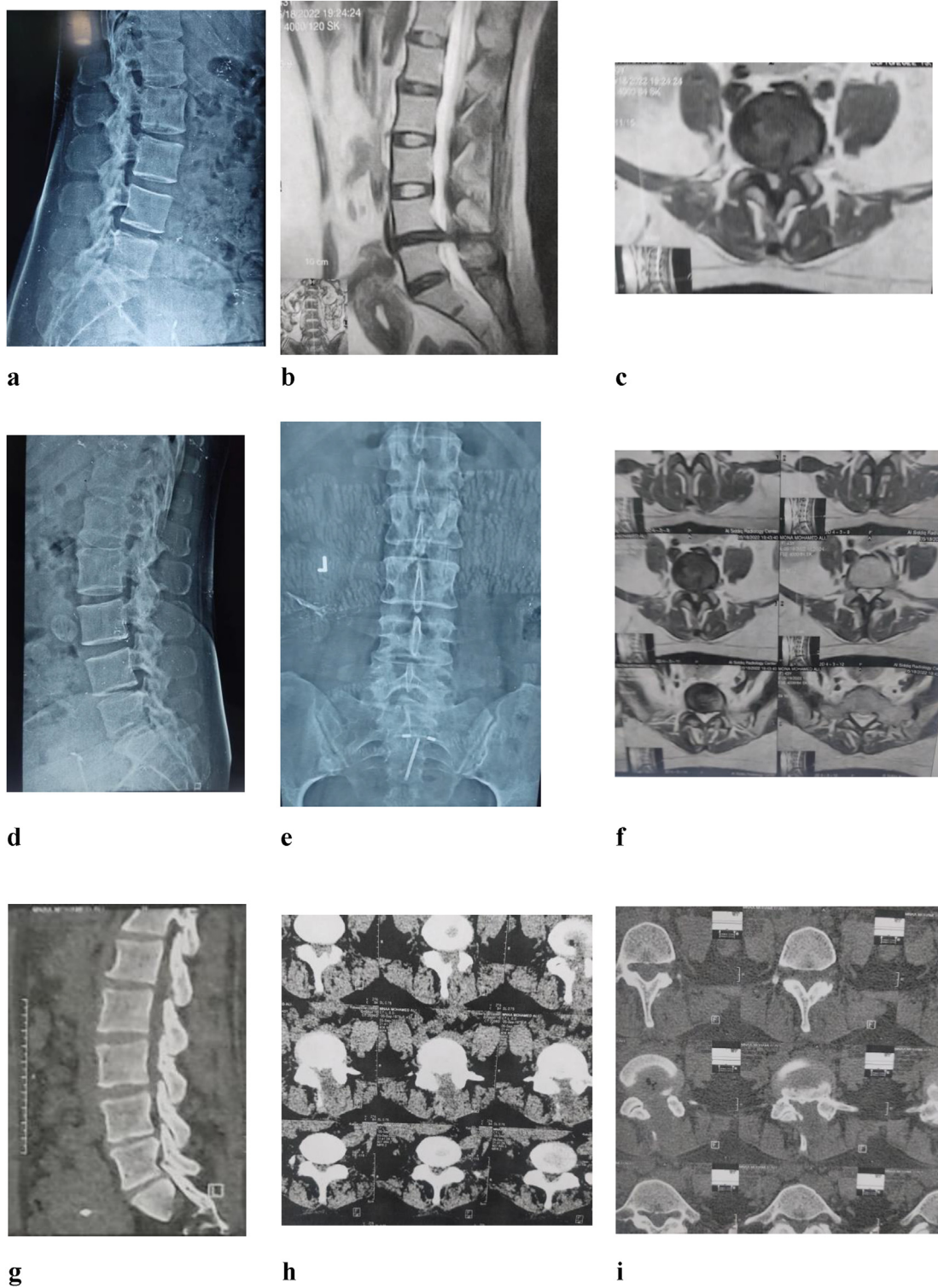


Fig. 1. Female patient aged 60 years old, presented with sciatica, LBP, and claudication. a) Preoperative radiography, b) preoperative sagittal MRI, and c) preoperative axial MRI shows L4–5 disc prolapse causing L4–5 canal stenosis, d) and e) postoperative radiography, f) postoperative sagittal computed tomography, g) and i) postoperative axial computed tomography shows adequate reduction of the prolapse.

PELDS exhibits a significant learning curve (especially in the early stage of learning).<sup>12</sup>

However, effective and appropriate decompression can be achieved by the accumulation of experience and the utilization of advanced tools, such as visualized burrs and trephines. The potential success rate of PELDS for LSS beyond the first learning phase may exceed 86.55%. The procedure was rendered more challenging due to the relatively limited scope of the surgical domain known as PELDS. Moreover, the presence of bone decompression during endoscopic procedures might impede the effective use of endoscopic tools, potentially leading to neurovascular harm and inadequate decompression. This is particularly relevant during the initial stages of the learning process.<sup>13</sup>

The efficacy of transforaminal endoscopic procedures has been documented in disc surgery and unilateral foraminal stenosis; nevertheless, the presence of anatomical constraints poses challenges for treating symptomatic bilateral recess stenosis. This approach demonstrates greater utility in the context of foraminal stenosis and lateral recess stenosis, as opposed to central spinal stenosis. The aforementioned constraints, particularly in the L5–S1 region, encompass a prominent iliac crest, an expansive L5 transverse process, a substantial facet joint, and a constricted intervertebral disc space.<sup>14</sup>

The utilization of endoscopic spinal surgical techniques and tools has led to the reevaluation of previous contraindications, resulting in their transformation into indications for the application of full-endoscopic spinal decompression in the management of lumbar-degenerative disorders. There exist several papers detailing the problems and contraindications associated with complete endoscopic lumbar decompression. Incidental durotomy stands out as the most prevalent complication within this group.<sup>15</sup>

A study reported complications that included dural tears, the patient experienced a postoperative hematoma, neurological complication, and fracture of the inferior articular process. In this study, we observed a complication known as durotomy, which occurred at an incidence rate of 13.0%. Nevertheless, the remaining individuals were not documented.<sup>16</sup>

In 2015, a prospective randomized study was done to compare the efficacy and outcomes of bilateral spinal decompression for lumbar central stenosis using two different surgical approaches: the full-endoscopic interlaminar approach and the microsurgical laminotomy technique. The study is classified as level-1 evidence. The primary exclusion criteria for this study included individuals with significant LBP, foraminal stenosis in the lower level,

fresh soft disc herniations accompanied by bony stenosis, degenerative spondylolisthesis exceeding Meyerding grade I, multidirectional rotation slide, scoliosis exceeding 20°, previous surgical intervention in the same segment, and cauda equina syndrome. In addition, in this study, several problems were seen, including postoperative transitory dysesthesia, transient urine retention, and dura injuries.<sup>17</sup>

Another group of complications was reported in which the observed clinical manifestations were foot dorsiflexion paresis, epidural hematoma, delayed wound healing, and soft-tissue infections. No additional problems, such as spondylodiscitis, cauda equina syndrome, or thrombosis, were seen. Besides acute dysesthesia and transient urine retention, the incidence of complications was found to be 5%, with a notably higher occurrence observed in the microscopic surgery group.<sup>17</sup>

A prospective study examines the outcomes of full-endoscopic-aided lumbar decompressive surgery conducted in an outpatient, ambulatory facility. The study is classified as level-3 evidence. This investigation identified a total of three severe and three minor postoperative problems. The three primary problems observed in this study were instances of early postoperative reherniation, which subsequently necessitated reoperation. The observed mild consequences encompassed two instances of sympathetically mediated pain syndrome and one instance of transitory urine retention.<sup>18</sup>

Another study was conducted to examine a series of reported cases involving contralateral occurrences. In this study, examining the efficacy of the topic of interest is the surgical procedure known as interlaminar keyhole percutaneous endoscopic lumbar surgery (supported by level-4 evidence), a case of epidural hematoma was documented as a consequence following the procedure's endoscopic decompression. It has been observed that epidural hematoma has been documented as a complication in multiple studies, however, our study did not report this complication, although it reported other complications.<sup>19</sup>

A study was conducted retrospectively to investigate the efficacy of percutaneous endoscopic laminotomy with flavectomy using a uniportal, unilateral technique for the treatment of lumbar canal or lateral recess stenosis. This study is classified as level 3-evidence.<sup>20</sup>

The present study excluded certain cases from consideration, including those involving segmental instability and degenerative spondylolisthesis that surpass Meyerding grade I, multidirectional rotation slip, and scoliosis surpassing 20° paired with foraminal stenosis at the same or lower level, along

with instances involving concurrent pathological events, including acute inflammation or infection, or tumor. Additionally, the researchers documented instances of postoperative transitory dysesthesia, lower-extremity motor impairment, dural tears, and recurrent disc problems.

A retrospective study was conducted to investigate the efficacy of full-endoscopic interlaminar decompression, specifically focusing on level-3 evidence. The study included a total of 51 cases. Exclusion criteria encompassed patients exhibiting the individual presents with nonspecific symptoms, indicating the possibility of lateral recess or foraminal stenosis, spondylolisthesis, and a history of previous back surgery, or contraindications to surgery stemming from a bleeding tendency. Nevertheless, there were no instances of significant consequences, e.g., epidural hemorrhage, dural or nerve injury, or infection that were documented.<sup>21</sup>

#### 4.1. Conclusion

The initial findings of the uniportal–contralateral PESLD approach show promising results, with around 80% of patients demonstrating a favorable-to-outstanding outcome. Moreover, the operation exhibits a relatively safe profile, with a moderate occurrence of potential problems. Nevertheless, it is important to conduct an extensive and comprehensive investigation with extended periods of observation in order to obtain more precise and reliable outcomes pertaining to the efficacy of this particular methodology.

#### Conflicts of interest

There are no conflicts of interest.

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