Role of Spine Endoscopy in the Treatment of Lumbosacral Radiculopathy

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Abstract

Background: Minimally invasive spine techniques such as spine endoscopy have emerged as an effective treatment option for cases of lumbar disc prolapse and lumbar canal stenosis, offering reduced postoperative pain and faster recovery.

Objectives: To evaluate the safety and efficacy of spine-endoscopy in cases of lumbosacral radiculopathy caused by lumbar disc prolapse or lumbar canal stenosis.

Patients and methods: This prospective cohort study was conducted at Qena University Hospitals and Ain Shams University Hospitals, Egypt, involving 40 patients with lumbar disc prolapse "LDP" or lumbar canal stenosis "LCS" who underwent endoscopic lumbar surgery. Surgical approaches included percutaneous endoscopic interlaminar discectomy and Percutaneous Endoscopic Interlaminar Lumbar Laminectomy . Clinical outcomes were assessed using the Visual Analogue Scale "VAS", Japanese Orthopaedic Association Back Pain Evaluation Questionnaire "JOABPEQ", Oswestry Disability Index "ODI", and Macnab's criteria at 1-day and 6-month follow-ups.

Results: The study population consisted of 70% male patients with a mean age of 45.15 ± 15.83 years. All patients had low back pain, with 87.5% experiencing sciatica. Primary LDP was the most common pathology (62.5%). Surgical success was high, VAS scores reduced from 8 preoperatively to 0 at 6 months ($p < 0.001$), and ODI improved from 84.9% to 3.6% ($p < 0.001$). JOABPEQ results demonstrated marked functional improvement, with walking ability reaching 100% at 6 months. Macnab criteria indicated excellent outcomes in 80% of patients. Dural tear (15%) was the only encountered complication.

Conclusion: Spine endoscopy is safe and effective for treating lumbosacral radiculopathy, offering significant pain relief, functional recovery, and high patient satisfaction.

Keywords: Endoscopic spine surgery; Lumbar disc prolapse; Lumbar canal stenosis; VAS; JOABPEQ; ODI; Macnab.

DOI: 10.21608/SVUIJM.2025.359823.2114

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Received: 18 February, 2025.
Revised: 26 March, 2025.
Accepted: 27 March, 2025.
Published: 15 June, 2025

Cite this article as Radwan Nouby Mahmoud, Ali Hamdan, Mohamad Abdelraouf Metwally Farrag, Amr Tayel, Omar Yousef Hammad. (2025). Role of Spine Endoscopy in the Treatment of Lumbosacral Radiculopathy. SVU-International Journal of Medical Sciences. Vol.8, Issue 1, pp: 1309-1318.

Introduction

Lumbosacral radiculopathy is a common condition resulting from the compression or irritation of nerve roots in the lower spine, often leading to low back pain, sciatica, and neurological deficits. Open spine surgery has been the primary method of treatment for severe cases where conservative management fails. However, advancements in minimally invasive techniques, such as spine endoscopy, have revolutionized the approach to treating lumbosacral radiculopathy (**Hoy et al., 2010).**

Spine endoscopy offers a less invasive alternative to conventional surgery, utilizing small incisions and specialized instruments to access and treat the affected areas with minimal disruption to surrounding tissues. This technique has gained popularity due to its ability to reduce postoperative pain, and accelerate patient recovery (**Hasan et al., 2019).**

Endoscopic lumbar spine surgery has two approaches, transforaminal approach and interlaminar approach. In the transforaminal approach, a lateral incision through Kambin's triangle is used and indicated for far lateral LDP, on other hand, a paramedian incision through interlaminar space is used and indicated for central and paracentral LDP. Most common used techniques are full endoscopy (single channel that allows only one surgical instrument to be used), and tubular endoscopy (single channel but large enough to allow multiple surgical instruments) **(Simpson et al., 2022).**

Our aim in this study is to evaluate the efficacy and safety of spine-endoscopy in cases of lumbosacral radiculopathy due to lumbar disc prolapse or lumbar canal stenosis.

Patients and methods

This prospective cohort study was conducted at Neurosurgery Department, Qena University Hospitals, South Valley University, Egypt. Ain Shams University Hospitals, Ain shams University, Egypt. The study was conducted on 40 patients complaining of lower limbs radiculopathy due to lumbar disc prolapse or lumbar canal stenosis, underwent endoscopic lumbar surgery.

All subjects included in the study signed a written informed consent. The protocol of the study was approved by the institutional research ethics committee review board.

Ethical Approval Code: SVU-MED-NES014-2-22-4-391

Inclusion criteria

1. Patient age: 16 – 70 years old,
2. Male and Female patients,
3. Patients with body mass index "BMI" ranging from "below 18.5" to 39 (underweight, normal, overweight and obese).
4. Patients with lower limbs radiculopathy caused by lumbar disc prolapse (from L1-S1 disc prolapse either central, paracentral, lateral, subligamentous or epidural at one or two levels) or lumbar canal stenosis, who are refractory to conservative treatments for 2 months (except patients with progressive neurological deficit).
5. Patients with recurrent disc prolapse.

Exclusion criteria

1. Patient age below 16 years old (pediatrics age group according to WHO classification).
2. Patient age over 70 years old (due to low physical activity).
3. Patients with BMI over 39 (morbid obesity)
4. Patients with lower limbs radiculopathy caused by far lateral lumbar disc prolapse.
5. Patients with distinct instability in dynamic radiographs.
6. Patients who have tumors or infections of the spine.

7. Patients with coagulopathies.
8. Patients with comorbidities that contraindicate general anesthesia and local anesthesia.

All patients were subjected to:

- Complete history taking: Personal history, Complaint & its duration, Present history, Past surgical and medical history.
- Physical examinations: General examination and complete neurological examination.
- Investigational Studies: Routine laboratory investigations (Complete blood count, C-reactive protein, Erythrocyte sedimentation rate, Coagulation profile, Liver and kidney functions), Radiological investigations: (X-ray of Lumbosacral Spine "A/P, Lateral and Dynamic", MRI of Lumbosacral Spine).

Procedures

Procedures done are Percutaneous Endoscopic Interlaminar Discectomy "PEILD" and Percutaneous Endoscopic Interlaminar Lumbar Laminectomy "PEILL", in which, under general or spinal anesthesia surgical access is prepared while the patient in prone position. Skin incision: Marking of the targeted lumbar level is done using c-arm imaging (lateral image) as shown in **(Fig.1)**, followed by sterilization of the skin incision site.

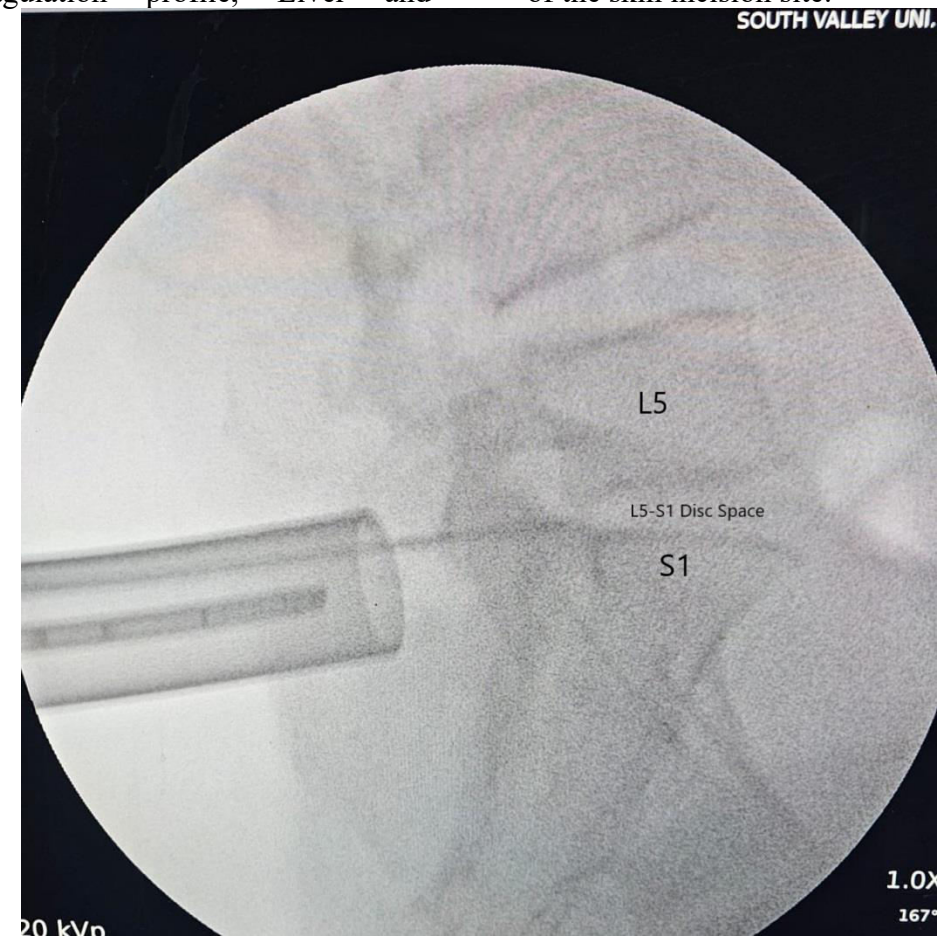

Fig.1. Intra-operative x-ray "lateral view" showing the site of PEILD at L5-S1.

The entry point is 5mm off the midline as a transverse skin incision which is cosmetically better, followed by longitudinal incision of deep fascia then K wire is inserted through the entry point under image control avoiding interlaminar

penetration or violation of dura. Insertion of Sequential Dilators: Dilators are inserted sequentially, all under image control. Insertion of Endoscope Lens: inserting the endoscopic lens through the attachment using regular irrigation to make sure of four bony borders rectangle that must be identified: 1- lower border of upper lamina superiorly, 2- upper border of lower lamina inferiorly, 3- spinous process medially 4- facet joint laterally. Laminectomy: Removal of soft tissues attaching to lamina followed by excision of lateral third of the ligamentum flavum, starting either interlaminar without laminectomy if interlaminar space is 14-18 mm diameter or using Kerrison for laminotomy only or hemilaminectomy depending on learning curve and experience of surgeon. At this step we do foraminotomy to expose and identify the root.

Discectomy: in PEILD, discectomy of 1 or 2 levels are done using a single skin incision "Uniportal" moving the endoscope along the vertical axis up and down to reach double level under image, starting to identify the disc bulge under image control then opening of disc capsule using endoscopic knife or endoscopic scalpel. Removing all disc fragments by disc rongeurs straight and up. We follow the rule of Navigation 5 ; navigating for missed fragments at 5 sites: 1-subligamentous site at undersurface of posterior longitudinal ligament, 2-antetior epidural site between posterior longitudinal ligament and dura, 3-posterior epidural between ligamentum flavum and posterior dura, 4-lateral site at lateral corner of disc space, 5-intradiscal site , sometimes disc fragments present at multicompartmental simultaneously.

Lumbar Canal Stenosis: For lumbar canal stenosis we use Uniportal bilateral PEILL, by moving the endoscope along the transverse axis under image control to do bilateral decompression for spinal canal. We move the endoscope along both transverse and longitudinal axis to deal with both bilateral and multiple levels at the same time though one port only.

Closure: At the end of procedure, we use frequent irrigation then we put GELFOAM for heamostasis. For dural tear we put fat Graft. The tamponading effect of muscle and deep fascia works as escalator door preventing CSF leak. One or two stitches of muscle then closure of lumbodorsal fascia longitudinally then subcutaneous tissue then subcuticular for skin incision is done **(Sebben et al., 2021).**

Outcome measures

- Technical success (Endoscopic discectomy without any residual fragment, Foraminotomy and good decompression of the canal stenosis without complications).
- Clinical success (cured lower limbs radiculopathy, improved lower back pain, improvement of neurological deficit according to type and time).
- Technical failure (Intraoperative and post-operative complications will be assessed)

Follow up

- Clinical follow up on monthly visits at outpatient clinic.
- Visual Analogue Scale 'VAS' **(Klimek et al., 2017),** Japanese Orthopaedic Association Back Pain Evaluation Questionnaire 'JOABPEQ' **(Fukui et al., 2009)**, Oswestry Disability Index 'ODI' **(Fairbank and Pynsent, 2000)**, and Macnab's outcome score **(Macnab, 1971)** will be done 1 day post operative, and 6 months post operative.
- Post operative imaging: 1-Immediate post-op lumbosacral x-ray and regular on every follow up visit, 2-Lumbosacral MRI or CT scan (if needed).

Statistical analysis

SPSS v26 was used for statical analysis. Mean and standard deviation (SD)

were used to present quantitative parametric data. Median and interquartile range (IQR) were used to report quantitative non-parametric data. Percentage (%) was used to report qualitative variables. Statistical significance was considered when P value is less than 0.05.

Results

The age of studied patients ranged from 19 to 74 years with a mean value (± SD) of 45.15 (±15.83) years. The study included 28 (70%) males and 12 (30%) females as shown in **(Table.1)**.

Table 1. Age and gender (n=40)

(n = 40)		
Age (years)	Mean ± SD	45.15 ± 15.83
	Range	19 - 74
Sex	Male	28 (70%)
	Female	12 (30%)

Four (10%) patients had diabetes mellitus, 3 (7.5%) patients suffered from hypertension, 2 (5%) patients suffered from ischemic heart disease, while 31 (77.5%) patients did not have history of any chronic disease as reported in **(Table.2)**.

Table 2. Chronic diseases (n=40)

Chronic Disease	**(n = 40)**
Diabetes mellitus	4 (10%)
Hypertension	3 (7.5%)
Ischemic heart disease	2 (5%)
No history of chronic diseases	31 (77.5%)

In our study, 40 (100%) patients had LBP, 35 (87.5%) patients had sciatica, and 5 (12.5%) patients had claudication pain as shown in **(Table.3)**.

Table.3. Types of pain symptoms (n=40)

Type of pain symptoms in the studied patients	**(n = 40)**
Low Back Pain	40 (100)
Sciatica	35 (87.5%)
Claudication pain	5 (12.5%)

The median duration for low back pain was 12 months, for sciatica was 4 months and for claudication pain was 6 months as presented in **(Table.4)**.

Table 4. Duration of Pain symptoms (n=40)

Type of pain in the studied patients	**Median of Durations "months"**
Low Back Pain	12
Sciatica	4
Claudication pain	6

In our study, 23 (57.5%) patients had lower limbs weakness while 17 (42.5%) patients had intact motor power. All patients 40 (100%) had intact sensation and sphincteric functions as shown in **(Table.5)**.

Table 5. Findings of motor power, sensation and sphincteric functions (n=40)

(n = 40)		
Motor power	Intact	17 (42.5%)
	Weakness	23 (57.5%)
Superficial and deep touch	Intact	40 (100%)

	Disturbed	0 (0%)
Sphincteric Functions	Intact	40 (100%)
	Disturbed	0 (0%)

The preoperative imaging findings in the studied patients were lumbar disc prolapse in 25 (62.5%) patients, recurrent lumbar disc prolapse in 10(25%) patients and lumbar canal stenosis in 5 (12.5%) patients as presented in **(Table.6)**.

Table 6. Preoperative imaging findings (n=40)

Imaging findings	**(n = 40)**
Lumbar Disc Prolapse	25 (62.5%)
Recurrent Lumbar Disc Prolapse	10(25%)
Lumbar Canal Stenosis	5 (12.5%)

The type of surgery done in the studied patients was Percutaneous Endoscopic Interlaminar Discectomy "PEILD" in 31 (77.50%) patients, Uniportal 2 levels PEILD in 4 (10%) patients, Uniportal Bilateral Percutaneous Endoscopic Interlaminar Lumbar Laminectomy "PEILL" in 2 (5%) patients, Uniportal 2 levels Bilateral PEILL in 2 (5%) patients, Uniportal 3 levels Bilateral PEILL in 1 (2.50%) patient as reported in **(Table.7)**.

Table 7. Types of performed surgeries (n=40)

Surgery	**(n = 40)**
PEILD	31 (77.50%)
Uniportal 2 levels PEILD	4 (10%)
Uniportal Bilateral PEILL	2 (5%)
Uniportal 2 levels Bilateral PEILL	2 (5%)
Uniportal 3 levels Bilateral PEILL	1 (2.50%)

Dural tear occurred in 6 (15%) patients, 34 (85%) patients did not have any other Surgical complications (neurological deficit, missed level, epidural hematoma) as shown in **(Table.8)**.

Table 8. Surgical complications (n=40)

Surgical complications	**(n = 40)**
Dural Tear	6 (15%)
No Complications	34 (85%)

The Visual analogue scale "VAS" was significantly lower at 1 day operative and 6 months operative than pre-operative($p < 0.001$) as shown in **(Table.9)**.

Table 9. Visual analogue scale "VAS" results (n=40)

Variables		**Pre-operative**	**1day post-operative**	**6 months post-operative**
VAS	**Median**	8	2	0
	IQR "Interquartile range"	7.75 - 9	1.75 - 3	0 - 1
P			< 0.001	< 0.001

The Oswestry Disability Index was significantly lower at 1 day post-operative and 6 months post-operative than pre-operative ($P < 0.001$) as presented in **(Table.10)**.

Table 10. Oswestry Disability Index results (n=40)

Variables		Pre-operative	1 day post-operative	6 months post-operative
Oswestry Disability Index (%)	**Mean ± SD**	84.9 ± 10.38	30.9 ± 3.93	3.6 ± 2.76
	Range	64 - 98	24.4 - 35.5	0 - 8
P			< 0.001	< 0.001

The low back pain, lumbar function, walking ability, social life function and mental health scores showed significant improvement at 1 day post-operative and 6 months post-operative than preoperative (P < 0.001) as presented in **(Table.11)**.

Table 11. The Japanese Orthopedic Association Back Pain Evaluation Questionnaire "JOABPEQ" Scores (n=40)

Variables		Pre-operative	1 day post-operative	6 months post-operative
Low Back Pain	**Mean ± SD**	27.9 ± 18.54	46.8 ± 17.78	90 ± 12.34
	Range	0 - 57	14 - 71	71 - 100
P			< 0.001	< 0.001
Lumbar function	**Mean ± SD**	13.9 ± 21.98	63.3 ± 14.31	91.6 ± 11.32
	Range	0 - 75	42 - 83	67 - 100
P			< 0.001	< 0.001
Walking ability	**Mean ± SD**	5.3 ± 8.35	57.9 ± 20.08	100 ± 0
	Range	0 - 21	21 - 71	100 - 100
P			< 0.001	< 0.001
Social life function	**Mean ± SD**	18.9 ± 11.86	51.3 ±17.14	94.5 ± 9.65
	Range	3 - 43	19 - 65	78 - 100
P			< 0.001	< 0.001
Mental health	**Mean ± SD**	23.8 ± 11.37	55.1 ± 9.48	87.1 ± 4.65
	Range	9 - 42	42 - 66	80 - 91
P			< 0.00	< 0.001

Excellent Macnab was significantly higher at 6 months post-operative than 1 day post-operative (P < 0.001) as shown in **(Table 12)**.

Table 12. Macnab's assessment of patient satisfaction (n=40):

(n = 40)		1 day post-operative	6 months post-operative
Macnab	**Excellent**	18 (45%)	32 (80%)
	Good	22 (55%)	8 (20%)
P			< 0.001

There were no cases of recurrent disc prolapse at the end of follow up period (6 months post operative) as reported in **(Table.13)**.

Table 13. Rate of recurrent disc prolapse at the end of follow up period (n=40):

Variable	6 months post-operative
Recurrent disc prolapse	0 (0%)

Discussion

This study evaluated safety and efficacy of spine-endoscopy in treating lumbosacral radiculopathy, focusing on both clinical outcomes and patient satisfaction.

Our study population comprised predominantly male patients (70%), with a mean age of 45.15 ± 15.83 years.

In accordance, **Huang et al. (2024**) reported 80 patients with Lumbar disc herniation in a cohort study, with an average age of 47.8 ± 16.8 years, included 53 males and 27 females.

In our study, all patients (100%) were presented with low back pain, with a high proportion (87.5%) experiencing sciatica. The distribution of pathologies showed a predominance of primary LDP (62.5%), followed by recurrent LDP (25%) and LCS (12.5%).

This distribution pattern is similar to that reported by **Chen et al. (2023**), who found primary disc herniation to be the most common indication for endoscopic spine surgery.

In our study, the surgical approaches employed in our study included PEILD (77.50%), Uniportal 2 levels PEILD (10%), Uniportal Bilateral PEILL (5%), Uniportal 2 levels Bilateral PEILL (5%) and Uniportal 3 levels Bilateral PEILL (2.50%). This distribution reflects the versatility of endoscopic techniques in addressing various spinal pathologies.

Our approach selection aligns with recent trends in minimally invasive spine surgery, as documented by **Choi et al. (2013),** who reported successful outcomes with patients who underwent percutaneous endoscopic interlaminar lumbar discectomy or percutaneous endoscopic transforaminal lumbar discectomy.

In our study, the VAS scores showed significant improvement from a median of 8 preoperatively to 0 at 6 months postoperatively ($p < 0.001$).

A Meta-Analysis by **Kim et al. (2018)** that included studies with fellow-up periods ranged from 12 months to 42 months, revealed that percutaneous endoscopic lumbar discectomy had significantly better VAS results compared to open lumbar microdiscectomy at the final follow-up.

In our study, the Oswestry Disability Index improved from 84.9% preoperatively to 3.6% at 6 months postoperatively ($p < 0.001$).

Meng et al. (2021) reported that the ODI also decreased from 60.2 ± 7.3 to 17.9 ± 3.4 at 6 months after the interlaminar endoscopic spine system surgery.

In a study with a mean follow up of 19.7 months reported by **Sun et al. (2020)** of patients with lumbar canal stenosis that underwent endoscopic lumbar surgery, Oswestry Disability Index “ODI” showed significant improvement with maintenance of lumbar stability.

In our study, the JOABPEQ results demonstrated significant improvements across all domains: Low back pain, Lumbar function, Walking ability, Social life function and Mental health. In a study of patient with lumbar canal stenosis that underwent endoscopic lumbar spine laminectomy reported by **Sun et al. (2020)**, Japanese Orthopedic Association scores showed significant improvement.

Yoshikane et al. (2021) reported that JOABPEQ scores improved significantly post operatively in patients that underwent endoscopic unilateral lumbar laminotomy for decompression of lumbar canal stenosis without degenerative spondylolisthesis.

In our study, the Macnab criteria results showed excellent outcomes in 80% of patients at 6 months, with the remaining 20% reporting good outcomes. This high satisfaction rate is comparable to or better than those reported in similar studies.

In a study by **Choi et al. (2016)** comparing the results of percutaneous endoscopic discectomy and open microdiscectomy, the surgical satisfaction rate of the "percutaneous endoscopic discectomy" group was significantly higher than that of the "open microdiscectomy" group.

Meng et al. (2021) reported excellent Macnab score (86.4%) post interlaminar endoscopic spine surgery.

The complication rate in our study was relatively low. Dural tear was the highest reported complication (15%). However, our study showed no instances of missed levels, epidural hematoma, infection nor recurrent disc prolapse at the end of the follow up period, which are significant advantages compared to conventional techniques.

Choi et al. (2016) reported that there were no peri-operative complications in a study that compared results of patients with large lumbar disc prolapse treated by either percutaneous endoscopic discectomy or open microdiscectomy.

In a prospective randomized controlled "RC" study reported by **Ruetten et al. (2009)**, results of patients with degenerative lateral recess stenosis and were treated with either conventional microsurgery or full endoscopic spine surgery showed that the rate of complications was significantly lower in the full endoscopic spine surgery group than the conventional group (5% vs. 11%).

Conclusion

Spine-endoscopy is safe and effective for treating lumbosacral radiculopathy caused by lumbar disc prolapse or lumbar canal stenosis, with significant improvement of pain, function, and quality of life measures.

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