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Ipsilateral Interlaminar Uniportal Endoscopic Approach for L5–S1 Foraminal Decompression: Step-by-Step Technique and Surgical Pearls

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ABSTRACT

Objective: *To describe a novel ipsilateral interlaminar uniportal endoscopic approach for L5–S1 foraminal decompression that enables both lateral recess and foraminal decompression through a single interlaminar window.*

Methods: *Five patients with unilateral L5–S1 foraminal stenosis and radiculopathy unresponsive to conservative therapy underwent endoscopic decompression using the ipsilateral interlaminar approach. The technique involves the surgeon initially standing ipsilateral for lateral recess decompression and then switching to the contralateral side to complete foraminal decompression through the same portal.*

Results: *All five patients tolerated surgery well and were discharged the same day. Postoperative follow-ups at 2 weeks, 6 weeks, 3 months and 6 months demonstrated improved pain scores. The technique provided direct visualization of the traversing and exiting nerve roots, allowed adequate decompression with minimal bone resection, and eliminated the need for a separate transforaminal window.*

Conclusion: *The described ipsilateral interlaminar uniportal endoscopic approach provides a safe and efficient alternative for L5–S1 foraminal decompression, overcoming limitations of the transforaminal route in cases with a high iliac crest. The method is intuitive for surgeons familiar with interlaminar endoscopy and offers optimal decompression through a single portal. Larger prospective studies are warranted to validate these findings.*

Keywords

Endoscopic spine surgery, Uniportal endoscopy, Interlaminar approach, L5-S1, Foraminal stenosis, Foraminal decompression, Lumbar radiculopathy.

Introduction

Endoscopic spine surgery has emerged as a valuable minimally invasive option for lumbar pathology [1]. Uniportal endoscopic systems allow targeted decompression with reduced soft-tissue trauma. Although foraminal and extraforaminal pathologies are typically approached transforaminally [2], the L5–S1 level poses unique challenges due to the high iliac crest and steep disc angle [3]. In males and patients with deep-seated foramina, transforaminal access becomes particularly restrictive.

Alternative routes have been explored. The trans-iliac approach [4] creates a bony window through the ilium but increases risk to the superior gluteal bundle. Interlaminar techniques [5] are familiar to most spine surgeons but are usually employed for central or paracentral pathology. The contralateral interlaminar endoscopic lumbar foraminotomy (ICELF) [6,7] allows foraminal access but is technically demanding due to unfamiliar visualization angles.

We present a novel ipsilateral interlaminar uniportal endoscopic technique for L5–S1 foraminal decompression/discectomy (IILFD). This approach enables the surgeon to decompress both

the lateral recess and the foramen through one interlaminar window by simply changing operating position, thus overcoming the limitations of conventional transforaminal access.

Methods

We have included total five patients who underwent IILFD procedure between December 2024- January 2026 (Table 1). All patients included in the report received conservative treatment including but not limited to physical therapy (PT), non-steroidal anti-inflammatory (NSAID) medication and transforaminal epidural spinal injection (TFESI). Visual analogue score (VAS) was utilized for the quantitative measurement of the radiculopathy. VAS was recorded preoperative and postoperatively (at 6 months follow-up).

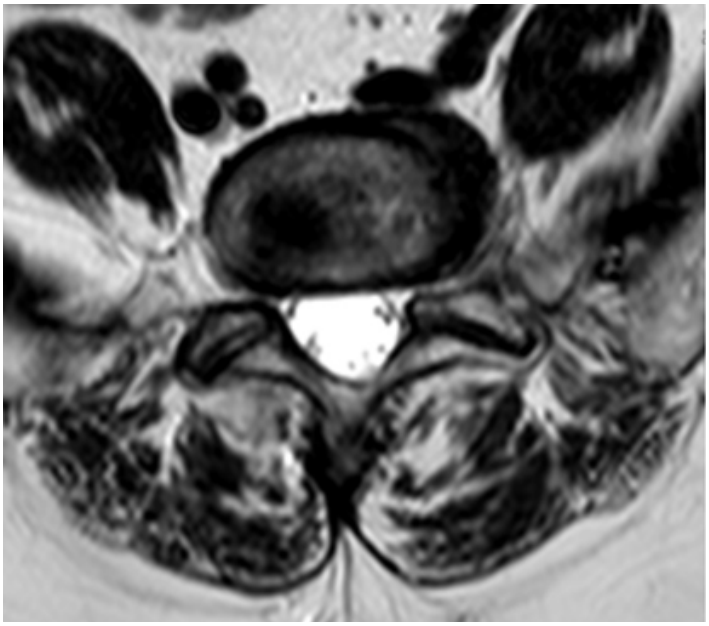


Figure 1A: T2 Sequence axial section through L5-S1 demonstrating left sided hypertrophied facet joint causing lateral recess stenosis.



Figure 1B: T2 Sequence sagittal section through L5-S1 demonstrating left sided foraminal stenosis.

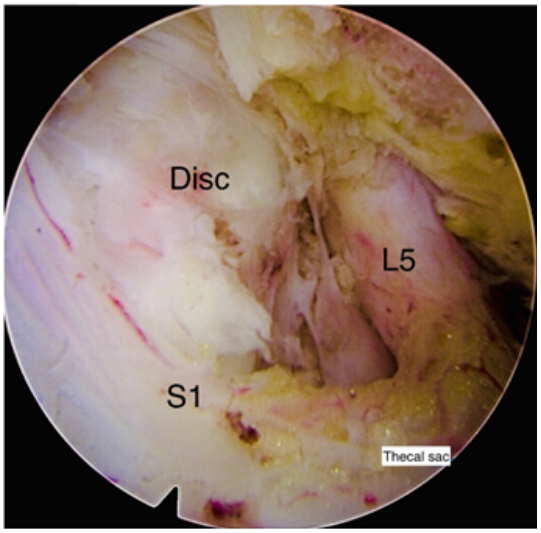


Figure 1C: Intraoperative picture demonstrating satisfactory decompression of S1 traversing and L5 exiting nerve root.

Table 1: Case reports.

Case	Age/Sex	Radiculopathy	Radiological presentation	Conservative treatment	Surgery	Preop VAS	Postop VAS (At 6 months)
1	67/F	Left L5	Left L5-S1 foraminal stenosis (Figure 1A, 1B)	NSAIDS, PT, TFESI	Left IILFD L5-S1 (Figures 1C, 1D)	9	1
2	69/M	Left L4, L5	Degenerative scoliosis, left L4-5 and L5-S1 Foraminal stenosis (Figure 2A, 2B)	NSAIDS, PT, TFESI	Left TELD L4-5, Left IILFD L5-S1 (Figure 2C)	8	0
3	76/F	Right L5	Degenerative scoliosis, right L5-S1 foraminal stenosis (Figure 3A, 3B)	NSAIDS, PT, TFESI	Right IILFD (Figure 3C)	7	0
4	47/F	Right L5	Right foraminal disc herniation L5-S1	NSAIDS, PT, TFESI	Right IILFDD	10	0
5	61/M	Right L5	Right foraminal stenosis L5-S1	NSAIDS, PT, TFESI	Right IILFDD	7	1

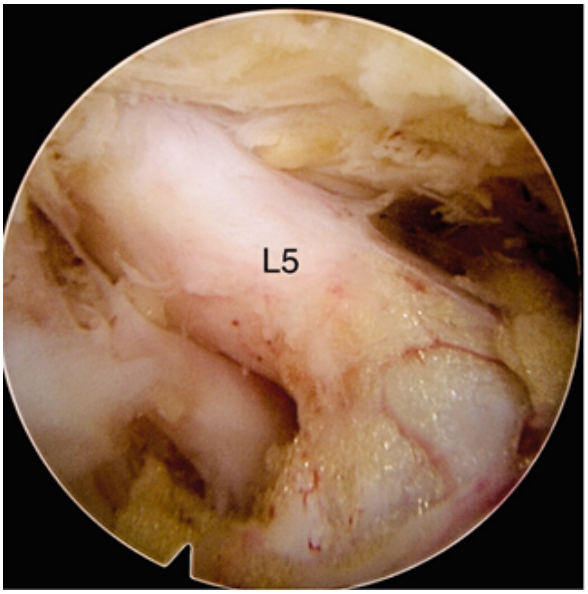


Figure 1D: Intraoperative picture demonstrating effective foraminal decompression.

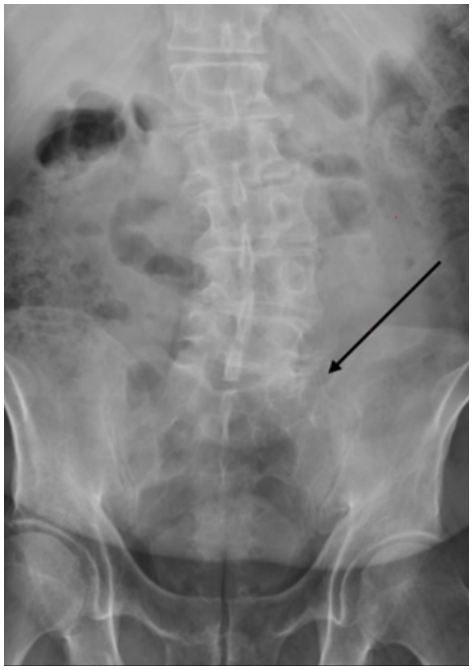


Figure 2A: Anteroposterior radiograph of the lumbar spine demonstrating a fractional coronal curve with asymmetric collapse of the L4–L5 and L5–S1 disc spaces, leading to foraminal stenosis. Concavity of the fractional curve makes the transforaminal access (Black arrow) even more challenging.



Figure 2B: T2 Sequence sagittal section through L5-S1 demonstrating left sided foraminal stenosis.

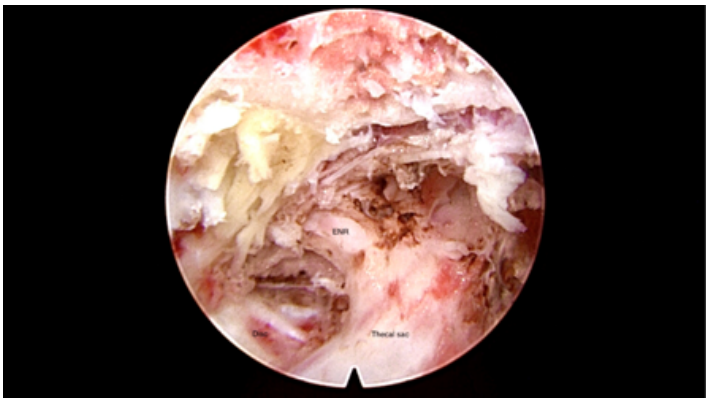


Figure 2C: Intraoperative picture demonstrating satisfactory foraminal decompression L5 exiting nerve root.



Figure 3A: Anteroposterior radiograph of the lumbar spine demonstrating a fractional coronal curve with asymmetric collapse of L5–S1 disc spaces,

leading to foraminal stenosis on the right side.



Figure 3B: T2 Sequence sagittal section through L5-S1 demonstrating right sided foraminal stenosis.



Figure 3C: Intraoperative picture demonstrating satisfactory foraminal decompression L5 exiting nerve root.

Surgical Technique

After induction of general anesthesia, the patient is positioned prone on a radiolucent Wilson frame to reduce lumbar lordosis and open the interlaminar window. All bony landmarks are confirmed using anteroposterior (AP) and lateral fluoroscopy. The abdomen is kept free to minimize epidural venous pressure.

Step 1: Localization and Skin Entry

Under C-arm guidance, the target is the medial border of the L5–S1 facet joint, specifically the lower third of the interlaminar window on the affected side. A radiopaque instrument is used to confirm the trajectory on both AP and lateral fluoroscopy. The ideal trajectory targets the L5–S1 disc space with a 10°–15° caudal-to-cranial angle. This angulation fully utilizes the interlaminar corridor and minimizes bony resection from the lamina and inferior articular process (IAP).

After infiltration with local anesthetic, a spinal needle is advanced toward the target under live fluoroscopy. Once the needle tip contacts the medial border of ipsilateral facet joint, its position is confirmed in two planes. The skin entry point is marked and an 8 mm longitudinal incision is made using a No. 11 blade through skin and fascia.

Step 2: Dilation and Docking

A serial dilator system is inserted along the planned trajectory until bone contact is achieved at the medial edge of facet joint. A working sleeve (7.9 mm outer diameter) is then advanced and docked over the lamina and facet junction. The Arthrex uniportal endoscope (outer diameter 7 mm, working channel 4.3 mm, 30° lens, continuous irrigation) is inserted. Constant saline irrigation maintains a clear view and hemostasis through hydrostatic tamponade.

Step 3: Exposure and Identification of Landmarks

Soft tissue and muscle fibers within the interlaminar space are cleared using endoscopic radiofrequency ablation and pituitary rongeurs. The key anatomical landmarks are sequentially identified:

- The L5 lamina superiorly
- The inferior articular process (IAP) laterally
- The superior border of S1 lamina
- The ligamentum flavum (LF) centrally

Step 4: Laminotomy and Lateral Recess Decompression

A 3.0 mm Arthrex side-cutting diamond burr with a retractable safety hood is used to create a laminotomy at the inferior border of L5 and medial one-third of the IAP. Medial border of the superior articular process (SAP) is exposed and shaved to expose Superior S1 lamina and SAP junction. After adequate bony work, The LF is exposed from the inferior border of L5 to the superior aspect of S1.

The ligamentum flavum is then resected in a piecemeal manner using a cutting endoscopic punch and 3.0 mm Kerrison rongeurs, maintaining a plane between the LF and the underlying dura. Upon resection, the traversing S1 nerve root and the thecal sac are visualized. The lateral recess is decompressed by following the S1 nerve root distally to its foramen, confirming free mobility and dural pulsation (Figure 1C).

Step 5: Transition to Foraminal Decompression

At this stage, the surgeon moves to the contralateral side of the table while maintaining the same portal. This change of position allows a direct viewing angle into the L5–S1 foramen from medial to lateral. Shifting of the endoscopic tower or using a secondary monitor may be required to maintain the visualization without excessive turning of the neck.

Using the endoscope, the laminotomy is extended laterally toward the pedicle of L5. The exiting L5 nerve root (ENR) is identified beneath a thin epineural fat pad, which serves as a key orientation

landmark. The fat pad is gently teased away with blunt dissectors to reveal the foraminal roof.

A high-speed burr is again utilized to undercut the foraminal roof and resect the hypertrophied portion of the superior articular process. Kerrison rongeurs remove the lateral and foraminal attachment of the LF. Turning the camera head towards one side and/or the other keeps the tip of the instruments under direct visualization. The decompression is considered adequate when the foraminal portion of the ENR can be visualized without any residual impingement of the nerve (Figure 1D and Figure 2C). Case 4 required foraminal discectomy which was accomplished after adequate foraminal bony work.

Step 6: Hemostasis and Closure

Minor bleeding from epidural vessels is controlled with radiofrequency coagulation or irrigation pressure adjustments. The surgical field is inspected for residual bone spicules or loose fragments. After confirming decompression, the working sheath is withdrawn, and the incision is closed in one or two subcuticular layers without a drain.

Discussion

The existing literature is summarized in Table 2. Foraminal decompression at L4–5 and higher levels is readily performed using transforaminal endoscopy [8]. However, the L5–S1 level is anatomically complex due to the high iliac crest, narrow interpedicular distance, and oblique disc angle [9]. These factors restrict the instrument trajectory and visualization, particularly in male patients or those with a deep-seated pelvis.

Multiple technical modifications have been described to overcome these obstacles. The trans-iliac approach [4] allows direct access to the foramen but places the entry portal near the superior gluteal neurovascular bundle, potentially increasing morbidity. Furthermore, the rigid bony corridor limits cannula mobility, making it difficult to combine lateral recess decompression through the same route. The transforaminal trans-SAP approach [10] avoids a trans-iliac window but requires extensive resection of the superior articular process, which may compromise facet integrity and segmental stability. Because of the concavity of the fractional curve at L5-S1 disc level, the disc space becomes even more deep and difficult to access precluding the utility of the transforaminal approach (Figure 2A). The contralateral interlaminar endoscopic lumbar foraminotomy (ICELF) technique [6] provides good visualization of the ventral foramen, yet it demands significant adaptation to an unfamiliar contralateral working angle and has a steeper learning curve. There are also ipsilateral interlaminar approach described for the foraminal decompression [11]. However, unlike the ipsilateral technique described by us these authors performed the foraminal decompression by standing on the ipsilateral side. Without switching the side, one may not accurately assess the foraminal structures which may not only require excessive bony resection but can also lead to incomplete decompression.

Our ipsilateral interlaminar approach combines the strengths of familiarity and anatomical orientation. The technique begins with a conventional interlaminar decompression — a procedure most endoscopic surgeons are already comfortable performing — and then transitions seamlessly into foraminal work by simply repositioning the surgeon to the contralateral side. This shift improves visualization of the exiting nerve root and the foraminal roof facilitating an effective foraminal decompression.

From an anatomical standpoint, the L5–S1 interlaminar window is the widest in the lumbar spine, often exceeding 12 mm in the vertical dimension [12]. This natural corridor makes it well suited for ipsilateral interlaminar endoscopic access, provided the trajectory is optimized. Utilizing a 10–15° cranial angulation allows the surgeon to fully exploit this window, thereby reducing the need for bony resection while maintaining stability of the facet complex.

In terms of ergonomics, changing the surgeon's position to the contralateral side after completing the lateral recess work provides a direct view down the L5–S1 foramen. This perspective simplifies identification of the exiting nerve and the overlying

Table 2: Comparative analysis of L5-S1 foraminal decompression techniques

Technique	Advantage	Disadvantage
Transiliac [4]	• Direct access to the foramen avoiding the ENR	• Risk of superior gluteal neurovascular injury • Rigid bony window limits maneuverability • Lateral recess decompression may need separate incision
Transforaminal Trans-SAP [10]	• Avoids trans-iliac route	• Excessive SAP resection may destabilize the facet joint • Risk of ENR injury due to the steep trajectory to the foramen
Contralateral approach (ICELF) [6]	• Addresses both lateral recess and foraminal pathology	• Technically demanding • Unfamiliar orientation
Ipsilateral interlaminar approach (by Moscatelli et al.) [11]	• Addresses both lateral recess and foraminal pathology • Familiar approach	• May require excessive bony resection • Incomplete foraminal decompression
Current technique	• Addresses both lateral recess and foraminal pathology • Familiar approach • Effective foraminal decompression with minimal bony resection	• Added learning curve to adapt to opposite-side orientation

foraminal ligamentum flavum, enabling controlled decompression under continuous visualization. The maneuver may initially feel counterintuitive, but with familiarity, it significantly enhances safety and confidence during foraminal work.

Regarding the learning curve, the approach requires orientation to a mirrored anatomical view when standing contralateral to the pathology. Surgeons experienced in standard interlaminar endoscopic decompression typically adapt within a few cases.

Potential indications for this technique include isolated or combined lateral recess and foraminal stenosis at the L5–S1 level, particularly in patients with a high iliac crest, a steep L5–S1 disc angle, or increased obliquity of the L5–S1 disc space secondary to scoliotic fractional curves. These anatomic configurations can severely restrict the working corridor of the transforaminal approach, making direct access to the foramen difficult or unsafe. In such cases, the ipsilateral interlaminar uniportal endoscopic approach provides a safer and more ergonomic alternative that allows complete decompression through a single interlaminar window without requiring excessive bone removal or multiple portals. Case 3 illustrates, the disc space shifts deeper making the access angle through transforaminal approach very steep (Figure 3A) and challenging which in turn may increase the risk of exiting nerve root injury. The aforementioned technique is a safe alternative in this patient group.

Finally, while both cases in this report demonstrated excellent outcomes, larger clinical series and biomechanical studies are warranted to validate long-term safety, recurrence rates, and comparative outcomes versus transforaminal and contralateral interlaminar techniques. Future work could also quantify operative time, blood loss, and postoperative recovery to better define its efficiency in clinical practice.

Conclusion

The ipsilateral interlaminar uniportal endoscopic approach for L5–S1 foraminal decompression is a safe, effective, and intuitive method for endoscopic spine surgeons. It allows comprehensive decompression of both lateral recess and foramen through a single portal. With further validation in larger cohorts, this approach may become a preferred minimally invasive solution for challenging L5–S1 foraminal stenosis.

Ethical Approval

All procedures performed were in accordance with institutional and national research committee standards and with the 1964 Helsinki declaration and its later amendments.

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