Technical Note

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Special issue

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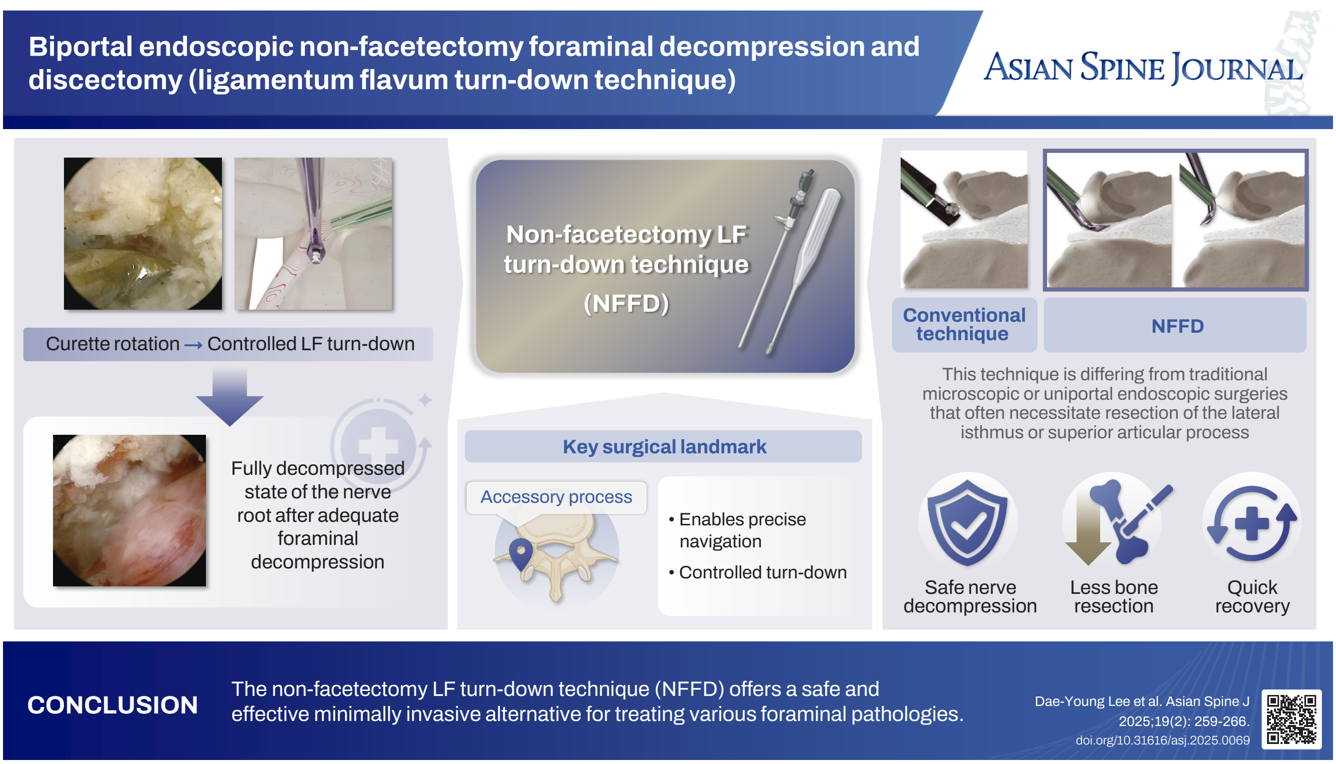

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Biportal endoscopic non-facetectomy foraminal decompression and discectomy (ligamentum flavum turn-down technique)

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This study introduces a novel biportal endoscopic foraminal decompression technique that minimizes bone removal while ensuring safe and effective nerve root decompression. Leveraging the accessory process as a key surgical landmark, this technique enables precise navigation and controlled turn-down of the ligamentum flavum (LF). A key advantage of this technique is its reduced requirement for bone resection, differing from traditional microscopic or uniportal endoscopic surgeries that often necessitate resection of the lateral isthmus or superior articular process. This technique is particularly beneficial for foraminal and extraforaminal herniated nucleus pulposus cases, where bony decompression needs are relatively lower compared to foraminal stenosis. Using the accessory process as a landmark also enhances surgical precision and reduces the risk of nerve root injury, providing a valuable advantage for less experienced surgeons. Despite these advantages, challenges exist, particularly at the L5–S1 level, where the less prominent accessory process and limited workspace due to anatomical constraints can pose difficulties. In cases of severe bony compression, additional bone removal may be necessary to achieve adequate decompression. In conclusion, the Non-facetectomy LF turn-down technique (non-facetectomy foraminal decompression) offers a safe and effective minimally invasive alternative for treating various foraminal pathologies.

Keywords: Non-facetectomy foraminal decompression; Minimally invasive surgery; Endoscopy; Spinal stenosis

Introduction

Foraminal stenosis, a common cause of radiculopathy, has been addressed through paraspinal approaches, first introduced by Wiltse and Spencer [1]. Over time, these techniques have evolved, progressing from minimally invasive tubular surgery to endoscopic surgery, which boasts excellent visualization, minimal blood loss, and effective decompression [2-7]. However, compared to the interlaminar approach, the transforaminal (paraspinal) approach remains relatively unfamiliar to many spine surgeons [8,9]. Furthermore, bony decompression is a fundamental step in most reported endoscopic techniques, but unintended excessive resection may increase the risk of postoperative instability. Notably, in cases of foraminal and extraforaminal herniated nucleus pulposus (HNP), the need for bony decompression is relatively lower compared to foraminal stenosis.

This study presents a novel endoscopic technique to achieve safe and effective foraminal decompression while minimizing unnecessary bone removal. Leveraging the accessory process as a key surgical landmark, this approach enables more precise and safe nerve root decompression.

Technical Notes

This study focuses on the surgical technique, and due to its retrospective nature, it was exempt from institutional review board approval, with informed consent being waived accordingly.

Patient position and anesthesia

The procedure is performed under general or spinal anesthesia, depending on the patient's condition and the surgeon's preference. Following anesthesia induction, the patient is positioned prone on a Wilson frame table, ensuring the abdomen remains uncompressed to minimize intra-abdominal pressure and venous congestion. All pressure points are adequately padded to prevent complications such as pressure sores or nerve injuries.

Skin incisions (making two portals)

Under C-arm fluoroscopic guidance (AP view), the appropriate surgical level is identified and marked. Two longitudinal skin incisions, approximately 7–8 mm long, are made approximately one pedicle width lateral to the pedicle's lateral border. The cranial portal is cre-

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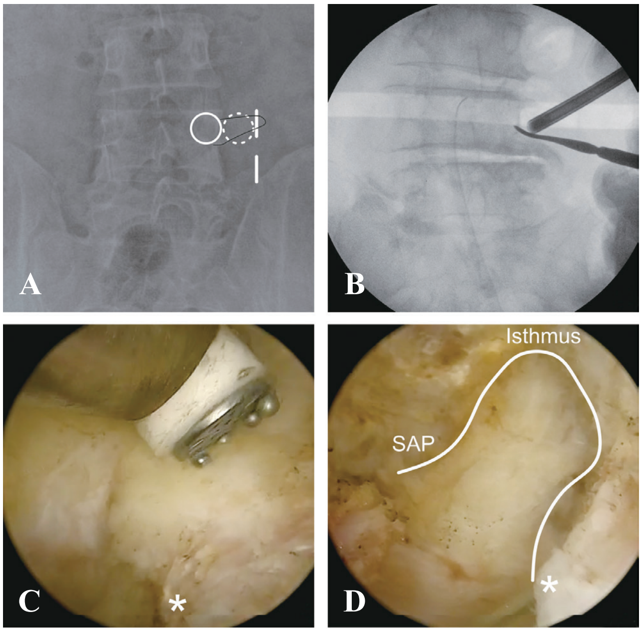

Fig. 1. Anteroposterior view showing the portal placement. **(A)** Two longitudinal skin incisions are made approximately one pedicle width lateral to the pedicle's lateral border. The cranial portal is positioned at the pedicle level, while the caudal portal is placed approximately 2 cm caudally. **(B)** The docking point is located at the transverse process. **(C)** Endoscopic view showing soft tissue dissection centered around the accessory process using a radiofrequency probe. (*) indicates the accessory process. **(D)** Identifying key anatomical landmarks, including the accessory process, isthmus, and superior articular process (SAP). (*) marks the accessory process.

ated at the pedicle level while the caudal portal is placed approximately 2 cm apart caudally (Fig. 1A). A No. 10 blade is used to make a perpendicular and definitive incision through the fascia. A proper fascial incision is crucial as an incomplete incision can disrupt the saline flow, compromising clear visualization and irrigation during the procedure. The cranial portal is designated as the viewing portal, while the caudal portal serves as the working portal. The hydrostatic pressure is set to 30–40 mm Hg. In paraspinal approaches, maintaining adequate fluid outflow is particularly important to prevent complications such as abdominal fluid retention. When necessary, a working cannula can be used to enhance fluid outflow and maintain a clear surgical field.

The cranial vertebra's transverse process serves as a docking point (Fig. 1B). Under C-arm fluoroscopic guidance, a triangular arrangement of the scopic sheath and serial dilator at the target point is established. A radiofrequency probe is employed to carefully expose the key surgical landmarks, including the transverse process, the lateral side of the superior articular process, and the lateral isthmus (Fig. 1C, D).

Foraminal decompression

The accessory process serves as the most important landmark in our technique. Using a freer elevator, soft tissues are meticulously detached from the medial side of the accessory process (Fig. 2A). A significant advantage of this approach is that the nerve root lies deeper than the accessory process, allowing for safe removal of soft tissues without risking direct injury to the nerve root.

The tip of the curette is gently pushed beneath the superior articular process (SAP), maintaining continuous contact with the bony surface. This allows for direct undermining of the ligamentum flavum (LF) attachment (Fig. 2B). By applying rotational force with the curette, a controlled turn-down of the LF is achieved, facilitating its detachment and effective soft tissue decompression (Fig. 2C). To minimize the risk of nerve injury, the rotational force is applied away from the nerve root. Throughout this process, the face of the curette remains directed toward the ventral surface of the SAP. After addressing the ventral surface of the SAP, the curette is guided upward along the bony contour toward the lateral isthmus. This precise motion facilitates the safe and complete detachment of the LF. Once detached, the underlying nerve root and perineural adipose tissue can be safely visualized (Fig. 2D). With the nerve root exposed, its trajectory serves as a reference for removing any remaining portions of the LF using a curette or Kerrison rongeur (Fig. 3A). Typically, the lateral isthmus is situated medial to the pedicle's lateral wall, allowing the curette to access the medial wall of the pedicle, which marks the boundary of the foramen. Intraoperatively, the C-arm is used to confirm whether adequate decompression has been achieved up to the medial foramen (Fig. 3C, D).

In cases of bony compressive lesions, such as SAP spurs or lateral isthmus spurs, careful tunneling around the nerve root can be performed using a curette, Kerrison rongeur, or an arthroscopic shaver burr. For added safety, it is recommended to use a burr equipped with a protection device on one side to prevent accidental nerve root injury.

Additional discectomy may be necessary in cases where disc protrusion or extrusion has resulted in significant foraminal narrowing. If annulotomy is required, a small radiofrequency probe is used to release the annular fibers. Lastly, a ball-tip probe is used to confirm the free mobility of the nerve root, ensuring that adequate neural decompression has been achieved, completing the decompression process.

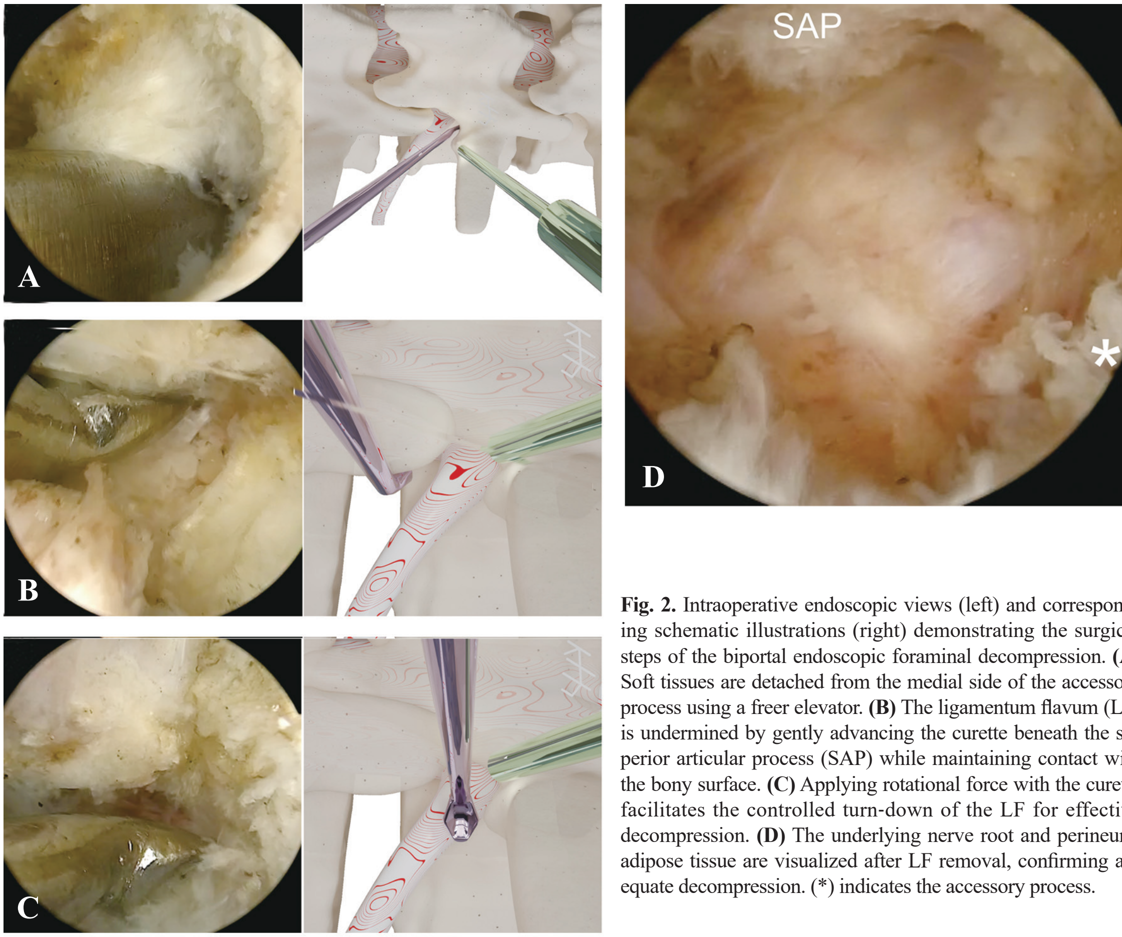

Fig. 2. Intraoperative endoscopic views (left) and corresponding schematic illustrations (right) demonstrating the surgical steps of the biportal endoscopic foraminal decompression. **(A)** Soft tissues are detached from the medial side of the accessory process using a freer elevator. **(B)** The ligamentum flavum (LF) is undermined by gently advancing the curette beneath the superior articular process (SAP) while maintaining contact with the bony surface. **(C)** Applying rotational force with the curette facilitates the controlled turn-down of the LF for effective decompression. **(D)** The underlying nerve root and perineural adipose tissue are visualized after LF removal, confirming adequate decompression. (*) indicates the accessory process.

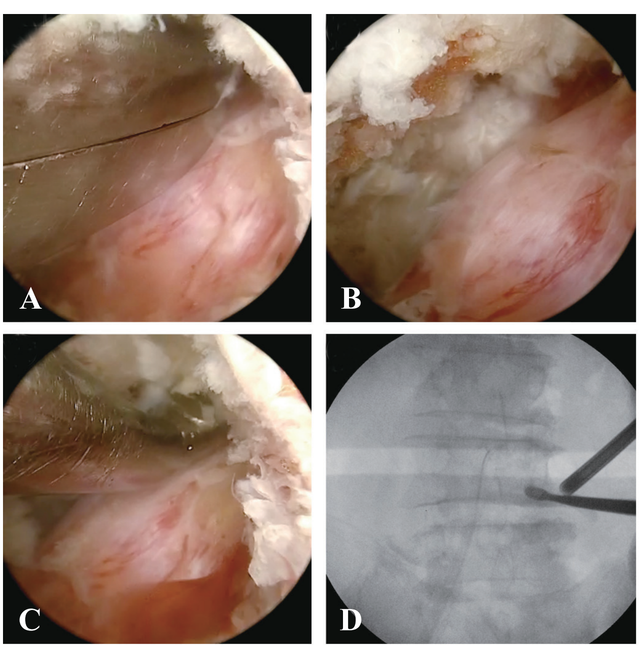

Fig. 3. **(A)** Endoscopic view demonstrating additional decompression using a Kerrison rongeur to remove any remaining portions of the ligamentum flavum or bony structures if necessary. **(B)** Fully decompressed state of the nerve root after adequate foraminal decompression. **(C, D)** Intraoperative C-arm fluoroscopic images confirming that sufficient decompression has been achieved up to the medial foramen.

Wound closure

Meticulous hemostasis is achieved, with hemostatic agents used as necessary. Once bleeding is controlled, a hemovac drain is inserted through the working portal. Each of the two wounds is closed with a single subcutaneous suture using absorbable material, followed by two nylon stitches for the skin closure. Finally, proper level is confirmed intraoperatively using the C-arm before completing the procedure.

Discussion

Advantages

Minimal bone resection

A major advantage of this technique is the minimization of bone resection. In traditional microscopic tubular surgeries, or even one-portal surgery, routine resection of the lateral isthmus or SAP tip is often necessary to access the foramen, overcome the fixed vertical viewpoint, and secure the working space [10,11].

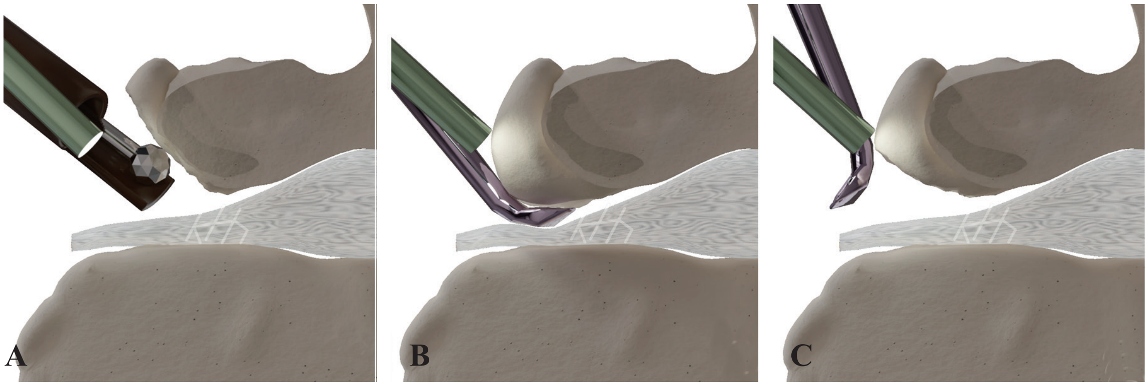

Fig. 4. Schematic illustrations comparing traditional decompression techniques. **(A)** Conventional technique using a burr to perform bony decompression. **(B)** A curette is inserted into the ventral side of the superior articular process for decompression. **(C)** Controlled decompression is achieved through minimal bone resection using rotational, sweeping, and peel-off maneuvers with a curette.

However, advancements in endoscopy now allow for a cleaner and easier visualization. In particular, biportal endoscopic surgery enables visualization from variable angles rather than a fixed viewpoint [4-6,12,13], making it possible to safely access the foramen, minimizing routine removal of the lateral isthmus or SAP.

The pathology of foraminal stenosis can be broadly categorized into soft tissue elements (e.g., hypertrophied LF, disc protrusion or extrusion) and bony elements (e.g., hypertrophied SAP, lateral recess spur) [11,14]. When soft tissue compression is the primary pathology, extensive bony decompression can be avoided (Fig. 4). This is particularly relevant in cases of foraminal and extraforaminal HNP, where the need for bony decompression is often lower compared to foraminal stenosis.

Safe ligament flavum turn-down maneuver (accessory process as a landmark)

The second advantage lies in the use of the accessory process as a key surgical landmark to safely expose the nerve root and reduce the risk of critical complications, such as iatrogenic root injury. During paraspinal approaches, young surgeons often struggle with nerve root identification and spatial orientation, increasing the risk of root injury when employing instruments like burrs or Kerrison rongeurs.

The accessory process is a prominent structure extending from the transverse process, making it easily identifiable. By using a freer to detach the soft tissue on the medial side of the accessory process, the pedicle's inferior wall can be safely and efficiently accessed. A curette is then employed to perform controlled maneuvers such as "rotation," "sweeping," and "peel-off" to detach the ligamentum flavum using the turn-down technique, rather than a piecemeal approach. This ensures safe exposure of the nerve root, which is a critical strength of this technique (Fig. 4).

The accessory process also serves as a depth guide, allowing the operator to confidently dissect soft tissue at shallower levels. Since the nerve root typically lies deeper than the accessory process, the operator can safely proceed medially and cranially, using the accessory process as a reference point for soft tissue detachment. Furthermore, even when additional bony decompression is required, the exposed nerve root provides a clear anatomical landmark, enabling precise decompression with instruments like curettes, Kerrison rongeurs, or burrs (Supplement 1).

Illustrated cases

Case 1: L4/5 paraspinal foraminal decompression at right side

A 64-year-old woman presented with severe right buttock pain as the primary symptom, accompanied by intermittent neurological claudication. Her symptoms had progressively worsened over the past six months. Preoperative magnetic resonance imaging (MRI) revealed right L4/5 foraminal stenosis. The patient underwent biportal endoscopic foraminal decompression (Fig. 5), resulting in improved symptoms. She was discharged on postoperative day 3.

For right-sided foraminotomy, the same technique can be applied using the dominant hand (right hand) as the working hand and the non-dominant hand (left hand) as the viewing hand. However, to optimize decompression, it is essential to align the working trajectory with the oblique course of the nerve root. While right-handed surgeons typically perform right-sided foraminotomy without difficulty, challenging cases with large accessory processes or narrow working spaces

Fig. 5. Preoperative and postoperative imaging of a 64-year-old female who presented with right buttock pain. **(A, C)** Preoperative magnetic resonance imaging and computed tomography scans revealed right L4/5 foraminal stenosis caused by soft tissue hypertrophy (ligamentum flavum thickening and disc bulging), resulting in nerve pinching. **(B, D)** The patient underwent biportal endoscopic foraminal decompression with minimal bone resection.

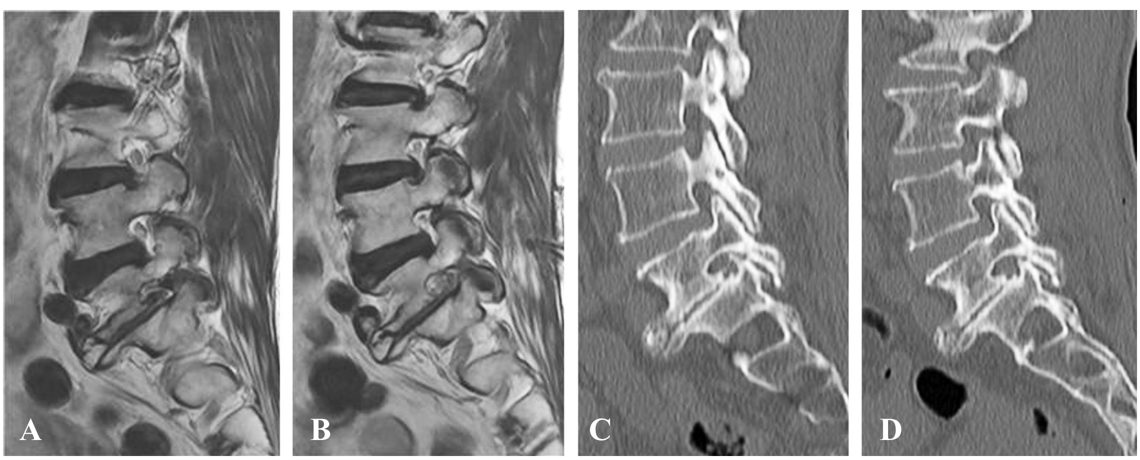

Fig. 6. Preoperative and postoperative imaging of a 65-year-old female who presented with left buttock pain and radiating pain along the L5 dermatome. **(A, C)** Preoperative magnetic resonance imaging and computed tomography scans revealed left L5/S1 foraminal stenosis. **(B, D)** The patient underwent biportal endoscopic foraminal decompression while preserving the facet joint.

may require partial bony removal. In such situations, using the non-dominant hand as the working hand can provide a more advantageous angle.

Case 2: L5/S1 paraspinal foraminal decompression at left side

A 65-year-old woman presented with left buttock pain and L5 dermatomal radiating pain. Preoperative MRI revealed left L5/S1 foraminal stenosis. The patient underwent biportal endoscopic foraminal decompression (Fig. 6), resulting in improved symptoms postoperatively.

Limitations

Challenges at the L5–S1 level

While this technique can be applied at the L5–S1 level, certain anatomical factors may pose challenges. The accessory process becomes less prominent at the L5 level, limiting its utility as a surgical landmark [15-17]. Additionally, the large L5 transverse process and sacral alar at the L5–S1 level reduce the available workspace and increase the depth required for decompression [3,12]. In such cases, sufficient bone resection may be unavoidable.

However, for isolated foraminal stenosis without extraforaminal lesions, our technique demonstrated feasibility even at the L5–S1 level. Ongoing refinements and further studies may help broaden its applicability at this level.

Severe bony compression

In cases where hypertrophied SAP or lateral recess spurs directly compress the nerve root, removal of these bony structures is necessary for adequate decompression. Preoperative imaging, such as CT or MRI, is crucial for a detailed analysis of the pathology, allowing for an individualized surgical strategy. While this study does not provide specific guidelines for the appropriate extent of bone resection based on individual pathology, further research is required to establish more precise criteria.

Conclusions

The Non-facetectomy LF turn-down technique offers a minimally invasive solution for addressing foraminal stenosis and foraminal/extraforaminal HNP. By utilizing the accessory process as a key surgical landmark and minimizing bone resection, this technique provides an effective alternative approach to existing approaches for foraminal decompression.

Key Points

- The accessory process serves as a prominent and easily identifiable landmark for safe nerve root exposure.
- Minimizes bony decompression, reducing the risk of instability and complications.
- The ligamentum flavum turn-down technique offers an alternative approach for treating degenerative lumbar foraminal stenosis and foraminal/extraforaminal herniated nucleus pulposus
- Enables precise nerve root decompression, even in cases requiring additional bony decompression.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Author Contributions

Conceptualization: DYL, HBJ, HSK, JBL. Methodology: DYL, HBJ. Resources: DYL. Investigation: HBJ, JBL. Visualization: HSK, JBL, SHK. Validation: SYP. Project administration: DYL, HBJ. Supervision: DYL, SYP. Writing–original draft: DYL, HBJ. Writing–review & editing: DYL, SYP, HBJ, JBL, SHK. Final approval of the manuscript: all authors.

Supplementary Materials

Supplementary materials can be available from https://doi.org/10.31616/2025.0069. Supplement 1. Biportal endoscopic non-facetectomy foraminal decompression (ligament flavum turn-down technique).

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