Technical Note

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Nonlaminotomy bilateral decompression: a novel approach in biportal endoscopic spine surgery for spinal stenosis

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Biportal endoscopic spine surgery (BESS) is an emerging technique for lumbar spinal stenosis. Previous BESS techniques involve partial osteotomy for access to spinal canal such as partial laminotomy, partial facetectomy, and other forms to access the spinal canal for decompression. However, approaches that include osteotomy can cause bone bleeding intraoperatively, leading to obscured vision, and may be at risk of postoperative facet arthritis and segmental instability due to damage to the posterior stability structure. This study aimed to introduce a BESS technique, i.e., nonlaminotomy bilateral decompression (NLBD) that allows for decompression through the interlaminar space without damaging the posterior bony structures. For this, various sizes of curved curettes are mainly used than Kerrison rongeurs. The small tip of the curved curette allows it to reach any part of the spinal canal through the interlaminar space, and its rounded back reduces the risk of nerve damage during decompression. In addition, by changing the portals, decompression through the interlaminar space can be performed without osteotomy. Nine checkpoints were assessed for the complete decompression during surgery. In conclusion, NLBD is an alternative BESS approach that achieves adequate decompression while preserving the posterior structure as much as possible.

Keywords: Non-laminotomy bilateral decompression; NLBD; Biportal endoscopic spine surgery; Lumbar spinal stenosis; Minimal invasive spine surgery

Introduction

Lumbar spinal stenosis (LSS) is the predominant reason for spinal surgeries among older people [1]. Historically, extensive laminectomy, with or without fusion, was considered the gold standard [2]. However, this traditional method often involves significant soft tissue dissection, which can lead to complications such as paraspinal muscle atrophy, fatty degeneration, and postsurgical syndrome [3]. Randomized controlled trials have shown little additional benefit of fusion procedures after decompression for LSS, indicating that simple decompression is effective [4,5].

Over the past 2 decades, minimally invasive spine surgery has emerged as an effective treatment for various lumbar conditions, driven by advancements in surgical tools and endoscopic techniques [6,7]. By transitioning from miniopen to tubular and percutaneous endoscopic methods, minimally invasive spine surgery offers benefits including reduced wound size, less pain, minimal blood loss, quicker recovery, and shorter hospitalizations [8]. Biomechanical research underscores the importance of the posterior spinal column, including interspinous ligaments, facet joints, and capsules, in preserving stability. This highlights the need to protect paraspinal muscles and posterior structures for optimal long-term outcomes [9].

Unilateral biportal endoscopic decompression, a percutaneous full endoscopic strategy, utilizes two small incisions adjacent to the spinous process, offering enhanced surgical precision without the constraints of traditional endoscopic tubes or channels [10-12]. Unilateral biportal endoscopic decompression facilitates accurate decompression with a visually magnified and clear operative field, making it an alternative option for preserving spinal integrity during decompression for LSS [13-18].

The traditional approach of biportal endoscopic spine surgery (BESS) involves accessing the spinal canal by performing partial laminectomy, partial facetectomy, and partial spinous process removal to secure a clear view [19-21]. Although relatively good clinical results have been reported, the approach has a risk of side effects such as iatrogenic instability (e.g., vacant facet and iatrogenic spondylolysis) [22-24]. Bone bleeding may cause foggy vision intraoperatively [25,26].

Herein, we introduce a novel decompression technique called nonlaminotomy bilateral decompression (NLBD). This approach involves decompression solely through the interlaminar space, removing the ligamentum flavum (LF) without osteotomy.

Technical Notes

This study focuses on the surgical technique and is a retrospective research note based on a single case report. As a result, it was conducted without the approval by institutional review board, and informed consent was waived due to its retrospective nature.

Operation setting

After spinal anesthesia, the patient is positioned prone on a Jackson table or Wilson frame to minimize abdominal pressure. The eyes are not compressed to avoid ophthalmic complications. The surgical field is widely draped aseptically. To confirm the target level, a draped C-arm is utilized, and the C-arm monitor is placed at the patient's feet. The endoscope screen is positioned on the opposite side of the surgeon.

The endoscopic surgery requires a camera, camera light, water line, scope guide, curved curette, Kerrison rongeur, pituitary forceps, and electrocautery device. The hydraulic pressure is set to 40 mm Hg.

Approach

The surgical level is confirmed using a C-arm, and the portal position is determined. Two portals, one superior and one inferior, are created along the medial pedicle line with a skin incision of approximately 1 cm. Typically, the superior and inferior portals serve as the viewing and working portals, respectively.

Soft tissue dissection is performed adequately to expose the lumbosacral fascia. If the fascia is not adequately opened, water does not drain properly during surgery, which makes it challenging to achieve a clear view. After adequate soft tissue dissection, the interlaminar space at the corresponding level is accessed using blunt instruments.

An electrocauterization device is inserted into the working portal to remove the soft tissue around the camera, secure a clear view, and create a working space. If in doubt about the level at this time, the position must be reconfirmed with the C-arm.

Dissection is performed up to the point where the inferior margin of the upper vertebra lamina meets the ventral/inferior margin of the spinous process and then downward to the superior margin of the lower vertebra lamina. The LF is checked whether it is adequately exposed within the field of view. Anatomical boundaries of the superficial layer of the LF include the inferior margin of the upper vertebra lamina, facet joint laterally, and superior margin of the lower vertebra lamina.

Decompression

The major difference between NLBD and traditional unilateral laminectomy bilateral decompression (ULBD) methods is that access to the spinal canal is through the interlaminar space, without laminotomy or facetectomy (Fig. 1).

Decompression is mainly performed using a curved curette. Appropriate curettes of varying sizes (i.e., small, medium, and large) may be chosen (Fig. 2). Decompression is performed in the order of the nine checkpoints presented in Fig. 3.

Once the LF is exposed, ipsilateral LF decompression is initiated. The superficial layer is carefully approached using a curved curette. After sufficiently scraping off the

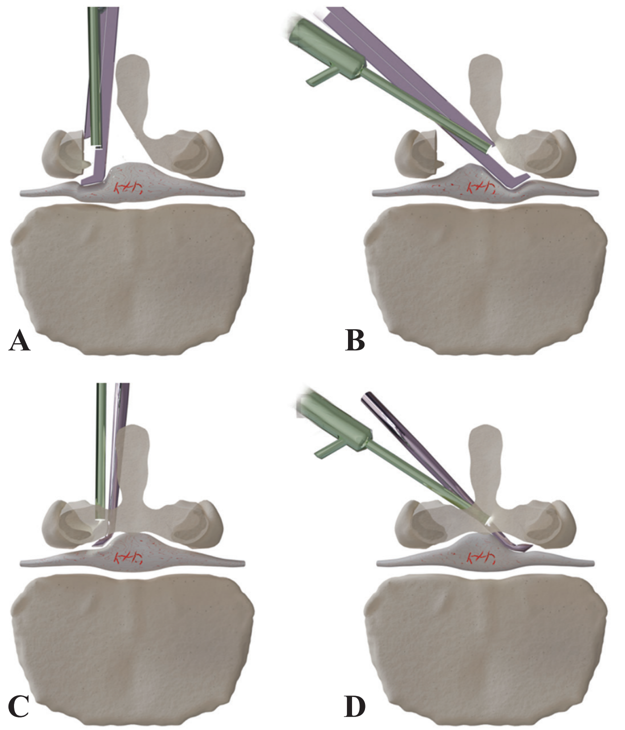

Fig. 1. (A, B) Traditional unilateral laminotomy and bilateral decompression using the biportal endoscopic spine surgery technique. A decompression device and a spine endoscope are inserted through the laminotomy space. Decompression using a Kerrison punch requires bone resection to insert the equipment at a 90° angle due to the length and thickness of the equipment in order to minimize nerve damage. **(C, D)** Non-laminotomy and bilateral decompression technique. A decompression device (curved curette) and an endoscope camera are inserted through the interlaminar space. Decompression using a curved curette allows for the removal of the ligamentum flavum without laminotomy by alternating the positions of the viewing and working portals. This method poses a lower risk of nerve damage compared to decompression using a Kerrison punch.

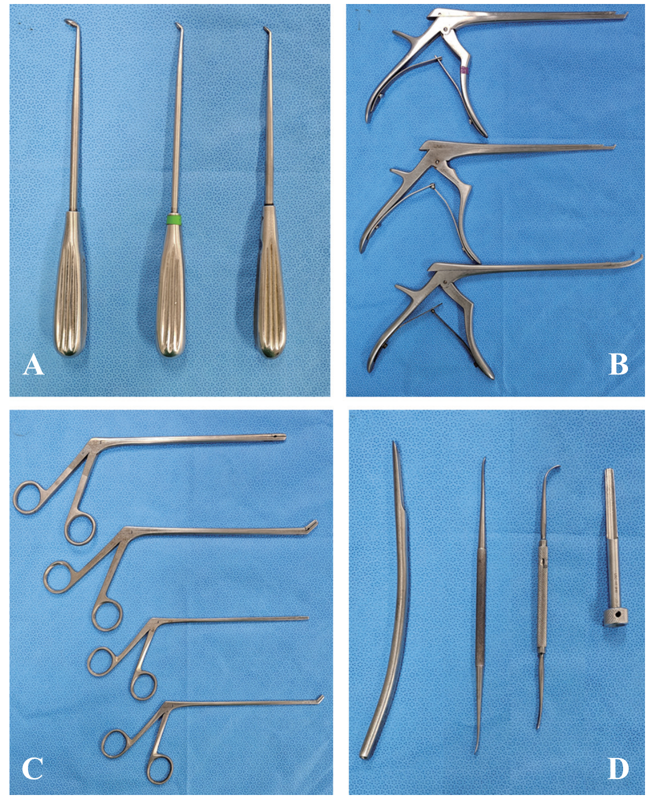

Fig. 2. Surgical instruments used for the biportal endoscopic spine surgery technique. **(A)** Curved curettes in various sizes. **(B)** Kerrison rongeurs (2 mm and 3 mm) with straight or curved tips. **(C)** Pituitary forceps in various sizes and types. **(D)** Muscle dilator and various types of nerve retractors.

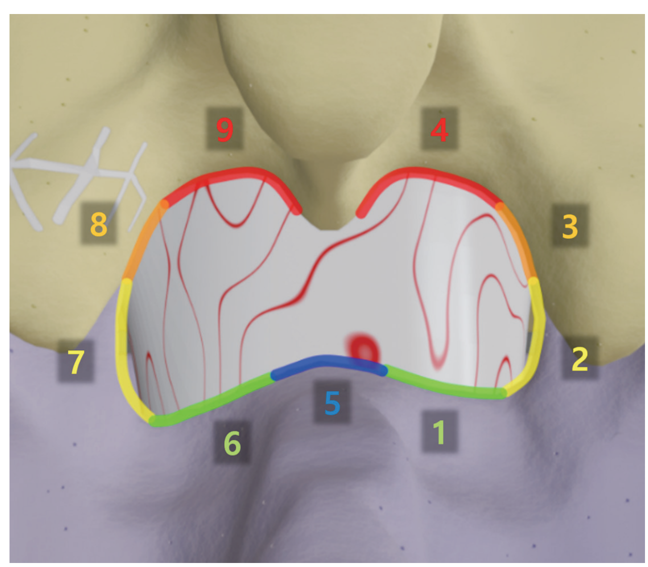

Fig. 3. Decompression nine-check point. 1: ipsilateral upper border of lower lamina; 2: ipsilateral superior articular process (SAP) border; 3: ipsilateral inferior articular process (IAP) undersurface; 4: ipsilateral under surface of upper lamiar; 5: center of lower laminar; 6: contralateral upper border of lower laminar; 7: contralateral SAP border; 8: contralateral IAP undersurface; 9: contralateral under surface of upper laminar.

LF using a curette for the superficial layer decompression, the tissue is removed using a Kerrison rongeurs, and the deep layer is exposed. The LF is detached from the bone margin at the ipsilateral upper border of the lower lamina using a curved curette. The LF is removed from the anterior surface of the superior articular process (SAP). The anterior surface of the inferior articular process (IAP) is scraped with a curved curette, followed by LF removal from the sublaminar area. After decompression on the ipsilateral side, the LF on the contralateral side is removed. After confirming the tip of the spinous process, which serves as a reference for the central area, contralateral side decompression is performed. By utilizing the maximum elasticity of the skin, sufficient contralateral decompression can be performed using a curved curette without creating an additional portal. The LF at the upper border of the lower lamina on the contralateral side is removed. The LF at the anterior part of the SAP is removed, followed by sequential decompression of the

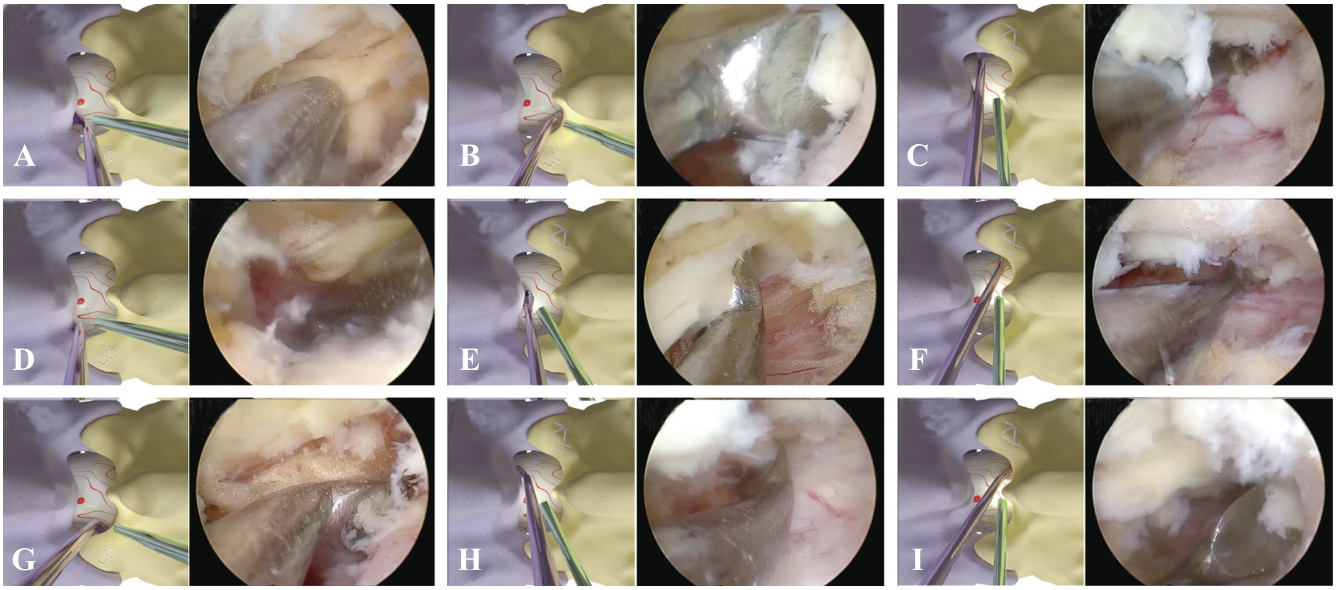

Fig. 4. Schematics of non-laminotomy bilateral decompression and related endoscopic pictures. **(A)** Decompression for ipsilateral upper border of lower lamina. **(B)** Ipsilateral superior articular process (SAP) border. **(C)** Ipsilateral inferior articular process (IAP) undersurface. **(D)** Ipsilateral under surface of upper lamiar. **(E)** Center of lower laminar. **(F)** Contralateral upper border of lower laminar. **(G)** Contralateral SAP border. **(H)** Contralateral IAP undersurface. **(I)** Contralateral under surface of upper laminar.

anterior part of the IAP, and finally, the LF in the contralateral sublamina space is removed (Fig. 4).

In stenosis caused by disc protrusion, the LF must be adequately decompressed to create sufficient space at the posterior and lateral aspects of the neural sac. Following this, the anterior part of the neural sac is dissected. Subsequently, the dural sac is retracted to one side using a nerve retractor, and the protruding disc is removed.

Hypertrophy of the facet joint or bony spurs may compress the neural tissue, which can be observed on preoperative magnetic resonance imaging. In such cases, the LF was removed via the interlaminar space, and an endoscope was used to examine the area of neural compression caused by the bony tissue within the spinal canal. Decompression was performed using a curet, ensuring that the lesions surrounding the neural tissue were adequately removed, and sufficient space was created around the nerves.

After decompression, a ball-tip probe is used to confirm the central decompression, and the both side exiting nerve roots are checked. Intraoperative bleeding is controlled using an appropriate electrocauterization device (Supplement 1). A representative case is shown in Fig. 5.

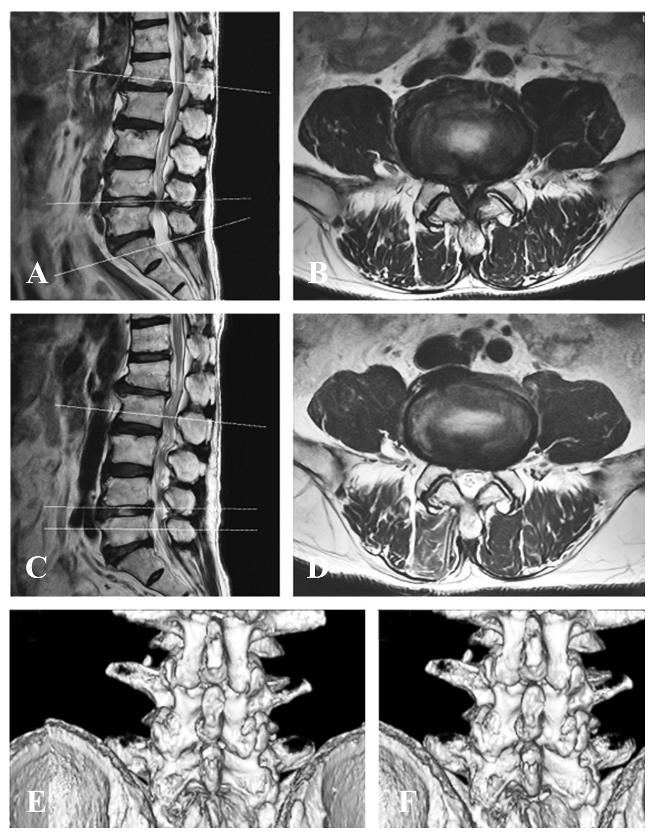

Fig. 5. A 55-year-old man complained of pain in both buttocks along with moderate neurogenic claudication. **(A, B)** Preoperative magnetic resonance imaging (MRI) revealed severe spinal stenosis. **(B)** Axial image represents Schiaz grade D spinal stenosis. **(C, D)** Postoperative MRI revealed adequate decompression of the spinal canal. **(E, F)** Preoperative and postoperative reconstructed computed tomography images showed that there were no bone defects after surgery.

Comparison with the traditional biportal endoscopic spine surgery approach

Advantages

NLBD does not require bone resection such as laminotomy, facetectomy, and partial spinous process removal. It could prevent bone bleeding, which may cause visual disruption intraoperatively [27-29] and help reduce the possibility of iatrogenic instability, which can occur after severe decompression [30-33], and operative pain, which may be related with facet fractures or iatrogenic isthmic lysis [34,35]. Moreover, NLBD could preserve intrinsic spinal muscles, which may be related with better patient outcomes in terms of postoperative pain and rehabilitation [36,37].

NLBD offers a sufficient decompression effect. So far, we have confirmed satisfactory decompression in postoperative magnetic resonance images. Decompression is mainly performed using a curette, which is a relatively nerve damage-free method compared with using a Kerrison rongeur.

Disadvantages

The learning curve of NLBD may be longer than that of the conventional method. Manipulating a scope and a curette with both hands requires high proficiency. Surgical complications such as dura tears and nerve injuries may occur. In addition, NLBD is difficult to perform in cases where the interlaminar space is not well secured because of severe spinal stenosis. In such cases, a minimal partial laminotomy should be performed to obtain a better view.

From December 2023 to the present, we have performed 201 NLBD cases; during the same period, a total of 19 patients (9.45%) underwent laminotomy. In cases where the interlaminar space was <3 mm, a selective partial laminectomy was performed. When the interlaminar space measures >3 mm on computed tomography (CT), bilateral decompression may be performed without laminotomy.

Discussion

NLBD is a technique for decompressing the spinal canal by excising the LF without removing any bone structures, except osteophytes, in patients with spinal stenosis. This approach minimizes damage to soft tissue structures in the posterior column, potentially facilitating postoperative patient recovery.

Over the years, extensive research has been conducted on decompression as a treatment for LSS [1,2]. Previous studies comparing decompression and decompression plus fusion have reported similar clinical outcomes, indicating that decompression is critical in patients with spinal stenosis [4,5]. However, concerns about postoperative instability resulting from wide laminectomy have led to ongoing research in minimally invasive spine surgery over the past 2 decades, emphasizing the importance of preserving posterior stabilizing structures [6-9,38]. One such surgical approach developed is the ULBD method by BESS [10]. Despite reports of the positive clinical outcomes of existing methods, the risks of postoperative complications due to bone removal during laminotomy and facetectomy need to be addressed [11-15]. As a solution, the NLBD method presented herein allows for LF removal through the interlaminar space without the need for bone resection.

By avoiding bone resection, NLBD could help prevent the surgical field by obscuring bone bleeding. Bone bleeding after laminotomy or laminectomy can compromise visibility in the surgical field during biportal endoscopic surgery. In such cases, bone wax or hemostatic agents are used to achieve hemostasis and clear the view before proceeding with the surgery [28]. However, in NLBD, no bone bleeding occurs, which eliminates this limitation on visibility. If bleeding is not controlled, increasing the pressure to maintain visibility can pose a risk of convulsions, a known concern [27,39]. Reduction of the bleeding focus during surgery could be an effective alternative to prevent convulsions during BESS.

NLBD could reduce the risk of iatrogenic instability. The risk for iatrogenic instability after laminectomy or other minimally invasive spine surgeries has already been reported [30,32-35]. This is associated with the increased stress on the remaining bone because of bone removal [9,24,38]. Because NLBD does not involve bone resection, it is expected to lower this anticipated risk. However, instability can arise from factors other than fractures, highlighting the need for further clinical studies.

When laminotomy is performed, iatrogenic facet fractures and iatrogenic pars interarticularis fractures associated with postoperative pain have been reported. According to previous reports, the group that underwent laminotomy experienced facet fractures and iatrogenic spondylolysis. This is likely linked to the stress riser effect observed in biomechanical experiments, which can lead to fatigue fractures. Therefore, NLBD may reduce the risk of pain associated with these complications of laminotomy. To validate this, future research based on direct clinical and radiological data is necessary.

In lumbar surgery, paraspinal muscle preservation significantly affects postoperative clinical outcomes [8,36]. Among the intrinsic spine muscles, the rotator muscles insert into the lamina [37]. Therefore, removing the lamina inevitably damages these rotator muscles. In multilevel surgeries, even if partial laminectomy is performed, the cumulative damage to the intrinsic muscles cannot be avoided. In contrast, NLBD can be performed endoscopically without resecting the lamina, which is expected to optimally preserve the intrinsic muscles. In multilevel stenosis, NLBD is anticipated to preserve more intrinsic muscles than traditional laminotomy methods. However, further clinical comparative studies are necessary to substantiate these findings.

This study has limitations. First, NLBD cannot be performed in cases where the interlaminar space is significantly narrowed. In severe spinal stenosis, the interlaminar space is often narrowed. Based on the author's experience, if the interlaminar space is <3 mm on CT, decompressing the spinal canal without partial laminotomy is difficult because it does not allow entry of the tip of the curette for decompression, making NLBD attempts challenging. In such cases, some parts of the lamina cortex may need to be removed to create adequate viewing and working spaces. In addition, in trefoil stenosis, spinal canal narrowing caused by bony structures necessitates laminotomy to achieve adequate spinal canal decompression [40,41]. Therefore, a preoperative CT for anatomical assessment of the canal is essential, and laminotomy should be performed in such cases. Consequently, NLBD is deemed infeasible in these situations. Finally, this study is presented as a technical note focusing on the technique. Therefore, it does not include an analysis of the NLBD-related clinical or radiological outcomes. Future research comparing the existing ULBD method with the described technique is expected for advancing minimally invasive spine surgery.

Despite these limitations, NLBD could be an alternative surgical approach that allows for the decompression of spinal stenosis without bone resection.

Key Points

- This technical note presents a new surgical method called nonlaminotomy bilateral decompression (NLBD), which allows for decompression through the interlaminar space without damaging the posterior bony structures.
- To achieve this, we introduce a 9-check point system for sufficient surgical decompression, primarily using curved curettes instead of Kerrison rongeurs or high-speed burrs for decompression procedures. Additionally, by changing the portals, decompression through the interlaminar space can be performed without osteotomy.
- As demonstrated in the cases presented in the paper, this method is feasible even in cases of severe spinal stenosis (Schiaz grade D).
- NLBD is a method that does not involve bone resection, which we believe can reduce the potential issues associated with the bone resection required in the traditional unilateral laminectomy bilateral decompression method.
- NLBD could serve as an alternative surgical strategy for degenerative lumbar spinal stenosis.

Conflict of Interest

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

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Author Contributions

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Supplementary Materials

Supplementary materials can be available from https://doi.org/10.31616/asj.2024.0210. Supplement 1. Non-laminotomy bilateral decompression: nine check point for complete decompression.

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