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# Uniportal Full Endoscopic 270° Decompression for Thoracic 1–2 Hard Disc Herniation With Ossification of the Ligamentum Flavum

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This article aims to demonstrate the uniportal full endoscopic surgery for treating complex anterior and posterior spinal pathology at the T1–2 level, offering a invasive, accessible, stable, and versatile approach to challenging anatomical situations. Uniportal full endoscopic surgery is one of the most minimally invasive spinal surgeries, utilizing slim, elongated, and compact instruments that provide access to lesions from any angle and distance. This characteristic makes the technique especially suitable for hard, such as the T1–2 level, where traditional approaches may be limited or difficult. We present the case of a 39-year-old male patient (height, 187 cm; weight, 130 kg) who developed myelopathy due to a hard disc herniation and ossification of the ligamentum flavum at the T1–2 leading to paraparesis, which was more severe on the left side. An anterior approach was challenging due to the anatomical constraints at the T1–2 level, as well as the patient's body size. A posterior access via the interlaminar approach facilitated the removal of the ossified ligamentum flavum. However, to the anterior lesion remained problematic without spinal cord retraction. Using the uniportal full endoscope, we were able to approach both anterior and posterior lesions through an incision 8 cm lateral to the midline, allowing for the treatment of the entire 270° arc of the pathology. The slim and elongated nature of the full endoscope enabled effective decompression without exerting pressure on the spinal cord, providing access from any angle and distance. This technique can be applied to a variety of cases involving difficult-to-access spinal.

**Keywords:** Endoscopic spine surgery, Thoracic vertebrae, Stenosis, Ligamentum flavum, Myelopathy, Intervertebral disc displacement

## CASE REPORT

A 39-year-old male patient presented with rapidly worsening bilateral leg paralysis and pain over the prior 2 weeks. Initially, the patient's muscle strength in both legs was graded at 3/5, but it rapidly deteriorated to grade 1/5 within just 3 days. Diagnostic workup revealed cervicothoracic multiple stenosis, with a magnetic resonance myelogram showing multiple cord signal blocks (Fig. 1A). Nerve conduction velocity and electromyography confirmed the diagnosis of myelopathy. Imaging findings revealed the following: C3–4 central stenosis due to ossification of the posterior longitudinal ligament (OPLL), accompanied by signal changes in the spinal cord (Fig. 1B). T1–2 central stenosis caused by a central to left-sided hard disc herniation and ossification of the ligamentum flavum (OLF) (Fig. 1C). T4–5 central stenosis primarily due to OLF and bilateral hard disc herniation, with accompanying spinal cord signal changes (Fig. 1D). None of the lesions demonstrated clear signs of instability. Given the complexity of the case, the patient underwent staged operations. The decision to perform staged surgeries was based

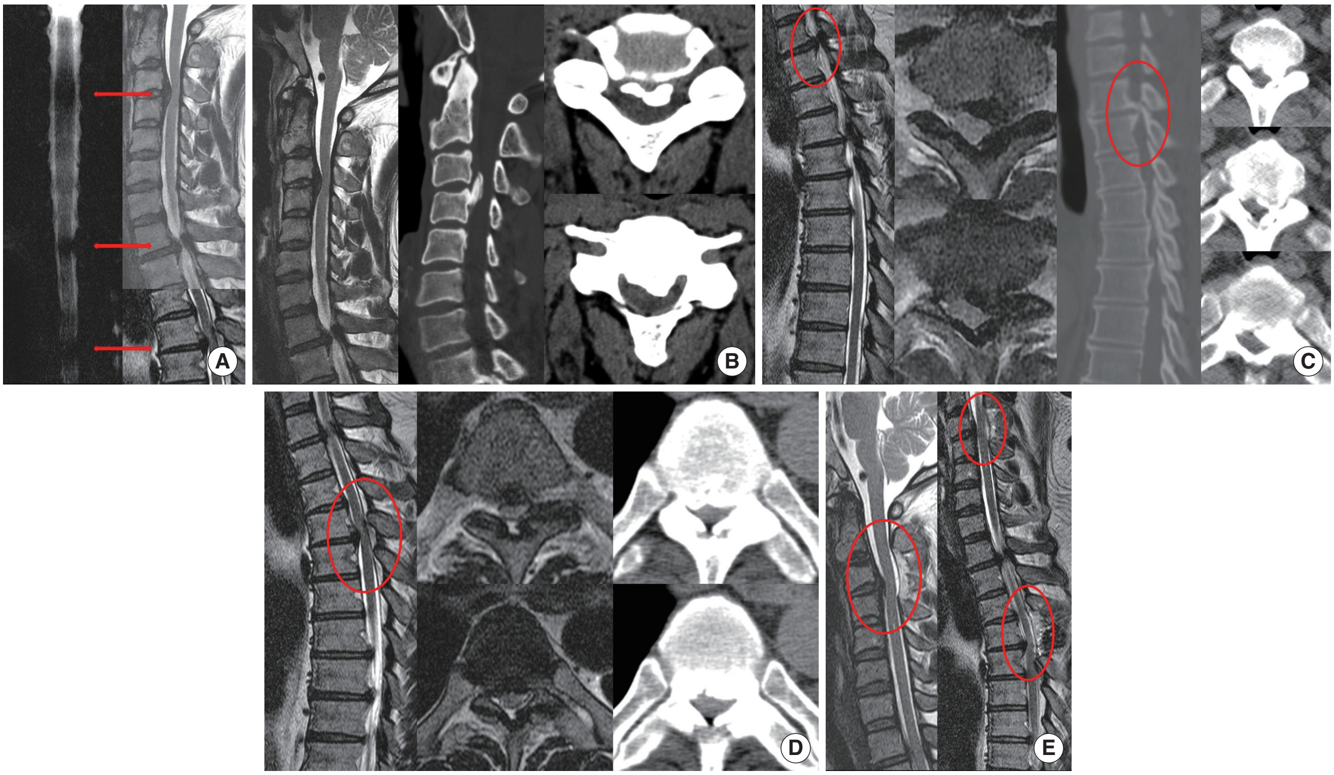


**Fig. 1.** (A) Cervicothoracic multiple stenosis with total signal block. The red arrows indicate the cervicothoracic lesions targeted for surgery. From top to bottom, they represent the C3–4, T1–2, and T4–5 lesions, respectively. (B) Central stenosis at C3–4 with ossification of the posterior longitudinal ligament and signal changes in the spinal cord. (C) Central stenosis due to central to left-sided hard disc herniation and ossification of the ligamentum flavum (OLF). The red ellipses indicate the T1–2 lesion. (D) Central stenosis was mainly caused by OLF and bilateral hard disc herniation, alongside a spinal cord signal change. (E) Postoperative magnetic resonance imaging shows a completely decompressed cord at C3–4 and T4–5 levels. The red ellipse in the left image represents the C3–4 level, while the red ellipses in the right image represent the C3–4 and T4–5 levels from top to bottom.

on the need to address each issue individually. This approach was chosen to ensure precise problem-solving for each pathology. Performing all surgeries simultaneously could potentially complicate the identification of the exact source of any postoperative complications. Moreover, if complications arose in multiple areas at once, managing them could become significantly more challenging. Addressing one issue might allow catastrophic damage to continue in another area. Thus, a staged operation was chosen to accurately manage each potential problem. The order of surgeries was determined based on the understanding that the cervical spine is generally a mobile segment and may be the primary cause of the patient's symptoms. Given that the patient presented with bilateral symptoms without clear directionality, and magnetic resonance imaging (MRI) myelogram showed a bilateral signal block in the cervical spine, the cervical pathology was prioritized as the first surgery. For the thoracic lesions, the T4–5 segment, which exhibited a more severe bilateral total signal block on the MRI myelogram, was selected for the second surgery. Finally, the T1–2 segment, which demonstrated a near-total signal block (more pronounced on the left side), was scheduled as the third surgery. The first surgery addressed the C3–4 lesion using a unilateral biportal endoscope (UBE) system. In the cervical spine, unlike in the thoracic and lumbar regions, the lamina has a shallower angle and is thinner, which increases the risk of spinal cord compression when inserting instruments beneath the lamina. Therefore, to safely achieve bilateral decompression from behind the cord, we opted for a spinous preserving laminectomy, rather than using a unilateral approach for bilateral decompression (ULBD), which is commonly employed in thoracic and lumbar cases. This approach allowed for indirect decompression.[1] When approaching from the midline, it is impossible to remove anterior pathology without retracting the cord. However, angling the endoscope laterally presents additional challenges due to the characteristics of the cervical lamina. Performing a contralateral laminectomy without compressing the cord is nearly impossible in this region. Moreover, unlike the upper thoracic spine, the lateral margin of the thecal sac in the cervical spine is close to the facet, which, in the mobile cervical segment, increases the risk of facet damage and potential instability. As a result, direct removal of the ossification of the OPLL was not performed during this surgery. Postoperatively, leg muscle strength improved to grade 3 in the right leg and grade 2 in the left leg, allowing the patient to walk with a walker. One week later, the second surgery was performed on the T4–5 segment using the uniportal full endoscope system for ULBD. Postoperatively, the patient showed improvement in muscle strength, with grade 4 in the right leg and grade 3 in the left leg, which enabled him to walk short distances without the aid of a walker. The postoperative MRI demonstrated a significantly decompressed spinal cord (Fig. 1E). While symptoms improved rapidly after the surgery, the patient continued to experience bilateral weakness, predominantly on the left side, following both the first and second surgeries. This led us to conclude that the T1–2 level was likely contributing to the ongoing myelopathy. Given the patient's young age, we aimed to address this issue before any permanent damage occurred. The patient was also highly motivated to proceed with treatment, and we scheduled the T1–2 surgery for 2 weeks later. At the T1–2 level, the thecal sac is narrower compared to the cervical spine, and the lamina is relatively wider, thicker, and more substantial. This anatomical feature allows for ULBD without contacting the thecal sac.[2] Additionally, although the thecal sac width is narrow, the canal size does not significantly decrease compared to the cervical spine. By resecting only up to the medial margin of the upper and lower pedicles, it is possible to achieve relatively wide disc exposure without substantial facet damage or increased instability. This provides a clearer view of the thecal sac and disc, making it easier to remove anterior pathology without compromising the spinal cord.[3]

Given the characteristics of the thoracic spine, a uniportal full endoscopic system was utilized to approach the lesion from both the posterior and anterior sides, aiming for a 270° decompression to remove the pathology in a single step.

This study was approved by the Institutional Review Board of Wooridul Spine Hospital (approval number: 2024-08-WSH-004), and the requirement for patient consent was waived due

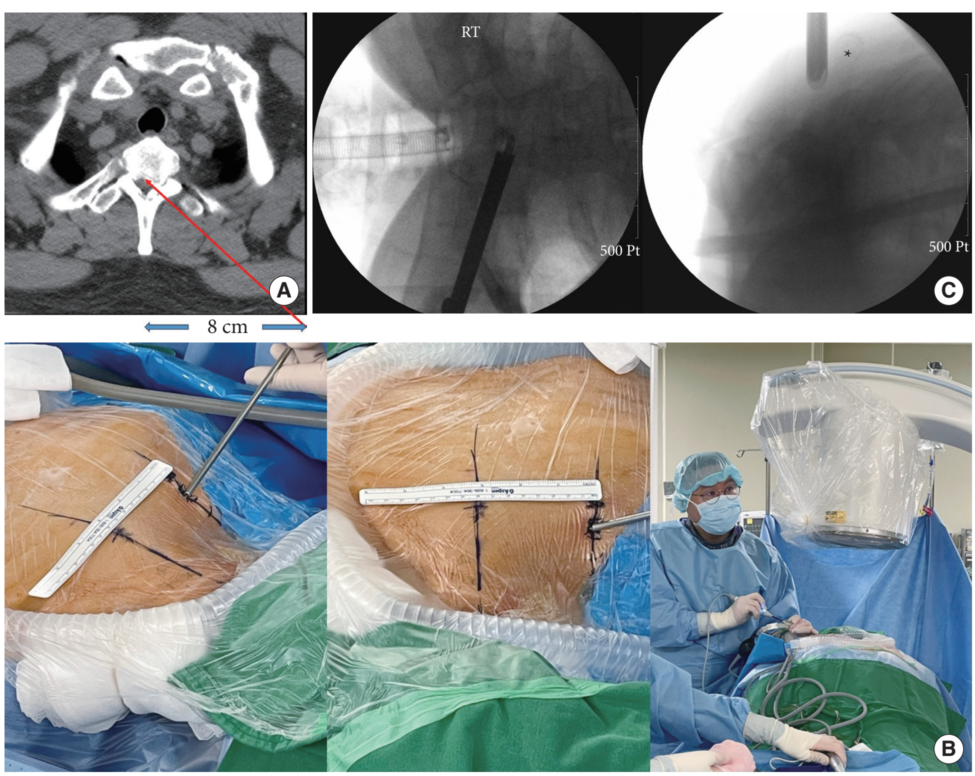


**Fig. 2.** (A) The skin was incised 8 cm lateral to the midline at the T1–2 level. The red arrow indicates the approach route. (B) The skin incision was located within the trapezius muscle. Since the lateral C-arm view did not provide adequate visualization, the surgery was primarily performed using the anteroposterior view. (C) In the left anteroposterior view, the endoscopic probe is touching the posterior aspect of the T1 spinous process, and in the right oblique view, the probe is touching the anterior aspect of the T1 spinous process. The asterisk indicates the tip of the T1 spinous process.


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to the retrospective nature of the study and the complete anonymization of patient identifiers.

## SURGICAL TECHNIQUE

Under general anesthesia, the patient was positioned prone, and the surgery was performed using a uniportal full endoscopic approach. A 150-mm working length endoscope with 2 irrigation channels, a 7.3-mm outer diameter, and a 4.7-mm working channel (iLESSYS Pro, Joimax, Inc., Irvine, CA, USA) was used. The patient was positioned prone with the neck slightly flexed and secured on the Wilson frame. A skin incision was made 8 cm lateral to the midline at the T1–2 level (Fig. 2A), through the trapezius muscle (Fig. 2B) to minimize pressure on the spinal cord while accessing the anterior pathology. The incision was placed 8 cm laterally based on the CT scan, where a line was drawn following the angle of the medial part of the disc adjacent to the cord and extended to the skin, guiding the incision point.

Serial dilators were inserted through the incision. After contacting the tip of the T1 spinous process, an oblique working tube was inserted via the dilator. The endoscope was then introduced through the working tube. Since a lateral C-arm view was unavailable, anteroposterior and oblique C-arm views were used to locate the tip of the T1 spinous process and trace the path to the T1–2 junction (Fig. 2C). Although the instrument was inserted into the trapezius muscle, the endoscopic view provided clear landmarks for orientation.

An ipsilateral laminectomy was performed at the T1–2 junction. As the layers were gradually thinned, the ossification of the ligamentum flavum (OLF) and lamina junction were identified. An epidural space was visible as a gap between the hard lamina and the OLF mass. By continuing to thin the area, this gap was expanded along the OLF border. Once the cranial, caudal, and medial borders of the OLF mass were located, the medial margin of the T1 and T2 pedicles was identified, effectively securing three sides of the OLF mass.

The lateral portion of the OLF mass was carefully thinned, allowing it to be isolated and removed *en bloc* to avoid any compression of the spinal cord. Ipsilateral posterior decompression was performed, achieving 90° decompression. The contralateral OLF mass was then removed using the same technique, resulting in 180° decompression (Fig. 3A). Minimizing any pressure on the spinal cord during anterior disc mass removal was ac-

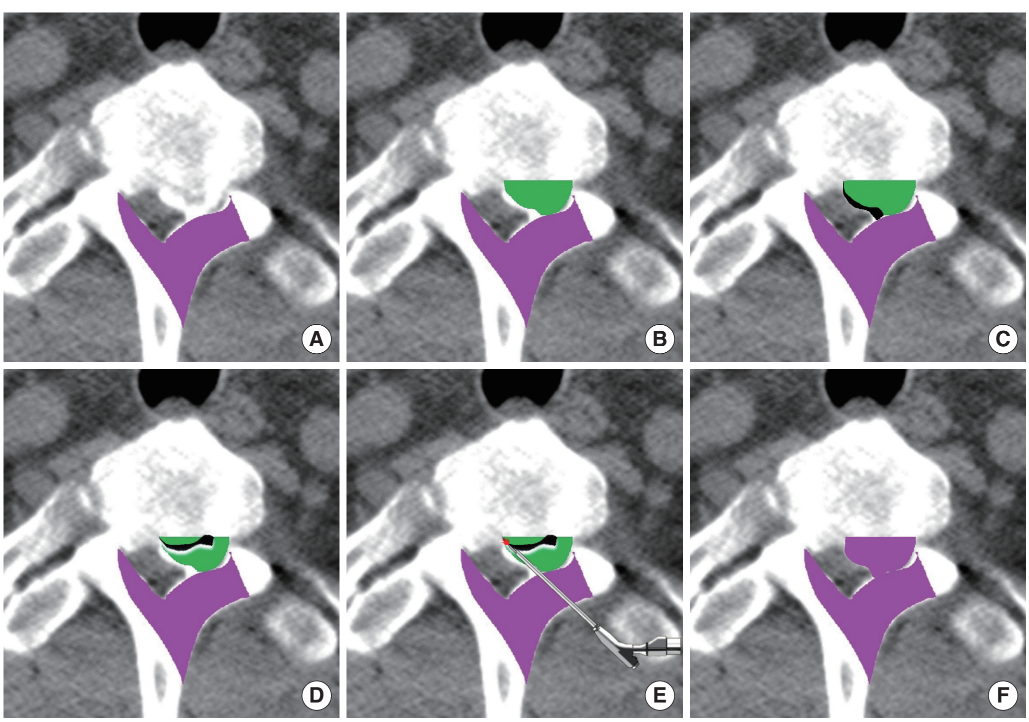


**Fig. 3.** Surgical summary. (A) 180° of decompression was performed posteriorly using unilateral approach bilateral decompression. (B) The inside of the disc was drilled out. (C) The disc was thinned into a flap, and the medial end was thinned to egg-shell thickness. (D) Initial decompression was performed by pressing down the flap. (E) The thin medial end of the flap is broken using an endoscopic chisel. (F) 270° decompression was completed.

complished by first decompressing the posterior structures.

At the T1–2 level, the thecal sac is narrow, and the distance from the thecal sac to the pedicle is relatively wide. This allows for natural and easy access to the disc once the posterior structures are removed. After exposing the disc, the boundary between the thecal sac and the disc was identified, followed by adhesiolysis. The posterior vertebral body surface and the cranial and caudal boundaries of the disc were then confirmed. The inside of the disc was drilled out using a 3.5-mm diamond burr (Fig. 3B). Subsequently, while safely thinning the disc into a flap under endoscopic visualization of the thecal sac, the medial end of the flap was specifically thinned to an egg-shell thickness, preparing it to function as a hinge (Fig. 3C). After the flap was isolated, it was separated from the thecal sac, ensuring it could be easily fragmented using a chisel. Care was taken not to thin the entire flap to an egg-shell thickness—except for the medial end—so that it could serve as a protector for the thecal sac. Initial decompression was achieved by pressing down on the flap with an endoscopic probe (Fig. 3D). Once the flap was fully separated from the thecal sac, further fragmentation was performed using an endoscopic chisel and hammering technique (Fig. 3E). The fragments were removed with endoscopic forceps, completing the 270° decompression (Fig. 3F). The disc was thoroughly removed up to the posterior surface of the vertebral body. After decompression, cord pulsation and thecal sac fluctuation due to water pressure were confirmed.

To prevent complications, such as hematoma formation that could result in catastrophic outcomes, a drain was inserted in all cases. The drain was introduced through the working tube and routed subcutaneously to a location separate from the surgical incision. The skin was then closed using subcutaneous sutures and skin glue.

## RESULTS

The patient underwent treatment for three lesions using a total of four incisions, each approximately 1 cm in length. Two incisions were used for the cervical UBE surgery, and one incision each for the thoracic full-endoscopic procedures. Postoperative MRI scans showed complete decompression of all affected areas (Fig. 4A), including full decompression of the thecal sac at the T1–2 level (Fig. 4B). Postoperative CT confirmed the complete removal of the left and right OLF masses and the anterior hard disc (Fig. 4C). In the sagittal view, cranial and caudal bone resection, comparable to that achieved via thoracotomy, was confirmed (Fig. 4D).

On postoperative day 1, the patient reported no significant difference in weakness between the left and right legs. By postoperative day 3, the muscle strength in both legs had improved to grade 5, allowing the patient to walk independently and be discharged without pain. At the final follow-up after 11 months, x-rays showed no progression of instability. The patient reported being able to walk up stairs and hike without difficulty.

## DISCUSSION

This surgery used the uniportal full endoscope to achieve a minimal invasive technique, requiring only a 1 cm incision to

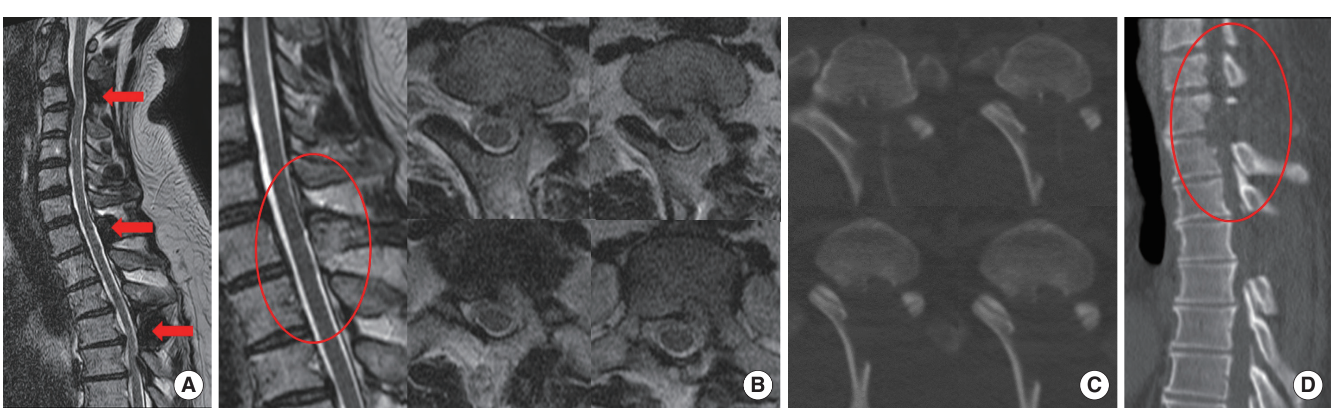


**Fig. 4.** (A) Postoperative magnetic resonance imaging (MRI) showed complete decompression in all affected areas. The red arrows represent, from top to bottom, the C3–4, T1–2, and T4–5 levels. (B) MRI showed a fully decompressed thecal sac at the T1–2 level. The red ellipse indicates the postoperative T1–2 level. (C) Postoperative computed tomography confirmed the complete removal of bilateral ossification of the ligamentum flavum masses and the anterior hard disc. (D) The sagittal view showed sufficient cranial and caudal bone resection, similar to that of thoracotomy. The red ellipse indicates the postoperative T1–2 level.


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perform a 270° decompression at the cord-level lesion. Minimizing incision size is crucial for preserving tissue integrity while providing adequate decompression. In cord-level surgeries, it is vital to avoid additional pressure on the already compressed cord areas in contact with the pathology.[4] Therefore, in this case, an *en bloc* resection method was employed, resecting only the normal tissue not in contact with the cord. This approach allowed safe removal of the pathology.[5]

During posterior decompression, the procedure was performed layer by layer, isolating the pathology and using the punch only in the normal areas to separate and remove the pathological tissue. This meticulous technique helped prevent undue pressure on the spinal cord and contributed to a successful outcome.

For anterior decompression, the boundary of the hard disc was first identified, and decompression was performed inside the disc without touching the cord, using the hard disc itself as a protector. The portion of the disc in direct contact with the spinal cord was carefully detached as a flap and then broken away in the opposite direction to ensure complete removal. Throughout the entire anterior and posterior procedure, great care was taken to avoid applying any pressure to the spinal cord.

Anterior approaches at the T1–2 level include various techniques such as the anterior suprasternal approach, anterior sternal splitting approach, and thoracotomy with lateral extracavitary exposure. However, these approaches present significant challenges in terms of access. The sternum often obstructs the surgical view, and thoracic kyphosis makes it difficult to reach the lesion at an optimal angle, often necessitating larger sternal incisions. Performing a sternotomy can increase morbidity, while thoracotomy is complicated by the presence of the aortic arch and great vessels.[6-12] Additionally, anterior approaches cannot access lesions located posterior to the thecal sac.

In contrast, posterior approaches include methods such as standard laminectomy, laminectomy with medial facetectomy, and transfacet pedicle-sparing discectomy.[12-18] At the T1–2 level, a posterior endoscopic interlaminar approach offers the possibility of performing ULBD (unilateral laminoplasty with bone decompression) from the posterior side, similar to techniques used at other thoracic levels.[19] However, removing anterior lesions without spinal cord retraction is nearly impossible when approaching from the posterior midline. This is particularly challenging when dealing with hard discs, as they are prone to erosion or adhesion to the dura, requiring extra caution during removal. In contrast to soft discs, which can be easily removed to relieve pressure, hard discs require meticulous removal in fragments, increasing the risk of inadvertently placing pressure on the spinal cord. Manipulating an already damaged cord can have serious adverse effects on the patient.[20,21] Therefore, pressure-free surgery is critical to avoid further compression or manipulation of the cord.

A posterolateral approach, angled away from the midline, offers a solution by avoiding spinal cord retraction, thereby preventing pressure on the cord. However, this approach, when performed from a sufficiently lateral position, requires extensive muscle dissection for adequate visualization. As the approach becomes more lateral, the working angles for instruments become shallower, which can interfere with instrument use and reduce efficiency. Traditional microscopic surgery requires significant muscle dissection to achieve a good working view, but the UBE system reduces muscle dissection by introducing only the scope and instruments. The relatively short length of these tools can limit the ability to achieve optimal surgical angles. Even with longer instruments, holding the scope in one hand and the instrument in the other compromises hand stability, which is critical during spinal cord surgeries and may increase the risk of complications.

The uniportal endoscopic system can access lesions from various angles and distances but may not be sufficient for fully decompressing a 180° anterior lesion from a single side. In cases with bilateral anterior lesions, switching between left and right

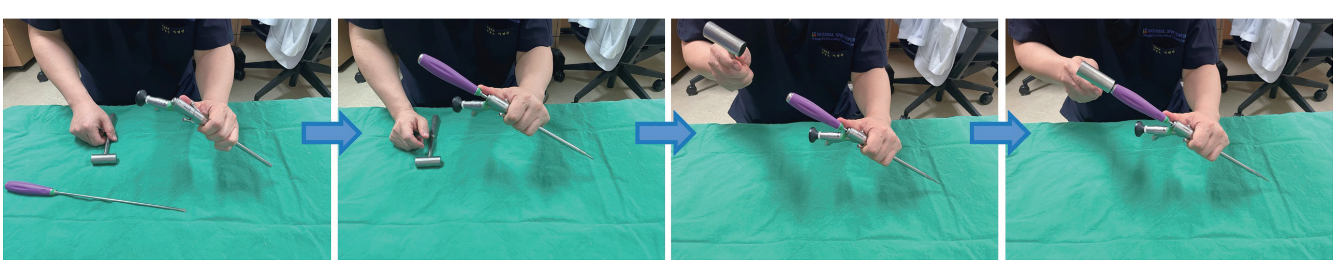

**Fig. 5.** The ways the surgeon can use the endoscopic chisel and hammer alone. One hand holds both the working tube and the endoscope. Insertion of the endoscopic chisel, length adjustment with the thumb, and firm hold. The hammer is held with the other hand. Hammering is performed alone.

approaches provides a minimally invasive alternative to more invasive anterior techniques. The uniportal system allows the surgeon to control both the working tube and the endoscope with one hand, while the thumb manipulates the instrument, offering a stable 3-point stabilization system for precision. This method ensures that the surgeon can perform complex tasks, such as holding an endoscopic chisel with one hand while hammering with the other, without needing an assistant (Fig. 5).

While the surgery typically requires only two hands, in more complex cases—such as this one, where an endoscopic chisel is used—having assistance can be invaluable. For example, when the operator holds the chisel and performs the hammering, the assistant can stabilize the working tube, or assist with hammering while the operator holds both the working tube and chisel securely.

However, even minor mistakes can lead to catastrophic outcomes, making it essential for the primary surgeon to maintain complete control independently throughout the procedure. The slim and elongated design of the uniportal system allows the surgeon to operate independently and effectively, ensuring a minimally invasive, accessible, and stable procedure. The endoscope's magnification of small areas provides a detailed view of the relationship between the hard lesion and the thecal sac, facilitating the identification and careful dissection of any adhesions. These features make uniportal endoscopy a safe and minimally invasive option, especially for difficult-to-access thoracic cord lesions.

## NOTES

**Video File:** The video file for this article is available at https://doi.org/10.14245/ns.2449044.522.

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## REFERENCES

1. Ma HJ, Lee SH, Park CH. Uniportal full endoscopic spinous process-preserving laminectomy for bilateral decompression in cervical stenotic myelopathy: patient series. J Neurosurg Case Lessons 2023;5:CASE2378.
2. Ganapathy MK, Reddy V, Tadi P. Neuroanatomy, spinal cord morphology. 2024 Sep 10. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan–.
3. Peabody T, Black AC, Das JM. Anatomy, back, vertebral canal. 2023 Nov 16. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan–.
4. Bae J, Kim J, Lee SH, et al. Comparative analysis of transforaminal endoscopic thoracic discectomy and microscopic discectomy for symptomatic thoracic disc herniation. Neurospine 2022;19:555-62.
5. Kim JY, Ha JS, Lee CK, et al. Biportal endoscopic posterior thoracic laminectomy for thoracic spondylotic myelopathy caused by ossification of the ligamentum flavum: technical developments and outcomes. Neurospine 2023;20:129-40.
6. Rossitti S, Stephensen H, Ekholm S, et al. The anterior approach to high thoracic (T1-T2) disc herniation. Br J Neurosurg 1993;7:189-92.
7. Nakahara S, Sato T. First thoracic disc herniation with myelopathy. Eur Spine J 1995;4:366-7.
8. Winter RB, Siebert R. Herniated thoracic disc at T1-T2 with paraparesis. Transthoracic excision and fusion, case report with 4-year follow-up. Spine (Phila Pa 1976) 1993;18:782-4.
9. Sharan AD, Przybylski GJ, Tartaglino L. Approaching the upper thoracic vertebrae without sternotomy or thoracotomy: a radiographic analysis with clinical application. Spine (Phila Pa 1976) 2000;25:910-6.
10. Caner H, Kilinçoglu BF, Benli S, et al. Magnetic resonance image findings and surgical considerations in T1-2 disc herniation. Can J Neurol Sci 2003;30:152-4.
11. Gille O, Razafimahandry HJ, Söderlund C, et al. [T1-T2 disc herniation: two cases]. Rev Chir Orthop Reparatrice Appar Mot 2006;92:715-8. French.
12. Rahimizadeh A, Zohrevand AH, Kabir NM, et al. T1-T2 disc herniation: report of four cases and review of the literature. Surg Neurol Int 2019;10:56.
13. Lloyd TV, Johnson JC, Paul DJ, et al. Horner's syndrome secondary to herniated disc at T1--T2. AJR Am J Roentgenol 1980;134:184-5.
14. Alberico AM, Sahni KS, Hall JA Jr, et al. High thoracic disc herniation. Neurosurgery 1986;19:449-51.

15. Kumar R, Buckley TF. First thoracic disc protrusion. Spine (Phila Pa 1976) 1986;11:499-501.
16. Morgan H, Abood C. Disc herniation at T1-2. Report of four cases and literature review. J Neurosurg 1998;88:148-50.
17. Patterson RH Jr, Arbit E. A surgical approach through the pedicle to protruded thoracic discs. J Neurosurg 1978;48: 768-72.
18. Bransford R, Zhang F, Bellabarba C, et al. Early experience treating thoracic disc herniations using a modified transfacet pedicle-sparing decompression and fusion. J Neurosurg Spine 2010;12:221-31.
19. Ruetten S, Hahn P, Oezdemir S, et al. Full-endoscopic uniportal decompression in disc herniations and stenosis of the thoracic spine using the interlaminar, extraforaminal, or transthoracic retropleural approach. J Neurosurg Spine 2018;29: 157-68.
20. Hott JS, Feiz-Erfan I, Kenny K, et al. Surgical management of giant herniated thoracic discs: analysis of 20 cases. J Neurosurg Spine 2005;3:191-7.
21. Lin YP, Lin R, Chen S, et al. Thoracic full-endoscopic unilateral laminotomy with bilateral decompression for treating ossification of the ligamentum flavum with myelopathy. Ann Transl Med 2021;9:977.