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Retrospective Case Review

Fully Endoscopic 360° Decompression Surgery for Thoracic Spinal Stenosis: Technical Note and Report of 8 Cases

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Background: Surgical options for treating thoracic spinal cord compression that results from circumferential stenosis typically involve instrumented fusion procedures. The authors present here an outpatient, awake, endoscopic surgical option for treating thoracic stenosis that avoids fusion.

Objectives: To evaluate the outcome and safety of combining fully endoscopic transforaminal and posterior approaches for ventral and dorsal decompression of thoracic spinal stenosis.

Study Design: Retrospective case review.

Setting: Single-center acute-care hospital.

Methods: Eight patients with single-level, significant stenosis of the thoracic spinal canal were treated with fully endoscopic transforaminal and posterior approaches to achieve 360° ventral and dorsal decompression. Patients were followed up to 30 months postoperatively. Axial back pain was measured by the Visual Analog Scale (VAS) score, and paired Student t-test was used for statistical analysis.

Results: Successful decompression was achieved in all 8 patients. All surgeries were performed as outpatient procedures under local anesthesia with intravenous (IV) sedation. There were no intraoperative dura tears, spinal cord or nerve root injury, postoperative infections, or cases of iatrogenic-induced segmental instability. All patients had significant improvement with VAS scores significantly lower postoperatively.

Limitations: Small case series evaluated retrospectively with 15-month average follow-up.

Conclusions: Combining fully endoscopic transforaminal and posterior approaches for both ventral and dorsal decompression under local anesthesia with IV sedation is an effective and safe minimally invasive surgical treatment for thoracic spinal stenosis.

Key words: Thoracic spinal stenosis, fully endoscopic, transforaminal, myelopathy, bilateral laminotomy/unilateral approach

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Thoracic spinal stenosis is a relatively rare spinal disorder that is the result, typically, of degenerative processes that include disc herniation, endplate osteophyte formation, ossification of the posterior longitudinal ligament, and hypertrophy of the facet joints and/or ligamentum flavum (1,2). Surgery to treat thoracic spinal stenosis is often challenging. The goal is to achieve adequate decompression without manipulating the spinal cord. Individual planning is required, and various surgical techniques and approaches have been used (3-5). However, the traditional surgical intervention has a high incidence of complications (6-9). Although fully endoscopic technique via the transthoracic retro-pleural

or interlaminar approach has been recently reported (10-13), there has been no report of combing both a ventral transforaminal and posterior approach in a single stage. This case series describes the technique of a single-stage, fully endoscopic transforaminal decompression of the ventral epidural space, followed by bilateral laminotomy with unilateral approach for posterior decompression of the spinal canal. The unique advantage of this combined approach is to achieve adequate 360° decompression under local anesthesia with intravenous (IV) sedation that avoids fusion.

Methods

Patients

Eight consecutive patients (3 women, 5 men, average age 56 years, age range 38–76 years) were included in this case series. The locations of the pathology were T7/8 (2 cases), T9/T10 (2 cases), T10/T11 (3 cases, one patient shown in Fig. 1), and T11/T12 (1 case). All patients had significant thoracic axial pain and 4 of the 8 patients had clinical myelopathy characterized by symptoms including bilateral lower extremity numbness/tingling/feeling of weakness and lower extremity coordination/balance complaints. The average postoperative follow-up was 15 months (range, 7–30 months).

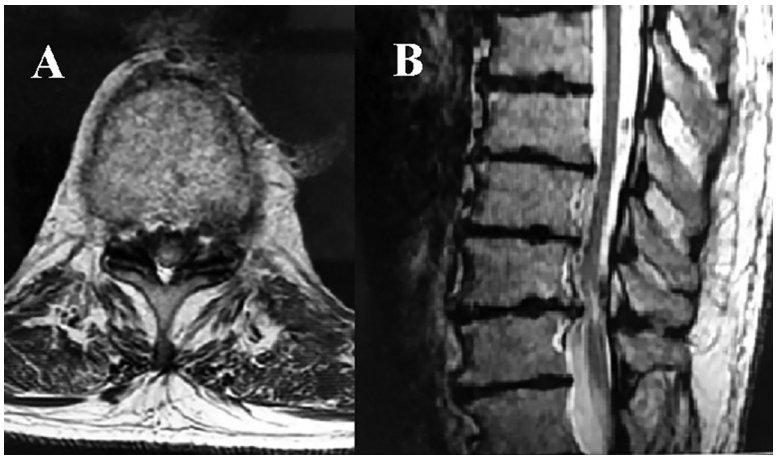

Fig. 1. *Magnetic resonance (MR) images of a 76-year-old male patient with symptomatic T10/T11 spinal stenosis and cord compression. (A) T2-weighted axial MR image at T10/11 demonstrating the circumferential canal narrowing and increased spinal cord signal. (B) Sagittal T2-weighted MR image demonstrating the T10/11 severe canal narrowing and increased spinal cord signal.*

Operative Procedure

Under local anesthesia (the approximate amount used was 40 mL of 1% lidocaine with epinephrine for the entire case) with IV sedation (fentanyl and Versed), the surgery was performed with the patient in the prone position on a radiolucent table, under biplanar fluoroscopic guidance. The level of anesthetic was titrated, so the patient was comfortable and able to communicate with the surgeon throughout the surgery. Preoperatively, the approach trajectory for the transforaminal approach angle was measured on the axial magnetic resonance images so the approach would avoid the ribs and pleura. Percutaneous entry was through the skin 7 to 9 cm lateral to the midline. Using intermittent fluoroscopic guidance, alternating between lateral and anterior-posterior (AP) views, a 15-cm 18-gauge needle was advanced and placed at the superior facet of the surgical level. Subsequently, the sequential dilators were passed through the soft tissue and docked on the ventral potion of the ipsilateral superior facet. Sequential reamers were used to enlarge the neural foramen by removing the ventral aspect of the superior facet and part of the rib head. The final beveled tubular retractor was then placed, and the Joimax (Irvine, CA) TESSYS endoscopic system with a 25° viewing angle was used. All surgical instruments were introduced under continuous irrigation and direct visualization through the intraendoscopic working channel (Fig. 2). The facet, pedicle, disc, and ligamentum flavum were visualized, and ventral epidural decompression was accomplished by removing the disc herniation without any manipulation or retraction of the spinal cord. If the disc herniation was calcified or if there was a bony osteophytic ridge of the disc endplate, the bony compression was drilled under direct visualization with a high-speed drill (Joimax Shrill, 3.5-mm diamond abrasor). Hemostasis was achieved with a radiofrequency probe. When the neural elements were visualized as well decompressed, the endoscopic instruments were withdrawn and the incision (8 mm) was closed without a drain.

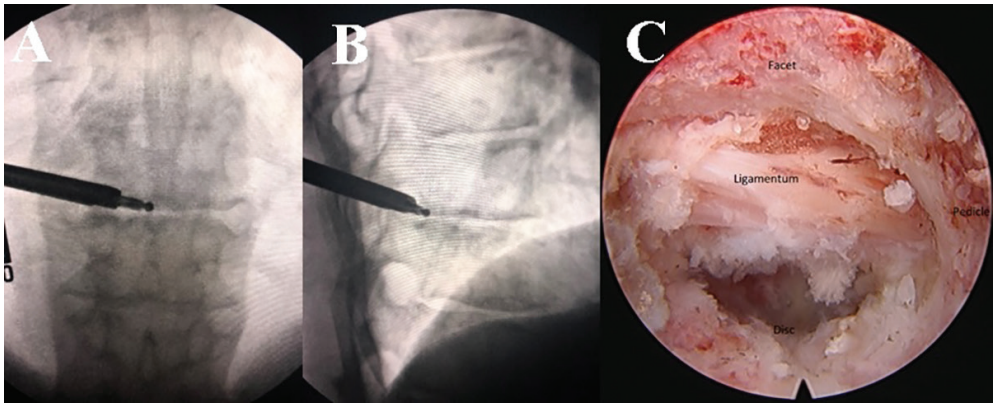

Fig. 2. *Transforaminal ventral epidural decompression procedure at T10/T11. (A) Intraoperative AP fluoroscopic images demonstrating the placement of the beveled tubular retractor, endoscope, and endoscopic grasper. (B) Intraoperative lateral fluoroscopic images (taken at the same time as the AP image in Fig. 2A) demonstrating the placement of the beveled tubular retractor, endoscope, and endoscopic grasper. (C) Intraoperative endoscopic camera image demonstrating the superior facet, pedicle, and ligamentum flavum, visualized after placement of the endoscopic camera through the transforaminal approach.*

After the ventral transforaminal decompression, patients underwent a fully endoscopic thoracic laminotomy (bilateral decompression with unilateral approach) of the same level, through a separate incision, with the Joimax iLESSYS Delta endoscopic system. This system utilizes a tubular retractor that has a 12.0-mm outer diameter and a 10.2-mm inner diameter. The working-channel endoscope that is placed inside the tubular retractor has a 10-mm outer diameter, 6-mm working channel, and 15° viewing angle (Fig. 3). The approach is a posterior paramedian approach. A 12-mm incision was made approximately 1 cm off midline. Soft tissue dilation was performed with sequential dilators docking on the interlaminar space. Next, the tubular retractor was placed over the dilators, and the dilators were removed. The working-channel endoscope was placed in the tubular retractor and under endoscopic visualization, decompression could be achieved using a high-speed endoscopic drill (Joimax Shrill, 4.5-mm diamond abrasor). The decompression is bilateral with ipsilateral and contralateral decompression achieved by drilling the lamina in a subspinous process approach. Straight micrograspers were used to remove ligamentum flavum, and endoscopic Kerrison punches (both 40° and 90° angles) with 1.5-mm footprints were used to remove additional bone and ligament. Meticulous dissection of the interface between the ligamentum flavum and the dura was done with a blunt-tipped micronerve hook. Continuous irrigation also helped to create a plane between the dura and the ligamentum flavum, helping to avoid a dural tear. Hemostasis was achieved with a radiofrequency probe. At the end of decompression, the thecal sac/spinal cord was seen well decompressed on both the contralateral and ipsilateral side (Fig. 3), and normal pulsation of the dural sac was seen. The 12-mm incision was closed in layers with absorbable sutures without a drain.

Results

The patients were decompressed in a single-stage combined fully endoscopic approach as described earlier.

The average operation time was approximately 160 minutes. The average hospital stay was 0.25 days. There were no intra- or postoperative complications.

At final follow-up (averaging 15 months with range of 7–30 months), the average postoperative Visual Analog Scale (VAS) score was 2.7, significantly lower than the average preoperative VAS of 8.1 (analysis with Student t-test confirmed the improvement was statistically significant at $P < 0.05$). No surgery or approach-related increase in thoracic back pain was reported. No postoperative neurologic deterioration was reported. The 4 patients with clinical myelopathy all reported significant improvement postoperatively.

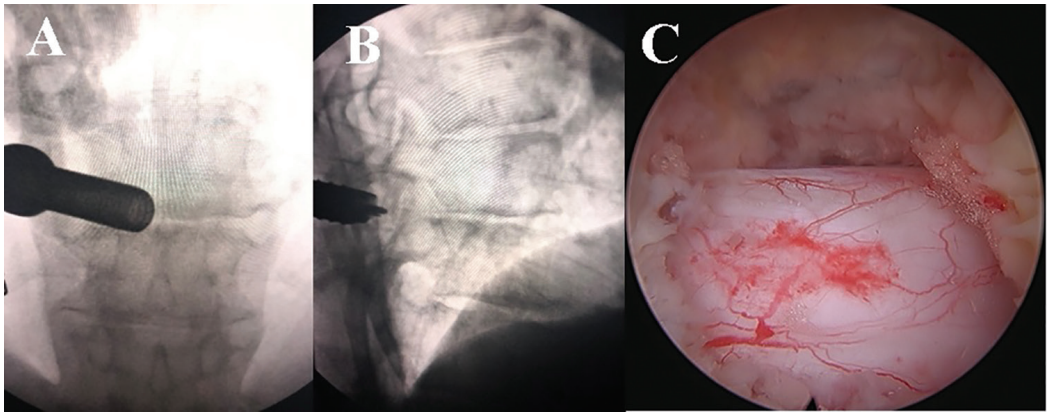

Fig. 3. *Bilateral laminotomy with unilateral approach for posterior decompression of the spinal canal. (A) Intraoperative AP fluoroscopic images demonstrates the tubular retractor placement for T10/T11 posterior decompression. (B) Intraoperative lateral fluoroscopic images demonstrates the tubular retractor placement for T10/T11 posterior decompression. (C) Intraoperative endoscopic camera image demonstrating the decompressed dural sac and spinal cord after endoscopic posterior decompression.*

Discussion

For thoracic spinal stenosis, traditional surgical intervention has a high incidence of complications (2-4,6,14). Postoperative neurologic deterioration is a devastating complication in thoracic decompressive surgery. Specific to thoracic spine surgery, the blood supply to the spinal cord can be interrupted iatrogenically during surgical intervention and lead to spinal cord ischemia and neurologic deterioration (15). In addition, direct trauma, manipulation, or retraction of spinal cord must be avoided during surgery. Endoscopic techniques have several advantages over more traditional surgical approaches including less tissue trauma and patient pain owing to the minimally invasive nature of the approach and instrumentation, as well as improved visualization owing to the nature (high definition) of the visualization and the position of the camera (at the pathology itself) (10,12).

There have been several more recent reports of endoscopic surgery for thoracic spinal decompression/discectomy that have been described in different studies (10-12,16-19). Presented here is the first study to suggest combining a transforaminal endoscopic ventral decompression with a posterior endoscopic compression. The combined fully endoscopic transforaminal and posterior bilateral decompression technique offers several advantages to the surgeon and patient: (1) clear visualization, (2) significantly reduced bleeding owing to the minimally invasive approach, (3) low complication rates (at least this is suggested in this small case cohort), and (4) the procedure can be performed without general anesthesia and as an outpatient procedure.

Several technical points should be made about the combined procedure presented here. During the transforaminal approach, bone resection of the facet joint and rib head (foraminoplasty) is necessary for access to the spinal canal. For the posterior decompression of the spinal canal, a larger endoscope, drill, and instruments are used. The working channel is more than 60% larger than that of the endoscope used in transforaminal approach. The increased size of the working channel makes treating central spinal stenosis more efficient. The goal of fully endoscopic laminectomy/laminotomy is the same as open decompression, yet it preserves midline structures and facet function/stability. The major disadvantage of the combined technique presented here is the relatively longer operative time. Because of the limitation of one-instrument-at-a-time in surgery through a working-channel endoscope, only one instrument can be used inside the working channel and the instruments are small.

Conclusions

A combined fully endoscopic transforaminal and posterior approach for both ventral and dorsal decompression under local anesthesia with IV sedation is pre-

sented here as a possible minimally invasive treatment for thoracic spinal stenosis. It is noted that this is a small retrospective case series, and a larger case series with longer term follow-up is needed.

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