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Thoracic Microendoscopic Discectomy

Kurt M. Eichholz, MD[a], John E. O'Toole, MD[b], Richard G. Fessler, MD, PhD[c,*]

[a]*Department of Neurological Surgery, Vanderbilt University, T-4224 Medical Center North, Nashville, TN 37232–2380, USA*
[b]*Department of Neurosurgery, Rush University Medical Center, 1725 West Harrison Street, Suite 970, Chicago, IL 60612, USA*
[c]*Section of Neurosurgery, The University of Chicago, 5841 South Maryland Avenue, MC 3026, Chicago, IL 60637, USA*

Thoracic disc herniations present a unique challenge for the spine surgeon in terms of patient selection, surgical technique, and potential complications. Thoracic disc herniations are a relatively rare condition, and have a reported incidence ranging from 1 in 1000 to 1 in 1,000,000 annually [1–3]. The decreased incidence of thoracic disc herniations is believed to be attributable to the increased rigidity of the thoracic cage, which causes the thoracic spine to have decreased flexion, extension, and rotation compared with the cervical and lumbar spine [4,5]. Despite the fact that thoracic disc herniations comprise a small percentage of the patients who ultimately require surgical intervention, patients may present with a wide variety of symptoms. In addition, a large array of surgical approaches has been developed to treat thoracic disc herniations. These have included posterior approaches (laminectomy), posterolateral (costotransversectomy, transfacet pedicle-sparing discectomy, transpedicular discectomy, and transversoartropediulectomy), lateral approaches (extracavitary and rhachotomy), transthoracic approaches (transpleural, extrapleural, and transsternal), and thoracoscopic approaches. The discrepancy between the small percentage of patients seen with this disease and the large number of surgical techniques developed is a testament to the difficulty the spine surgeon may encounter when attempting to treat these patients.

Complicating the surgical treatment of thoracic disc herniations are the potential devastating complications. The thoracic spinal cord, especially in the upper thoracic region, is in the watershed region of spinal vascular supply, leaving it prone to ischemic complications. Although root injury in the thoracic cord does not carry the morbidity and neurologic deficit that it does in the cervical or lumbar region, damage to the thoracic cord with its tenuous blood supply can render a patient paraplegic.

The previously mentioned approaches to thoracic disc herniations all have their advantages and disadvantages. Although anterior and lateral approaches allow the surgeon the greatest access to the intervertebral disc and vertebral body, these approaches also place the thoracic contents, including the lung, heart, and great vessels, at risk. Although posterior approaches are inherently safer, the large incision and amount of bone removed leave the patient prone to significant blood loss, paraspinal pain, and potential instability.

It is for these reasons that a new approach to thoracic disc herniations has been developed that allows the surgeon to treat these herniations through a minimally invasive posterior approach, resulting in decreased blood loss, hospital stay, postoperative pain, and recovery time. The thoracic microendoscopic discectomy (TMED) technique is a modification of the lumbar microendoscopic technique that has been used with success to treat multiple forms of pathologic conditions in the lumbar spine, including stenosis [6], disc herniations [7], and instability [8,9]. This

* Corresponding author.
E-mail address: rfessler@surgery.bsd.uchicago.edu (R.G. Fessler).

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article explores the indications for TMED, elaborates on the nuances of patient selection, describes the surgical technique, and discusses potential complications.

Indications and patient selection

As with any surgical procedure, patient selection is of paramount importance. One would expect that a laterally located disc herniation impinging on the exiting nerve root would cause pain radiating laterally around the thorax, whereas a centrally located disc herniation impinging on the thoracic cord would cause myelopathy, with spastic paraparesis in the lower extremities. A detailed history must be performed, with care taken to determine any recent history of trauma, infection, or suggestion of malignancy. Herpes zoster can mimic the thoracic radiculopathy seen in thoracic disc herniations, and metastatic lesions have also caused these herniations [10]. In addition, a well-performed physical examination with attention to sensory deficits over the anterior and posterior thoracic region may lead to the correct diagnosis.

Nevertheless, a review of the literature suggests that patient presentation may be extremely variable. Thoracic disc herniations have mimicked systemic, cardiac, renal, and orthopedic diseases. Eleraky and colleagues [11] described three patients who presented with symptoms of intense stabbing in the back radiating to the lateral chest wall, mimicking cardiac disease. After a cardiac workup was performed and found to be negative, MRI showed thoracic disc herniations that were treated surgically. Georges and coworkers [12] reported a patient who presented with pain similar to colicky pain found in conjunction with renal stones, which resulted from a calcified T11-to-T12 disc herniation. Others have described a rare radicular symptom presenting with unilateral paresis of the abdominal wall musculature [13]. Neurogenic claudication is most commonly attributable to lumbar stenosis, although others have reported this as a presentation of lower thoracic disc herniations [14,15]. Xiong and colleagues [16] reported a traumatic T9-to-T10 disc herniation causing abdominal and pelvic pain with periumbilical tenderness. After a gynecologic workup revealed endomyometritis that did not respond to nonsteroidal anti-inflammatory drugs and narcotics, the patient underwent a T9-to-T10 laminectomy and discectomy with dramatic improvement of her symptoms. In 1992, Bunning and Witten [17] reported on a patient who had recurrent dislocation of a total hip prosthesis, which was the result of spasticity attributable to a thoracic disc herniation causing myelopathy. Rarer presentations may be sudden flaccid paraplegia attributable to an intradural thoracic disc herniation [18], or chronic, as in the report by Jamieson and Ballantyne [19] of a thoracic disc herniation causing symptoms over 10 years when the patient performed rotatory movement of the thoracic spine during his golf swing. Thoracic disc herniations have also been reported in association with Scheuermann's disease [20,21] and as a result of chiropractic manipulation [22].

The clinician must correlate the patient history with physical examination and radiographic findings. This is essential because of the fact that thoracic disc herniations have been reported in up to 37% of asymptomatic patients [23–27]. The combination of widely varied presentation with the high incidence of thoracic disc herniations in the asymptomatic patient should cause the surgeon to have a high diagnostic certainty before undertaking surgical intervention to ensure the best outcome. Figs. 1 and 2 show sagittal and axial T2-weighted MRI images of a patient presenting with a symptomatic disc herniation at T6 to T7.

Surgical intervention

Thoracic disc herniations have been treated with a multitude of approaches, with varying success. Posterior approaches are comfortable for the spine surgeon because of the fact that

Fig. 1. Sagittal T2-weighted MRI scan of a patient with a T6-to-T7 disc herniation.

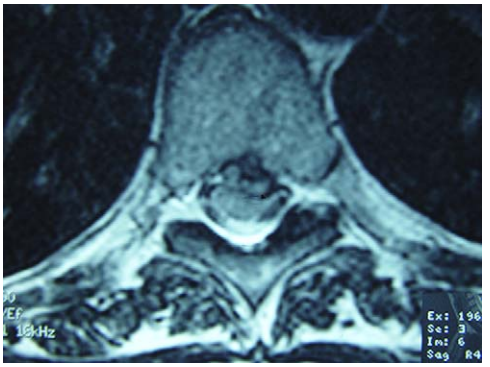

Fig. 2. Axial T2-weighted MRI scan of a patient with a T6-to-T7 disc herniation.

most lumbar spine disease is treated from a posterior midline approach. The ability to retract the thecal sac below the conus, which allows the posterior approach to be favored for most of the pathologic findings in the lumbar spine, is not present in the thoracic spine, however. The thoracic spinal cord is highly susceptible to injury with minimal retraction. Therefore, direct lateral approaches to the thoracic spine do not allow access to the central aspect of the intervertebral disc. Posterolateral approaches, including the costotransversectomy and transpedicular approach, require removal of supporting bone structure from the vertebral column. Although this type of approach allows safer access to more centrally located intervertebral disc herniations, the amount of bone removal necessary may be a cause of significant postoperative pain and morbidity. Although lateral and anterior approaches allow greater access to the intervertebral disc with minimal risk to the spinal cord, such access comes at the expense of risk to the thoracic structures. Transthoracic approaches have been shown to have a risk of disabling intercostal neuralgia in 50% of patients as well as postoperative atelectasis and pulmonary dysfunction in 33% of patients. Rosenthal and Dickman [28] showed that these complications could be reduced to 16% and 7%, respectively, with thoracoscopic approaches. Other potential pulmonary complications include pleural effusion, pulmonary contusion, hemothorax, and chylothorax [29–31].

Thoracic microendoscopic discectomy: surgical technique

The surgical technique for TMED is a modification of the technique used successfully in the lumbar spine [7]. General anesthetic is used, and the patient is positioned prone on a radiolucent Wilson frame mounted on a Jackson table. The Jackson table is preferred to facilitate movement of the C-arm fluoroscope into and out of the operative field. The arms are positioned above the patient, with care being taken not to overextend the arms beyond 90°. Continuous somatosensory evoked potential monitoring is performed during surgery. The endoscopic monitor and the fluoroscope monitor are positioned opposite the surgeon to facilitate viewing of these monitors.

Care and precision must be taken in localizing the appropriate operative level. The authors use lateral and anteroposterior (AP) fluoroscopy in localizing the level and count the level from the sacrum below or the occiput above at least twice.

Once the appropriate level is identified, a skin incision is made 3 to 4 cm lateral to the midline. A more lateral approach is required for larger patients to reduce any manipulation of the spinal cord during disc removal. A Kirschner wire (K-wire) is placed at the superior aspect of the caudal transverse process of the level of interest. A series of tubular muscle dilators are placed over the K-wire under fluoroscopic guidance. A tubular retractor is placed over the final dilator and attached to a table-mounted flexible arm. A rigid endoscope with a 30° lens is attached to the tubular retractor and positioned so that image displays medial anatomy at the top of the video monitor with lateral anatomy at the bottom. Rostral and caudal anatomy should be oriented in the same direction as the surgeon's view of the patient. The endoscopic view after the disc space is exposed is shown in Fig. 3. It is imperative for the surgeon to maintain proper orientation during the case, because loss of orientation can lead to inadvertent entry into the spinal canal with potential damage to the spinal cord or exiting nerve root.

Once the endoscope is placed, muscle and soft tissue overlying the field are removed with an insulated monopolar electrocautery. The exposure should yield the proximal transverse process and lateral facet. Once again, laterality of the dilator placement is essential to reduce manipulation of the spinal cord. Using a long, tapered, high-speed drill, the rostral aspect of the inferior transverse process and lateral facet is removed. This reveals the pedicle of the caudal vertebral body, which can be followed ventrally to the level of the disc space. The superior aspect of this pedicle can be removed with the drill to facilitate entry to the disc space (Fig. 4). Once the disc space is visualized, an

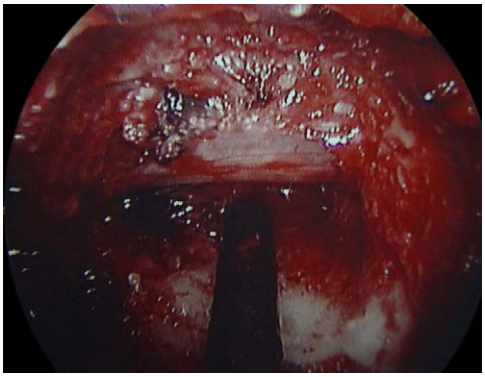

Fig. 3. Intraoperative endoscopic visualization of the surgical field during discectomy. The spinal cord is medial (*top*).

annulotomy knife is used to incise the annulus, and a combination of curettes and pituitary rongeurs is used to remove the herniated disc fragment.

The lateral-to-medial trajectory of the retractor, in combination with the 30° angle of the endoscope lens, allows direct visualization of the intervertebral disc space without manipulation of the spinal cord or neural elements. Using this technique, lateral disc herniations can be removed under direct visualization, whereas medially located disc herniations require the use of a downgoing curette or Woodson elevator to push the fragment down into the disc space, so that it can be removed from the lateral annulotomy. Using this technique, medial herniations can be removed while avoiding manipulation of the spinal cord.

After the herniated disc is removed, the operative field is copiously irrigated and meticulous hemostasis is obtained. The retractor is removed, suture is placed in the thoracodorsal fascia, and interrupted subcutaneous sutures are placed. The skin is closed with adhesive skin glue.

Complications and discussion

As with any surgical procedure, there is the potential for complications. It is the differences in minimally invasive techniques that make complications more prone to happen during the early steep learning curve. For the surgeon not familiar with endoscopic spinal surgery, experience is essential to obtain the hand-to-eye coordination necessary. For most neurosurgeons practicing spinal surgery, endoscopic techniques are unfamiliar. Inadvertent injury to neural structures can occur, because the surgeon has to adjust to using long instruments with minimal tactile feedback utilizing an unfamiliar visualization technique. In addition, the two-dimensional visualization of the endoscopic image on the video screen lacks the depth perception that surgeons who usually use a microscope with three-dimensional visualization are familiar with.

Dural violation is also a potential complication of TMED. With minimally invasive muscle-splitting retractors, the incidence of resultant

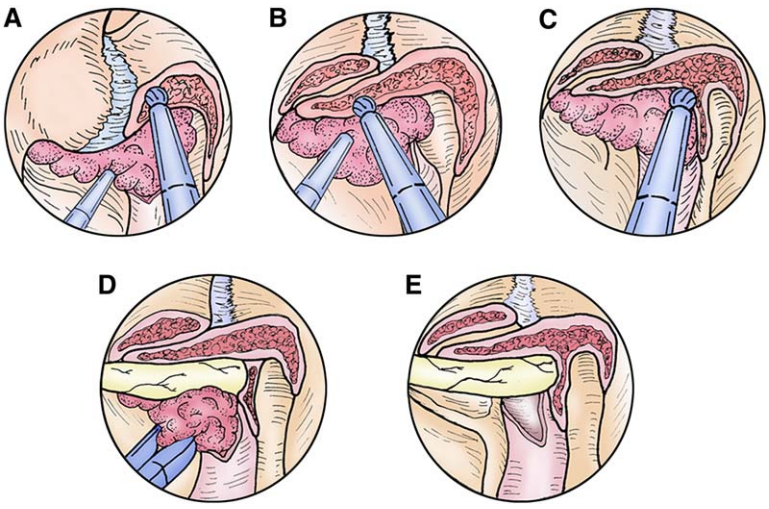

Fig. 4. Illustration shows drilling of the caudal proximal aspect of the transverse process (*A*), lateral aspect of the facet joint (*B*), and caudal lateral aspect of the pedicle (*C*) to remove the disc herniation (*D*), with decompression of the spinal cord (*E*).

pseudomeningocele formation is lower than with open surgery [32]. In the thoracic spine, however, dural violation is significantly more likely to involve neural injury to the spinal cord or the nerve root.

Others have described less invasive posterolateral approaches for thoracic disc herniations. The transfacet pedicle-sparing approach was described by Stillerman and colleagues [33] in 1995. This approach uses a 4-cm incision to remove the medial facet complex. An open rigid endoscope was used in some cases to aid with the discectomy. This approach avoided the need for a chest tube and reduced the potential for pulmonary complications. A later report by Stillerman and coworkers [34] advocated the pedicle-sparing approach over a transpedicular approach because of decreased bone and soft tissue destruction and less postoperative back pain. In 1999, Jho [35] described an endoscopic transpedicular thoracic approach. This approach used a 2-cm incision, stripping muscle from the lamina and face with a periosteal elevator. A drill was used to remove the lateral lamina, medial facet, and one third of the pedicle. A 70° endoscope was used to aid in the discectomy. Thoracic microendoscopic discectomy uses a more lateral trajectory in approaching the intervertebral disc space and utilizes a 30° endoscope, which allows improved visualization without distorting the surgeon's orientation.

TMED is a safe effective treatment for surgical removal of herniated thoracic intervertebral discs. This approach allows access through a minimally invasive muscle-splitting posterolateral approach that does not place the contents of the thoracic cavity at risk. It also allows approximately the same visualization that one would obtain with an open technique, such as a costotransversectomy or an open transpedicular approach, although significantly limiting the amount of muscle dissection and approach-related morbidity.

This technique has proven effective in the lumbar spine with a shorter length of hospital stay, less postoperative pain, decreased blood loss, and shorter recovery time. These same advantages can be expected in the thoracic spine with appropriate patient selection and proper surgical technique.

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