eXtreme Lateral Interbody Fusion (XLIF®)

EDITED BY

J. Allan Goodrich, MD

Associate Clinical Professor,
Department of Orthopaedic Surgery, Medical College of Georgia;
Augusta Orthopaedic Clinic, Augusta, Georgia

Ildemaro J. Volcan, MD

Associate Clinical Professor,
Department of Neurological Surgery, Medical College of Georgia;
West Augusta Spine Specialists, LLC, Augusta, Georgia

QUALITY MEDICAL PUBLISHING, INC.
St. Louis, Missouri
2008

Printed in Italy

PUBLISHER Karen Berger
EDITORIAL DIRECTOR Michelle Berger
PROJECT MANAGER Sara Blackwell
MANUSCRIPT EDITOR Rebecca Sweeney
ASSISTANT EDITOR Julie Dill
VICE PRESIDENT OF PRODUCTION AND MANUFACTURING Carolyn G. Reich
ART DIRECTION, BOOK, AND COVER DESIGN Amanda Yarberry Behr
SELECT ILLUSTRATIONS Robert Margulies
GRAPHICS TECHNICIAN Brett Stone
PRODUCTION Sandy Hanley
LAYOUT ARTIST/COMPOSITOR Elaine Kitsis

Quality Medical Publishing, Inc.
2248 Welsch Industrial Court
St. Louis, Missouri 63146
Telephone: 1-800-348-7808
Web site: *http://www.qmp.com*

LIBRARY OF CONGRESS CATALOGING-IN-PUBLICATION DATA

Extreme lateral interbody fusion / edited by J. Allan Goodrich, Ildemaro J. Volcan.
p. ; cm.
Includes bibliographical references and index.
ISBN 978-1-57626-277-1 (hardcover)
1. Spinal fusion. 2. Spine—Endoscopic surgery. I. Goodrich, J. Allan. II. Volcan, Ildemaro J.
[DNLM: 1. Lumbar Vertebrae—surgery. 2. Spinal Fusion—methods. 3. Surgical Procedures, Minimally Invasive—methods. 4. Thoracic Vertebrae—surgery. WE 750 E96 2008]
RD768.E98 2008
617.5′60597—dc22
2008021683

QM/QM/LG
5 4 3 2 1

20

Thoracic Disc Herniation: Extreme Lateral Approach

Vedat Deviren ▪ Murat Pekmezci ▪ Bobby Tay

Thoracic disc herniation is a relatively uncommon spinal condition that can cause severe functional disability. Unfortunately, there is no characteristic clinical presentation. Signs and symptoms can vary from obscure thoracic or abdominal pain to bowel/bladder dysfunction with severe myelopathy. However, magnetic resonance imaging (MRI) has revolutionized the detection and diagnosis of this problem. Because the natural history of the disease is also not well defined, indications for surgery—as well as the type of surgery that is optimal—are controversial. Surgical treatment is indicated for patients with frank myelopathy or severe radiculopathy, but the role of surgery for axial pain is still controversial. The optimal method of decompression is another topic for which a consensus has not been reached. There are several approaches to decompression, each with its own advantages and disadvantages. This chapter focuses on the general aspects of thoracic disc disease and treatment options, with an emphasis on a novel mini-incision, anterolateral, transthoracic, transpleural approach.

Incidence

Thoracic disc disease is a rare affliction, with an incidence of one case per million per year.[1] However, the incidence and prevalence of thoracic disc disease complicated by radiculopathy and/or myelopathy are unknown. Asymptomatic thoracic disc herniation may exist in up to 15% to 37% of the population in the United States.[2,3] Thoracic disc herniation is responsible for the symptoms in 0.2% of patients with back pain.[4] Surgery for thoracic disc herniation composes 0.15% to 1.8% of surgeries performed for all disc herniations.[5,6]

Etiologic Factors and Pathogenesis

In most cases, thoracic disc disease is a consequence of a degenerative process with or without coincident trauma. This observation is supported by the fact that most thoracic disc herniations are found in the lower thoracic spine, where degenerative changes are more prevalent.[7-9] Seventy-five percent of thoracic disc herniations occur below T8, and the most commonly affected level is T11-12.[10] This is attributed to the relative increased mobility of the lower thoracic spine and the relative weakness of the posterior longitudinal ligament in that area.

The thoracic spine and spinal cord have several unique features that make them vulnerable to injury.[11] The development of clinical symptoms is attributed to local vascular compromise leading to spinal cord dysfunction.[4,12,13] Doppman and Girton[14] demonstrated in an experimental animal model that neurologic deficits can recover—even in the presence of spinal cord distortion—if normal circulation is restored, whereas deficits usually persist if normal hemodynamics cannot be restored. These experimental results are supported by clinical observations that demonstrate both the persistence of neurologic deficits at several levels above the affected site and the lack of functional recovery even after an adequate decompression.[4,12,15]

Several anatomic structures and relationships predispose the thoracic spinal cord to anterior compression. The thoracic spine is normally kyphotic, and the spinal cord runs close to the posterior aspect of the vertebral bodies. Additionally, the dentate ligaments tether the spinal cord—limiting the cord's ability to drift away from anterior impingement.[16] The ratio of the spinal cord diameter to canal diameter is higher in the thoracic spine than in the cervical and lumbar areas, leaving less room for the spinal cord in case of stenosis.[11] Finally, the thoracic spinal cord is vulnerable to ischemic injury because of the presence of an anatomic area of poor blood supply called the *watershed zone*.[17] Unlike cervical and lumbar disc herniations, thoracic disc herniations are more frequently centrally located and are more likely to calcify.[18] They may be adherent to—and may even erode through—the dural sac over time. These characteristics of the thoracic spine and spinal cord are important for understanding the pathophysiology and treatment approaches for symptomatic thoracic disc disease.

Natural History

There is limited information on the natural history of thoracic disc disease. Wood et al[6] studied 20 asymptomatic patients with thoracic disc disease and reported that after 26 months of follow-up, all patients remained asymptomatic. In addition, 35 of the 48 disc herniations did not demonstrate any measurable change in size at the final follow-up. Brown et al[20] reviewed 55 patients who presented with symptomatic protrusions. Of these patients, 73% (40) were treated conservatively; 77% of those who were treated conservatively returned to their previous level of activity. Limited studies have concluded that patients with both axial pain and radiculopathy often respond to conservative treatment.

Natural history also differs among patients depending on symptoms. Patients with lower extremity symptoms tend to progress—the initial complaint of lower extremity pain is often followed by sensory disturbances, sphincter dysfunction, and myelopathy.[20,21] Rapid development of myelopathy is more common in younger patients who have a history of trauma. In the middle-aged population with degenerative disc disease and no significant trauma, the development of myelopathy occurs at a significantly slower pace.[12] Spontaneous recovery is not expected in patients with frank myelopathy, and surgical decompression is usually recommended.

Clinical Presentation

Thoracic disc herniation affects males and females equally and occurs more commonly during the third, fourth, and fifth decades of life.[4,12,22-25] Clinical presentation varies depending on the location and severity of the herniation. There is a wide variety of clinical presentations; back pain is usually the most common initial presentation, often described as a "burning" or "shooting" sensation that can be intermittent or constant.[26,27] Patients usually describe a pain that "bores right through the chest" or a band-like pain that radiates through the chest wall or flank. Depending on the neurologic level of involvement, patients may experience flank, abdominal, or groin pain. Because of this wide variation in the pain pattern, it is not uncommon for patients to be misdiagnosed with gallbladder disease, gastritis, and renal calculi.[25,27-31] Arce and Dohrmann,[10] in their review of the literature, reported that of 179 patients, 57% reported pain, 24% reported sensory disturbance, 17% reported motor weakness, and 2% described sphincter dysfunction. Most patients have signs and symptoms of cord compression at initial presentation.

Progression of spinal cord compression can result in bowel and bladder dysfunction, gait disturbance, variable sensory and/or motor dysfunction in the lower extremities, and paraplegia. Lesions between T11 and L1 can compress the conus medullaris and the cauda equina, resulting in lower extremity radiculopathy and sphincter disturbance. Patients who have compression above the conus medullaris usually present with long-tract signs such as gait disturbance, weakness, spasticity, and/or bowel and bladder dysfunction (retention, frequency, incomplete evacuation, or incontinence). Patients who have thoracic disc disease should have normal upper extremity function. If there are neurologic symptoms in the upper extremities, one should search for coexisting cervical stenosis, cranial pathology, or a systemic neurologic disease process.

Diagnosis

Evaluating thoracic disc herniation includes correlating the patient's symptoms with a detailed neurologic evaluation and a neuroradiologic evaluation. If a patient has long-tract signs and upper extremity involvement, the cervical spine should be examined to rule out cervical cord compression. In the absence of myelopathy, it is easy to overlook thoracic pathology and blame the often coexisting lumbar degenerative process for the patient's symptoms. Allowing patients to localize their back pain may help the clinician to reach the correct diagnosis.

MRI is becoming the gold standard for confirming diagnoses and localizing pathology in patients suspected to have thoracic disc disease (Fig. 20-1, *A*). It can help to differentiate among infectious, neoplastic, congenital, and degenerative processes.[8,32-34] Computed tomography (CT)-myelography also provides valuable information, because it can better delineate the degree of compression as well as diagnose ossification of the posterior longitudinal ligament or the ligamentum flavum (Fig. 20-1, *B*). Both imaging modalities provide valuable information and should be routine for evaluating patients with suspected thoracic disc disease.[10,32,33]

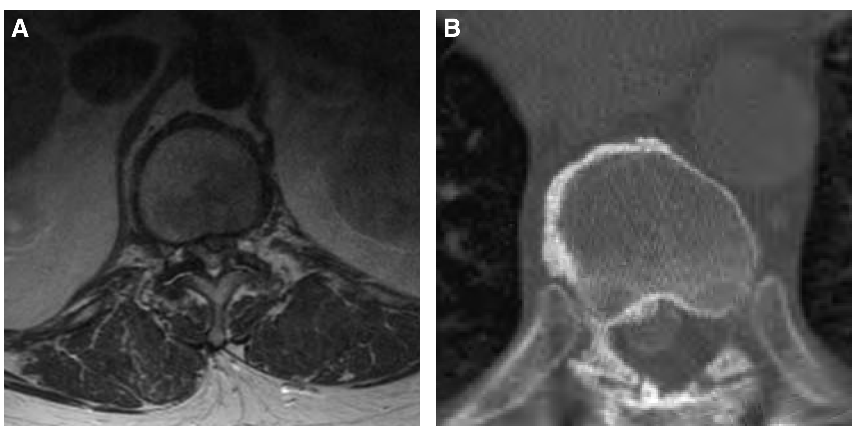

FIG. 20-1 **A,** Axial T-2 weighted MRI image of a patient who presented with worsening lower extremity spasticity and gait disturbance caused by a large central-paracentral thoracic disc herniation. **B,** Axial CT scan that demonstrates the large herniation compressing upon the thoracic spinal cord.

TREATMENT

Patients with thoracic disc disease can be divided into three groups. The first group includes patients who have myelopathy, with or without associated back pain or radicular symptoms. The second group consists of patients with lower extremity weakness or paralysis. The third group includes patients who present with back pain and radiculopathy without myelopathy. Surgical decompression is clearly indicated for the first and second groups, whereas the patients in the third group may benefit from conservative treatment. Surgery in the third group of patients is usually performed when there are persistent disabling symptoms despite optimal conservative care. Conservative treatment options include drug therapy with nonsteroidal antiinflammatory drugs, narcotics, and third generation pain medications such as tricyclics and serotonin-reuptake inhibitors; physical therapy; and intercostal nerve blocks.

When a surgical treatment is chosen, the affected level(s) should be confirmed with MRI. Several approaches have been reported in the literature for treating thoracic disc herniations. There is no gold standard approach, and each technique has advantages and disadvantages. There are several possible approaches—anterior, lateral, posterolateral, and posterior (Box 20-1). The posterior approach is laminectomy. Posterolateral approaches include transpedicular (with or without endoscopy) and transfacet, pedicle-sparing approaches. The lateral approach is costotransversectomy (lateral extracavitary approach). Anterior decompression can be achieved through either the transthoracic or the thoracoscopic approach.

POSTERIOR APPROACH

Laminectomy

Simple laminectomy with or without discectomy was the first technique used to treat thoracic disc herniations.[4,13,21,35] However, it is difficult to eliminate the anterior compressive forces over the thoracic spinal cord with this technique.[14,15] Excising the disc material using

BOX 20-1 Surgical Approaches for Treating Thoracic Disc Disease

Anterior (Anterolateral) Approaches

- Transthoracic extrapleural
- Transthoracic transpleural
- VATS

Posterolateral Approaches

- Lateral extracavitary
- Transpedicular
- Transpedicular facet sparing

Posterior Approaches

- Laminectomy

laminectomy is associated with significant morbidity and mortality.[4,21,35,36] In addition, it can further destabilize the posterior tension band, resulting in increased kyphosis and progression of compression. Perot and Munro[36] reviewed the literature to evaluate the safety and efficacy of laminectomy and discectomy to treat thoracic disc herniation. Of the 91 patients in the review, 40 had no improvement, and 16 became paraplegic. Some patients became paraplegic following simple laminectomy without any attempt to remove the herniated disc. Of note, 15 of the 16 patients who developed paraplegia had centrally located discs, which confirms the limited access to central discs with this approach. Laminectomy for thoracic disc disease is no longer used.

POSTEROLATERAL APPROACHES

Transpedicular Approach

The transpedicular approach was first described by Patterson and Arbit.[11] The major advantage of this approach is that it is less extensive, requiring less soft tissue dissection. Thus there are potential advantages, including decreased operation time, less blood loss, a shortened hospital stay, and a shorter period of rehabilitation. Posterolateral approaches allow better visualization of the herniated disc than posterior approaches and can be performed at any level. However, these approaches still limit visualization of the anterior spinal canal. Decompression of a central or centrolateral disc fragment is done blindly. It is also difficult to manage calcified discs or osteophytes. This problem can be alleviated either by using intraoperative ultrasound to assess the adequacy of decompression or by rotating the patient 15 to 20 degrees away from the surgeon. This modified transpedicular approach requires subtotal removal of the facet and pedicle. When performed unilaterally at one level, iatrogenic instability is uncommon. However, if more extensive pedicle and facet resection are required, posterior fusion and stabilization may be needed to prevent late kyphosis or olisthesis. Patterson and Arbit[11] reported on three patients who had thoracic disc herniation with myelopathy. The entire pedicle and facet were removed to achieve decompression. Two patients were cured, and one improved. However, this was an aggressive approach that created instability, and the procedure was modified to preserve as much of the facet and pedicle as possible. Le Roux et al[37] reported significant improvement in 20 patients who underwent decompression of their thoracic disc herniations using the transpedicular approach. Stillerman et al[38] described the transfacet pedicle-sparing approach in 1995. However, this approach still does not allow adequate viewing of central lesions, and the extent of decompression is difficult to evaluate.

Lateral Extracavitary Approach

The lateral extracavitary approach popularized by Larson et al[39] in 1976 evolved from early attempts at surgical treatment of Pott's disease of the spine.[40] Some earlier versions of the approach have been known as costotransversectomy, supradiaphragmatic splanchnicectomy, or lateral rachotomy.[41-43] In 1991, Fessler et al[44] reported a modification of the lateral extracavitary approach that extended its exposure up to the inferior aspect of C7. This technique is the lateral parascapular extrapleural approach and is most appropriate for anterior lesions from C7 to T6.

This approach provides access to every level of thoracolumbar spine, achieving a combined anterior-posterior procedure through the same incision. It provides excellent simultaneous exposure of the anterior, lateral, and posterior spine elements. It also allows simultaneous exposure of multiple segments between the inferior aspects of C7 down to L5. However, it is not useful for central or intradural disc herniations, because it provides poor exposure across the entire spinal canal.

The ideal patient for this approach is one with posterolateral disc herniation and significant comorbidities who may not tolerate a thoracotomy. In general, any disease process that causes myelopathy from anterior spinal cord compression or anterior spinal instability can be effectively treated using this approach. The procedure is performed with the patient in the prone or lateral decubitus position. The posterior portion of each rib on the side of the herniated disc is excised, and the pleura is mobilized and reflected anterolaterally. The transverse processes and remaining head and neck of each excised rib are then removed. The intervertebral foramen is enlarged by partial removal of the corresponding pedicles, and the dural sac is exposed. A cavity is created in the posterior aspect of the bodies and disc, allowing removal of disc fragments through the defect without manipulation of the spinal cord. The reported average clinical improvement is 85%, with a range of 71% to 91%.[45-47] Although radicular pain usually resolves, many patients continue to complain of intermittent back pain.[23,46]

ANTERIOR (ANTEROLATERAL) TRANSTHORACIC APPROACHES

Although lateral extracavitary and transpedicular approaches can provide good exposure of paracentral lesions, they are still inferior to the anterior approach for lesions that are directly ventral to the spinal cord. Furthermore, these approaches are less useful when there is intradural extension of a disc fragment or when there are significant adhesions between a disc and the dura.

There are several advantages to the transthoracic approach. It allows access to all herniations below T4. It provides direct exposure for all types of thoracic disc herniations (central, paracentral, and lateral). It enables access to both soft and hard discs and is especially helpful when decompressing calcified central herniations. It allows easy access to adjoining levels for multiple disc herniations. Finally, it permits excellent exposure and access for performing interbody fusion after the removal of a disc.

There are several drawbacks to the transthoracic approach. Pulmonary atelectasis often occurs postoperatively. If the diaphragm is released, a diaphragmatic hernia can occur. The great arterial and venous vessels can be damaged. Patients may develop persistent pain. There is a risk to the artery of Adamkiewicz during a left-sided approach, which can lead to spinal cord infarction. Some authors recommend using angiography to identify this major segmental vessel so that the exposure can be modified accordingly. Conversely, there is abundant collateral circulation in the region of the neural foramina that can provide blood flow to the cord, even with ligation of the artery of Adamkiewicz.[17,48,49] As long as electrocautery is used with caution when coagulating the vessels near the foramen, the risk to the vessel is small.[50]

Anterior Video-Assisted Thoracoscopic Surgery

Thoracoscopic spine surgery has found increased use over the past decade, and thoracic discectomy has become one of the common indications for the procedure.[51-55] Regan et al[55] reported on 29 patients who had thoracic discectomy with video-assisted thoracoscopic surgery (VATS); 76% of the patients reported satisfactory results. The advantages of VATS include reduced perioperative morbidity from minimal surgical dissection, avoidance of rib resection or spreading, enhanced visualization for the operating surgeons and support team, reduced postoperative pain with improved ventilatory excursion, shorter hospitalization and rehabilitation, and consequent decreased overall cost of care. In addition, because the ribs do not need to be retracted, the incidence of intercostal neuralgia is decreased. The main disadvantage of thoracoscopy is the technique itself. The procedure is performed with endoscopic visualization, which is very dependent on accurate portal placement. The average spine surgeon requires additional training to effectively perform the procedure, and the learning curve initially may result in prolonged operating times and an occasional conversion to open thoracotomy. In addition, the ipsilateral lung should be deflated during the procedure, which increases the risk for pulmonary complications such as pleural effusion, atelectasis, pneumonia, and pneumothorax. Anand and Regan[51] reported a 21% complication rate in a series of 100 patients. Of the complications, 15% were pulmonary in nature. McAfee et al[54] reported perioperative complications in 78 patients who had VATS (41 for thoracic disc herniation); the most common complications were intercostal neuralgia (8%) and atelectasis sufficient to delay discharge (6%). Although VATS has advantages, there are no studies in the literature that compare open thoracotomy with VATS in myelopathic patients with thoracic disc disease.

Anterior Transthoracic Transpleural Approach

An anterior transthoracic approach provides an excellent view of the dura-disc interval and allows decompression of the canal with the least manipulation of the neural structures. The anterior approach using a thoracotomy was described in 1969 by Perot and Munro,[36] and again in 1988 by Bohlman and Zdeblick.[2] Thoracotomy has been associated with significant perioperative discomfort and pulmonary complications. It usually involves resection of a rib, deflation of the ipsilateral lung, and insertion of a chest tube. Each of these maneuvers contributes to increased postoperative pain levels and pulmonary complications such as atelectasis and pneumonia. Depending on the extent of the decompression, an anterior fusion may be performed to prevent instability or deformity. Bohlman and Zdeblick[2] reported on 19 patients and concluded that the transthoracic approach, with its superior exposure, was preferred over costotransversectomy. Mulier and Debois's review[56] revealed superior neurologic recovery rates with anterior approaches compared with lateral and posterolateral approaches, at the expense of higher pulmonary complication rates. Otani et al[57] described a transthoracic extrapleural approach with the primary goal of decreasing pulmonary complications. They reported on 23 patients, and the results were similar to those in other series of transthoracic decompressions with no pulmonary complications.

MINIMALLY INVASIVE ANTEROLATERAL TRANSTHORACIC TRANSPLEURAL APPROACH

The lead author's (V.D.) preferred approach is the minimally invasive anterolateral transthoracic transpleural approach (XLIF-thoracic approach using the MaXcess® Access [NuVasive®, Inc., San Diego, CA] system), or a modification of a mini-thoracotomy approach. As with the lumbar XLIF procedure, the objective is to perform conventional surgery while avoiding collateral approach-related trauma. The XLIF technique allows surgeons to perform standard anterior discectomy and fusion with instrumentation through a minimally invasive approach. The advantages of this approach in the thoracic region include avoiding rib resection, performing the procedure under direct vision, and less perioperative morbidity. Because it allows for direct vision and conventional surgical techniques, the learning curve is much less than those for previously discussed minimally invasive options.

The MaXcess Retractor system eliminates the need to deflate the ipsilateral lung, theoretically decreasing the risk of postoperative atelectasis and pulmonary complications. We did not experience any pulmonary complications in the first 8 patients on whom we performed this procedure. We entered the thoracic cavity at the superior margin of the inferior rib to avoid the neurovascular bundle. Despite this, we had one patient with postoperative intercostal neuralgia. We believe this was caused by the use of a rigid retractor system. This technique does not necessarily eliminate chest tube placement after surgery, which is often a routine part of the conventional thoracotomy and thoracoscopy.

Surgical Technique

The procedure is performed under general endotracheal anesthesia. Because a very small area of the thoracic cavity is needed to perform the procedure, a regular endotracheal tube rather than a double lumen tube is used. Neuromonitoring is a standard part of the procedure and includes somatosensory evoked potentials (SSEPs), motor evoked potentials

(MEPs), and electromyogram (EMG) for the lower thoracic segments (T8-T12). A standard reversed operative table is used, and the patient is placed in the left lateral decubitus position so that the affected level lies at the break in the table. All the bony prominences are carefully padded. The patient is fixed to the table with 4-inch tape, and the table is flexed to open the affected level (Fig. 20-2, *A* and *B*).

The surgical field is widely prepared so the incision can be extended to a regular thoracotomy if necessary. The junction between the posterior and middle thirds of the disc space is marked on the skin using fluoroscopy (Fig. 20-2, *C* through *E*). A 4 to 5 cm incision is centered over the mark. The subcutaneous tissue and the intercostal muscles are divided using electrocautery. We prefer to enter the thoracic cavity through the superior edge of the rib that is overlying the disc space to avoid the neurovascular bundle at the superior aspect of the intercostal space. The level is verified with the C-arm, and Dilators are placed over the affected disc space (Fig. 20-2, *F* through *I*). Then the NuVasive MaXcess Retractor is introduced into the thoracic cavity (Fig. 20-2, *J* through *M*).

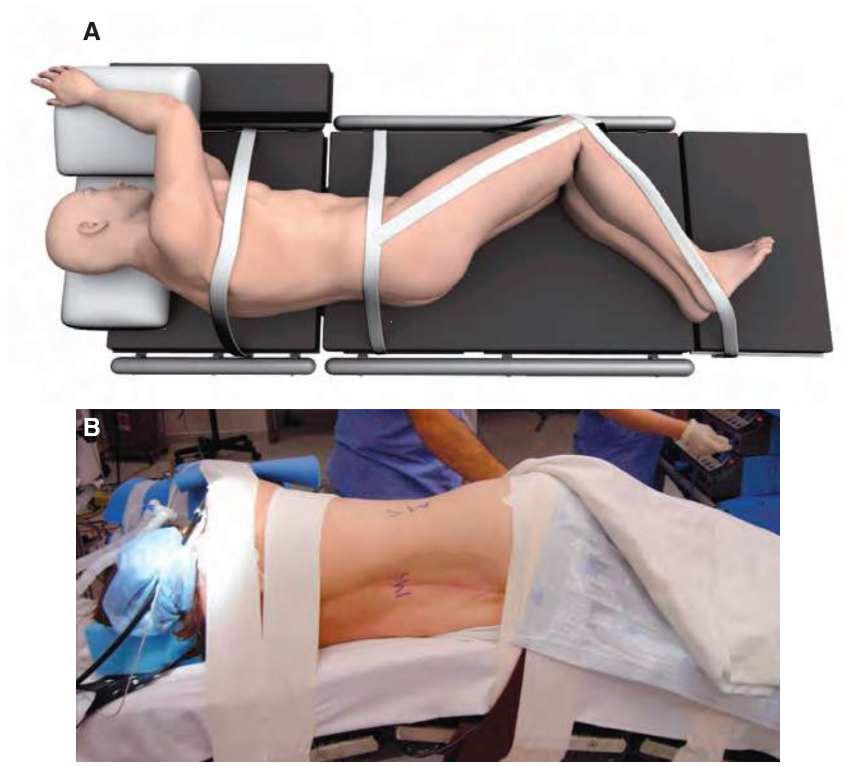

FIG. 20-2 **A,** An overhead view of a patient in the lateral decubitus position. The patient is secured to the operative table with 4-inch tape, with the lumbosacral spine at the break in the table to facilitate exposure. **B,** An intraoperative photograph of a patient in the lateral decubitus position, with the table flexed to facilitate exposure.

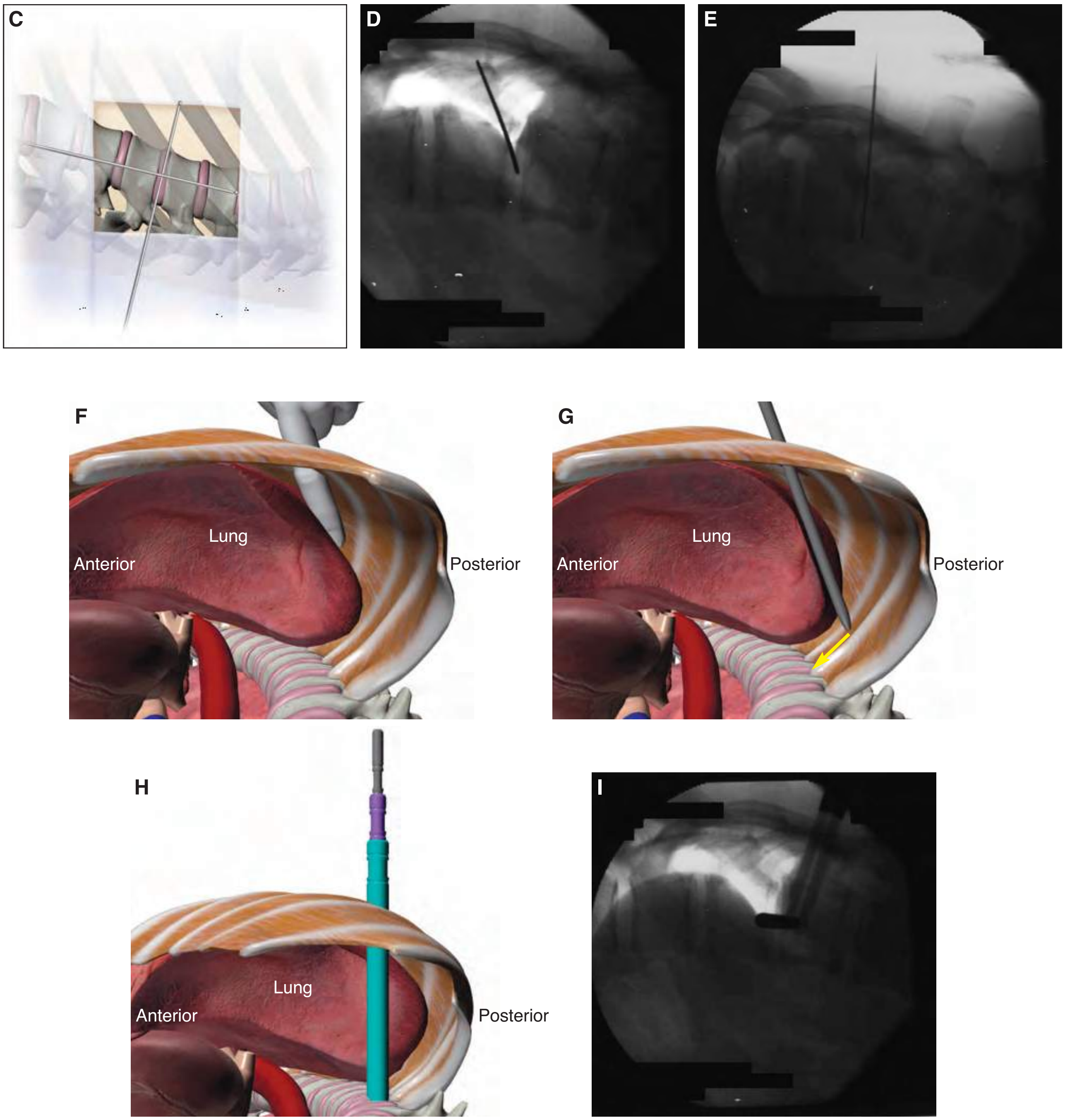

FIG. 20-2, cont'd **C,** The affected disc space is identified by **D,** anterior-posterior and **E,** lateral fluoroscopic imaging using a long guidewire placed on the skin to direct the location of the skin incision. **F-I,** The chest is entered through a 4-cm intercostal incision centered over the affected disc space. The first Dilator is placed through the incision to rest on the lateral aspect of the affected disc space, centered on the disc space in the lateral plane and in line with the disc space in the anterior-posterior plane.

Continued

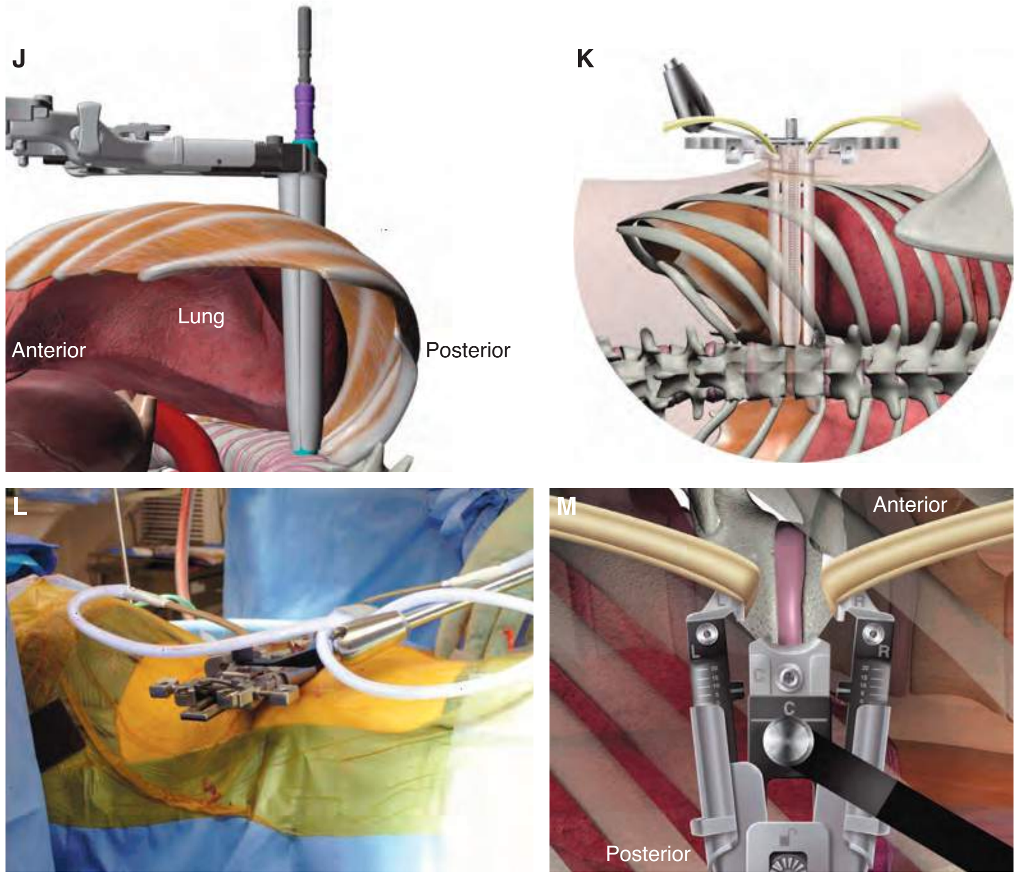

FIG. 20-2, cont'd **J-M,** An XLIF Retractor is placed over the final Dilator and docked onto the center of the disc space with the third Blade placed anteriorly (in contrast to the lumbar spine where the third Blade is positioned posteriorly).

This Retractor is specially designed for minimally invasive lateral and posterior lumbar procedures. It has three Blades for retracting soft tissue—a center Blade and two lateral Blades. The lateral Blades can be angled up to 25 degrees. Using the traditional approach, the middle Blade is fixed to the posterior third of the disc space with a Shim, and the two lateral Blades can be distracted to improve the operative field. Additional Shims in varying sizes can be attached to the Blades to prevent protrusion of soft tissues (such as the lung and diaphragm) to the field. During anterior thoracic discectomy, the Retractor is reversed to provide a better exposure (Fig. 20-3, *A* through *C*). Wet lap sponges are used behind the proximal Blade to retract the lung. Then a longitudinal incision is made over the parietal pleura. After blunt dissection of the pleura, the segmental vessels above and below the disc space are identified and clipped. The rib head overlying the posterolateral corner of the disc is identified and osteotomized (Fig. 20-3, *D*), which helps identify the posterolateral corner of the disc and the vertebral body. The disc is cut with a disc knife, and a standard discectomy is performed (Fig. 20-3, *E*). The anterior and posterior anulus is left intact. The posteroinferior corner of the vertebra above and the posterosuperior corner of the vertebra below are excised with a

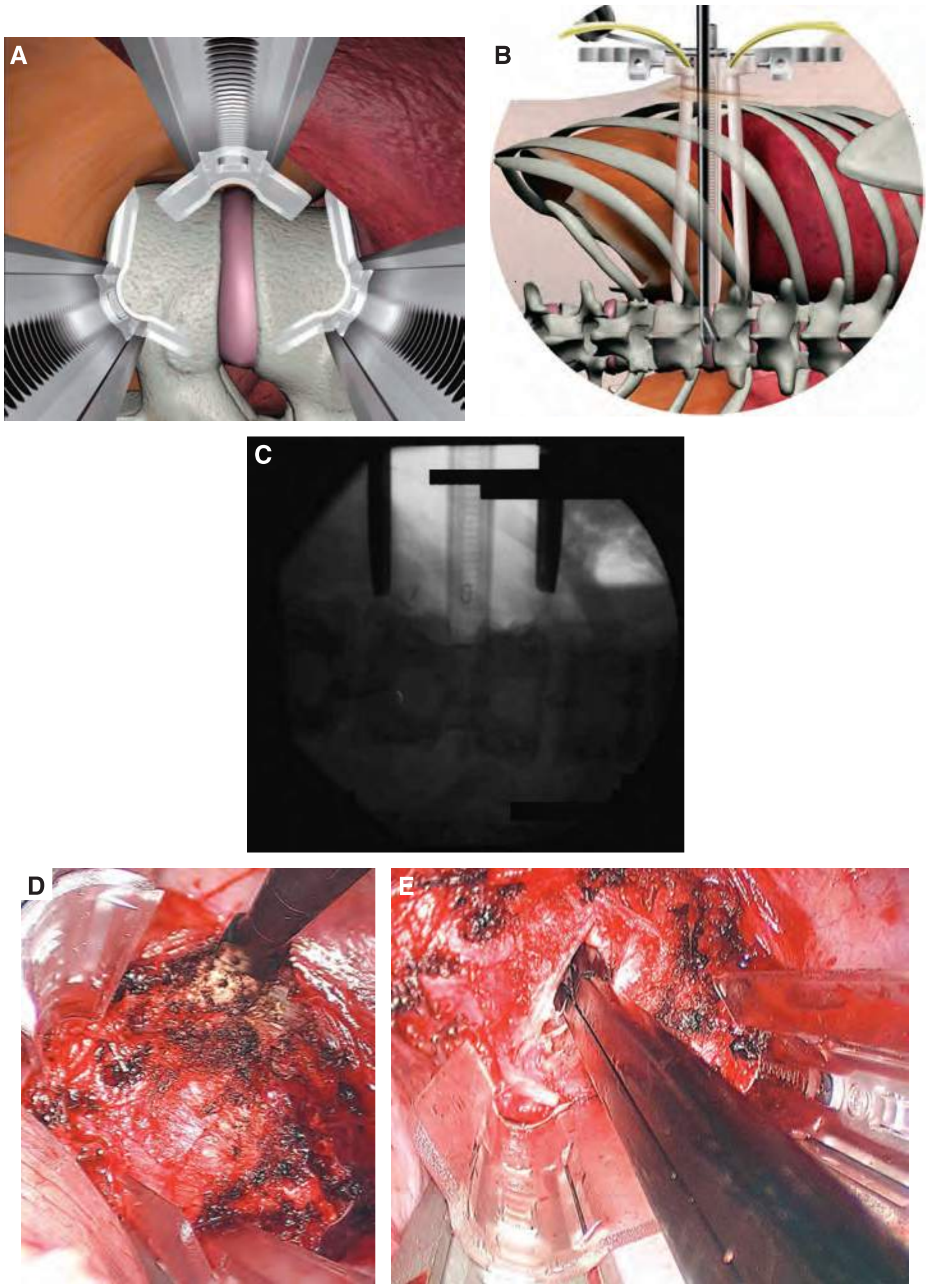

FIG. 20-3 **A-C,** The position of the Retractor is again verified using anterior and posterior fluoroscopy after the Retractor is expanded. **D,** The rib head is identified and removed with an osteotome to expose the pedicle. The bone is saved for use in the fusion. **E,** Disc material is removed with a Pituitary Rongeur to partially decompress the middle portion of the disc space to allow safer decompression of the spinal canal.

Continued

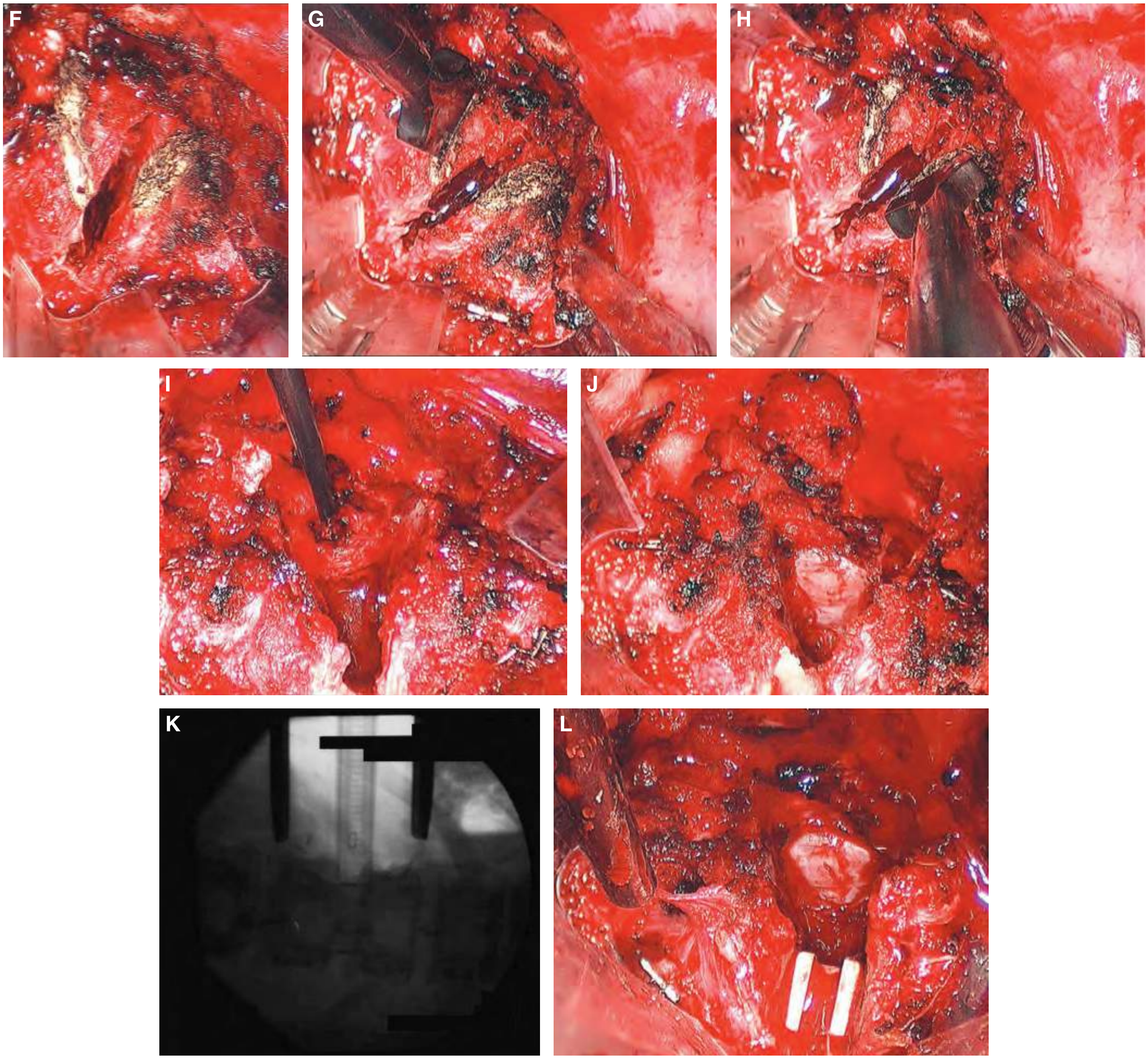

FIG. 20-3, cont'd **F-H,** Partial osteotomy of the posterior third of the superior and inferior endplates allows better visualization and decompression of the neural elements. **I** and **J,** The posterior longitudinal ligament is dissected away from the dura with a Penfield Dissector and is then cut transversely with a knife; the Penfield is used to protect the dura and spinal cord. **K** and **L,** Following decompression, the disc space is prepared with Rasps and reconstructed with a thoracic XLIF cage filled with local bone and bone morphogenic protein.

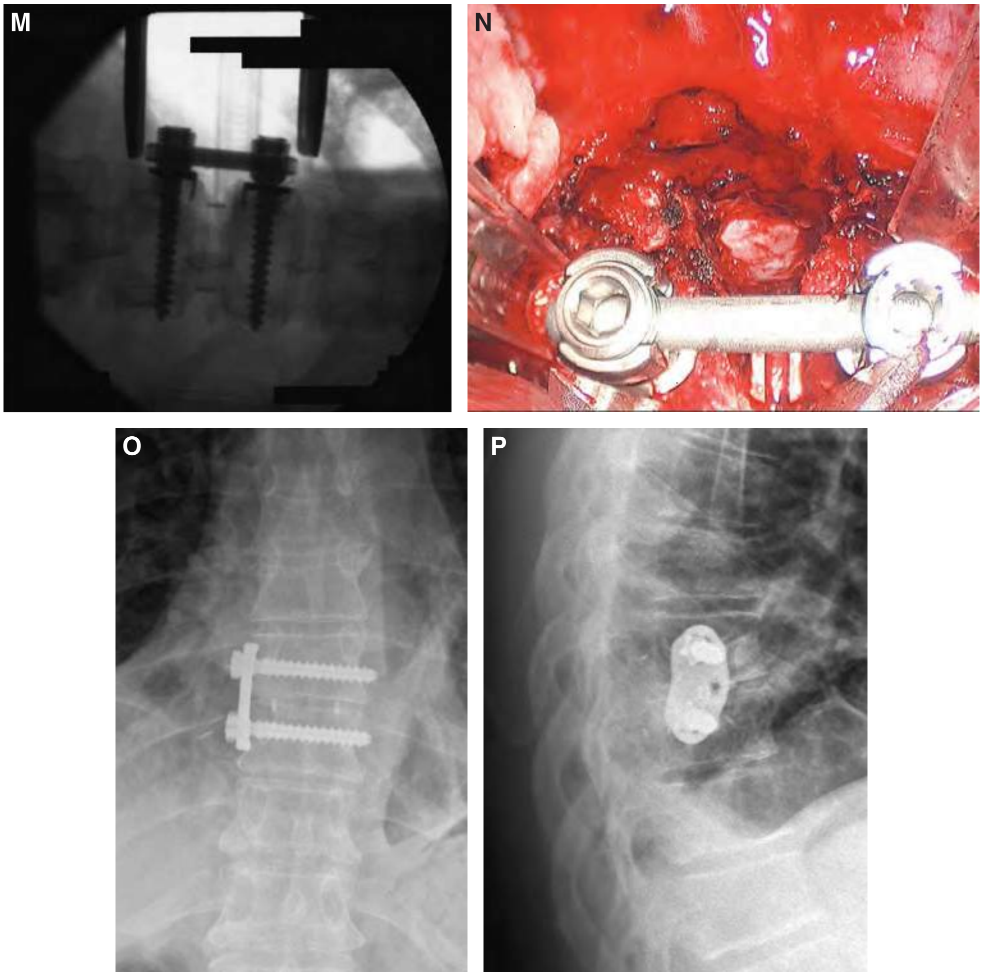

FIG. 20-3, cont'd **M** and **N,** The interspace is further stabilized with a lateral single-rod construct, as evidenced on the radiographs and intraoperative views of the construct. **O** and **P,** AP and lateral radiographs showing thoracic decompression with fusion and use of lateral plating (XLP®, NuVasive, Inc.).

straight osteotome to facilitate decompression (Fig. 20-3, *F* through *H*). I prefer using an osteotome to preserve local bone, which can be used as a bone graft during anterior fusion. The posterior border of the posterior anulus and posterior longitudinal ligament is identified and dissected off the dura using a Penfield Dissector. The posterior longitudinal ligament (PLL) is then dissected and removed using Curettes and Pituitary Rongeurs. The decompression is extended to the level of the contralateral pedicle (Fig. 20-3, *I* and *J*).

Following decompression of the spinal cord, a cage filled with local bone is placed into the disc space (Fig. 20-3, *K* and *L*). The affected level is stabilized with anterior instrumentation using either a screw-rod construct or a plate (Fig. 20-3, *M* through *P*).

The incision is closed in a standard fashion. A chest tube is placed, and it is removed on postoperative day 1 or 2, depending on the output. All patients are braced with a thoracolumbosacral orthosis (TLSO) for 6 weeks before they are allowed to move as tolerated.

Case Example

A 20-year-old woman presented with a primary complaint of worsening bilateral lower extremity pain, urinary retention, and fecal incontinence. An MRI examination revealed a T12-L1 disc herniation (Fig. 20-4, *A* and *B*). She was treated with anterior transthoracic transpleural discectomy and fusion (Fig. 20-4, *C* and *D*). Following surgery her lower extremity and bowel/bladder symptoms improved significantly. Her incision healed uneventfully (Fig. 20-4, *E*).

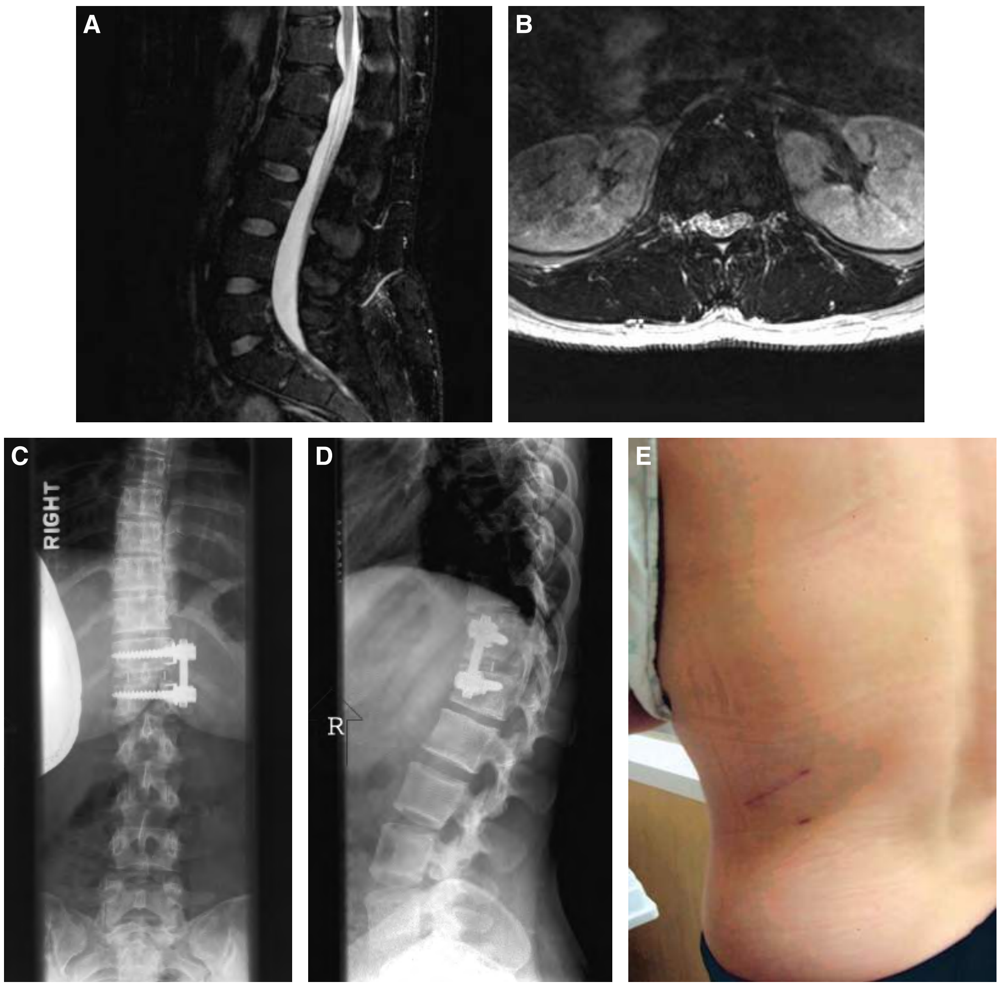

FIG. 20-4 **A,** Sagittal and **B,** axial T2-weighted MRI of a 20-year-old woman who presented with worsening bilateral lower extremity pain, urinary retention, and fecal incontinence. The MRI demonstrates a T12-L1 central disc herniation. **C,** Anteroposterior and **D,** lateral radiographs of this patient after treatment with thoracic disc excision and interbody fusion with lateral instrumentation. **E,** The minimal postoperative scar 1 month after the procedure.

Conclusion

Thoracic disc herniation is clinically challenging. Because it is rare—and because patients present with a variety of symptoms—diagnosis is often delayed or patients receive inappropriate treatment because of an incorrect diagnosis. Surgical treatment is indicated for patients with neurologic deficits or persistent pain that is refractory to conservative treatment. Appropriate surgical treatment provides both motor and gait improvement, with pain relief in approximately 80% to 90% of patients. Patients with risk factors such as coexistent neurologic disease, advanced age, long illness, and severe myelopathy often have less postoperative improvement than typical patients.[37]

There are several different approaches for treating thoracic disc herniation. Although there is no gold standard treatment, most surgeons agree that anterior decompression using a transthoracic, transpleural approach provides the best exposure and the most consistent decompression. Although VATS may provide less morbidity, it has a steep learning curve. We use a new minimally invasive, transthoracic, transpleural decompression technique that can be performed by spine surgeons without extensive training. The proposed advantages are less dissection (resulting in less perioperative morbidity), along with the advantages of conventional thoracotomy. However, long-term follow-up results remain to be documented.

REFERENCES

1. Russell T. Thoracic intervertebral disc protrusion: experience of 67 cases and review of the literature. Br J Neurosurg 3:153-160, 1989.
2. Bohlman HH, Zdeblick TA. Anterior excision of herniated thoracic discs. J Bone Joint Surg Am 70:1038-1047, 1988.
3. Otani K, Nakai S, Fujimura Y, et al. Surgical treatment of thoracic disc herniation using the anterior approach. J Bone Joint Surg Br 64:340-343, 1982.
4. Love JG, Kiefer EJ. Root pain and paraplegia due to protrusions of thoracic intervertebral disks. J Neurosurg 7:62-69, 1950.
5. Awwad EE, Martin DS, Smith KR, et al. Asymptomatic versus symptomatic herniated thoracic discs: their frequency and characteristics as detected by computed tomography after myelography. Neurosurgery 28:180-186, 1991.
6. Wood KB, Blair JM, Aepple DM, et al. The natural history of asymptomatic thoracic disc herniations. Spine 22:525-529; discussion 529-530, 1997.
7. Tahmouresie A. Herniated thoracic intervertebral disc—an unusual presentation: case report. Neurosurgery 7:623-625, 1980.
8. Blumenkopf B. Thoracic intervertebral disc herniations: diagnostic value of magnetic resonance imaging. Neurosurgery 23:36-40, 1988.
9. Videman T, Battié MC, Gill K, et al. Magnetic resonance imaging findings and their relationships in the thoracic and lumbar spine. Insights into the etiopathogenesis of spinal degeneration. Spine 20:928-935, 1995.
10. Arce CA, Dohrmann GJ. Thoracic disc herniation. Improved diagnosis with computed tomographic scanning and a review of the literature. Surg Neurol 23:356-361, 1985.

11. Patterson RH Jr, Arbit E. A surgical approach through the pedicle to protruded thoracic discs. J Neurosurg 48:768-772, 1978.
12. Arseni C, Nash F. Thoracic intervertebral disc protrusion: a clinical study. J Neurosurg 17:418-430, 1960.
13. Logue V. Thoracic intervertebral disc prolapse with spinal cord compression. J Neurol Neurosurg Psychiatry 15:227-241, 1952.
14. Doppman JL, Girton M. Angiographic study of the effect of laminectomy in the presence of acute anterior epidural masses. J Neurosurg 45:195-202, 1976.
15. Bennett MH, McCallum JE. Experimental decompression of spinal cord. Surg Neurol 8: 63-67, 1977.
16. Kahn EA. The role of dentate ligaments in spinal cord compression and the syndrome of lateral sclerosis. J Neurosurg 4:191-199, 1947.
17. Dommisse GF. The blood supply of the spinal cord. A critical vascular zone in spinal surgery. J Bone Joint Surg Br 56:225-235, 1974.
18. Severi P, Ruelle A, Andrioli G. Multiple calcified thoracic disc herniations. A case report. Spine 17:449-451, 1992.
19. Brown CW, Deffer PA Jr, Akmakjian J, et al. The natural history of thoracic disc herniation. Spine 17(6 Suppl):S97-S102, 1992.
20. Campbell E, Kite WC Jr, Whitfield RD. The thoracic herniated intervertebral disc syndrome. J Neurosurg 14:61-67, 1957.
21. Tovi D, Strang RR. Thoracic intervertebral disk protrusions. Acta Chir Scand Suppl Suppl 267: 1-41, 1960.
22. Abbott KH, Retter RH. Protrusions of thoracic intervertebral disks. Neurology 6:1-10, 1956.
23. Arce CA, Dohrmann GJ. Herniated thoracic disks. Neurol Clin 3:383-392, 1985.
24. Albrand OW, Corkill G. Thoracic disc herniation. Treatment and prognosis. Spine 4:41-46, 1979.
25. Benson MK, Byrnes DP. The clinical syndromes and surgical treatment of thoracic intervertebral disc prolapse. J Bone Joint Surg Br 57:471-477, 1975.
26. Wood KB, Garvey TA, Gundry C, et al. Magnetic resonance imaging of the thoracic spine. Evaluation of asymptomatic individuals. J Bone Joint Surg Am 77:1631-1638, 1995.
27. Xiong Y, Lachmann E, Marini S, et al. Thoracic disk herniation presenting as abdominal and pelvic pain: a case report. Arch Phys Med Rehabil 82:1142-1144, 2001.
28. Lyu RK, Chang HS, Tang LM, et al. Thoracic disc herniation mimicking acute lumbar disc disease. Spine 24:416-418, 1999.
29. Eleraky MA, Apostolides PJ, Dickman CA, et al. Herniated thoracic discs mimic cardiac disease: three case reports. Acta Neurochir (Wien) 140:643-646, 1998.
30. Ozturk C, Tezer M, Sirvanci M, et al. Far lateral thoracic disc herniation presenting with flank pain. Spine J 6:201-203, 2006.
31. Whitcomb DC, Martin SP, Schoen RE, et al. Chronic abdominal pain caused by thoracic disc herniation. Am J Gastroenterol 90:835-837, 1995.
32. Alvarez O, Roque CT, Pampati M. Multilevel thoracic disk herniations: CT and MR studies. J Comput Assist Tomogr 12:649-652, 1988.
33. Chambers AA. Thoracic disk herniation. Semin Roentgenol 23:111-117, 1988.
34. Francavilla TL, Powers A, Dina T, et al. MR imaging of thoracic disk herniations. J Comput Assist Tomogr 11:1062-1065, 1987.
35. Epstein JA. The syndrome of herniation of the lower thoracic intervertebral discs with nerve root and spinal cord compression. J Neurosurg 11:525-538, 1954.
36. Perot PL Jr, Munro DD. Transthoracic removal of midline thoracic disc protrusions causing spinal cord compression. J Neurosurg 31:452-458, 1969.

37. Le Roux PD, Haglund MM, Harris AB. Thoracic disc disease: experience with the transpedicular approach in twenty consecutive patients. Neurosurgery 33:58-66, 1993.
38. Stillerman CB, Chen TC, Day JD, et al. The transfacet pedicle-sparing approach for thoracic disc removal: cadaveric morphometric analysis and preliminary clinical experience. J Neurosurg 83: 971-976, 1995.
39. Larson SJ, Holst RA, Hemmy DC, et al. Lateral extracavitary approach to traumatic lesions of the thoracic and lumbar spine. J Neurosurg 45:628-637, 1976.
40. Menard V. Causes de la paraplegia dans la maladie de Pott, son traitement chirurgical par l'ouverture directe du foyer tuberculeaux des vertebras. Rev Orthop 5:47-64, 1894.
41. Alexander GL. Neurological complications of spinal tuberculosis. Proc R Soc Med 39:730-734, 1946.
42. Armour D. Lettsomian lecture on the surgery of the spinal cord and its membranes. Lancet 1:423-430, 1927.
43. Capener N. The evolution of lateral rhachotomy. J Bone Joint Surg Br 36:173-179, 1954.
44. Fessler RG, Dietze DD JR, Millan MM, et al. Lateral parascapular extrapleural approach to the upper thoracic spine. J Neurosurg 75:349-355, 1991.
45. Dietze DD Jr, Fessler RG. Thoracic disc herniations. Neurosurg Clin N Am 4:75-90, 1993.
46. Maiman DJ, Larson SJ, Luck E, et al. Lateral extracavitary approach to the spine for thoracic disc herniation: report of 23 cases. Neurosurgery 14:178-182, 1984.
47. Stillerman CB, Chen TC, Couldwell WT, et al. Experience in the surgical management of 82 symptomatic herniated thoracic discs and review of the literature. J Neurosurg 88:623-633, 1998.
48. Di Chiro G, Fried LC, Doppman JL. Experimental spinal cord angiography. Br J Radiol 43:19-30, 1970.
49. Currier BL, Eismont FJ, Green BA. Transthoracic disc excision and fusion for herniated thoracic discs. Spine 19:323-328, 1994.
50. Connolly E, moderator. Treatment of thoracic disc herniation with myelopathy: thoracotomy vs. costotransversectomy vs. the lateral extracavitary approach. In Al-Mefty O, Origitano TC, Harkey HL, eds. Controversies in Neurosurgery. New York: Thieme Medical Publishers, 1996, 246-250.
51. Anand N, Regan JJ. Video-assisted thoracoscopic surgery for thoracic disc disease: classification and outcome study of 100 consecutive cases with a 2-year minimum follow-up period. Spine 27:871-879, 2002.
52. Horowitz MB, Moossy JJ, Julian T, et al. Thoracic discectomy using video assisted thoracoscopy. Spine 19:1082-1086, 1994.
53. Mack MJ, Regan JJ, McAfee PC, et al. Video-assisted thoracic surgery for the anterior approach to the thoracic spine. Ann Thorac Surg 59:1100-1106, 1995.
54. McAfee PC, Regan JR, Zdeblick T, et al. The incidence of complications in endoscopic anterior thoracolumbar spinal reconstructive surgery. A prospective multicenter study comprising the first 100 consecutive cases. Spine 20:1624-1632, 1995.
55. Regan JJ, Ben-Yishay A, Mack MJ. Video-assisted thoracoscopic excision of herniated thoracic disc: description of technique and preliminary experience in the first 29 cases. J Spinal Disord 11:183-191, 1998.
56. Mulier S, Debois V. Thoracic disc herniations: transthoracic, lateral, or posterolateral approach? A review. Surg Neurol 49:599-606; discussion 606-608, 1998.
57. Otani K, Yoshida M, Fujii E, et al. Thoracic disc herniation. Surgical treatment in 23 patients. Spine 13:1262-1267, 1988.