Transcostovertebral approach for thoracic disc herniations

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Object. The authors describe a new posterolateral transcostovertebral approach for the removal of herniated thoracic discs.

Methods. From January 1994 to January 2000, 28 thoracic discs in 22 patients were excised via a new transcostovertebral surgical approach. Seventeen patients (77%) presented with axial pain, 14 (64%) with radicular pain, 13 (59%) with myelopathy, eight (36%) with sensory loss, and 10 (45%) with genitourinary (GU) symptoms such as urinary hesitancy or incontinence. The affected discs were approached using a midline incision to gain access of the costovertebral junction. The surgical corridor was posterolateral; the costovertebral joint and lateral edge of the vertebral endplates were drilled to expose the lateral annulus. The ribs were preserved, obviating the need for insertion of a chest tube postoperatively.

The average operating time per level was 200.5 minutes (range 90–360 minutes). The average blood loss was 231 ml (50–750 ml). The average length of stay was 3.8 days. Most patients were discharged home on postoperative Day 2 or 3. No patients were worse postoperatively. Improvement was demonstrated in 13 (76%) of 17 patients with axial pain, 11 (79%) of 14 patients with radicular pain, 11 (85%) of 13 patients with myelopathy, seven (88%) of eight patients with sensory loss, and six (60%) of 10 patients with GU symptoms.

Conclusions. This procedure is well suited for any thoracic disc level and offers several advantages over the traditional costotransversectomy or transthoracic approaches: shorter operating time, less blood loss, less extensive soft-tissue and bone dissection, reduced postoperative pain, and shorter hospital stays.

KEY WORDS • thoracic spine • intervertebral disc herniation • posterolateral approach • transcostovertebral approach

A symptomatic thoracic disc herniation is not uncommon, with an estimated prevalence of 7 to 15%, based on autopsy and myelography/CT studies. However, symptomatic thoracic disc herniation is rare, accounting for only 0.25 to 0.57% of all disc herniations reported in the literature. The incidence of clinically significant thoracic disc herniation is approximately one patient per 1,000,000 per year. The low incidence of this entity is directly related to the biomechanical stability of the thoracic spine.

The earliest reports of thoracic disc protrusion were published by Key in 1838 and by Middleton and Teacher in 1911. The first outcome review of surgically treated thoracic disc herniation was published by Hawk in 1936. These early reports and subsequent published series in the 1950s and 1960s revealed that a large number of patients suffered worsened neurological deficit or paraplegia after excision of a herniated thoracic disc. The perimvasive surgery-related outcome was attributed to the surgical approach at the time, which was primarily a laminectomy for extra- or intradural excision of the protruded disc. The development of anterior, lateral, or posterior approaches to thoracic discs provided better exposure and substantially reduced the risk of neurological injury associated with early procedures.

The choice of surgical approach depends on the level of the herniation, the side of involvement, the number of involved vertebral levels, and the surgeon’s experience. Approaches to thoracic discs can be posterior (laminectomy, transpedicular, or transfacet pedicle sparing); posterolateral (costotransversectomy, lateral (lateral rachotomy, lateral extracavitary, or minietrachotomy); anterior lateral (transthoracic) or thoracoscopic approach; or anterior (transsternal procedure).

The impetus for developing a new technique was to find a surgical approach to thoracic discs that requires less tissue and bone resection, allows quick access to the affected disc without painful rib resection and chest tube placement, provides adequate exposure for effective and safe disc excision, and causes less postoperative pain and provides for a faster recovery.

In the last 6 years, we have used this posterolateral transcostovertebral approach for the excision of herniated thoracic discs, and the results have been very gratifying.

Clinical Material and Methods

Patient Population

Twenty-eight thoracic discectomies were performed in
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Table 1: Summary of clinical and outcome data for 22 patients with herniated thoracic disc treated via the transcostovertebral approach.*

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* ct = central disc; imp = improved; lt = left paracentral; MVA = motor vehicle accident; myelop = myelopathy; resol = resolved; rt = right paracentral; sens = sensory loss.

22 patients (10 men and 12 women), who ranged in age from 28 to 63 years (Table 1). Of the surgically treated levels (T4–5 to T11–12), the most common levels were T7–8 (seven cases) and T8–9 (eight cases) (Fig. 1 upper). Seventeen (77%) of these patients presented with protracted axial pain and 14 (64%) with radicular pain refractory to conservative treatments. Thirteen patients (59%) also presented with myelopathy. Eight patients (36%) reported experiencing sensory loss below the level of herniation. Ten patients (45%) reported GU symptoms such as urinary hesitancy and frequency or incontinence (Fig. 1 lower). However, only four of these patients had undergone previous urodynamic studies confirming the presence of neurogenic bladder. History of traumatic injury was recorded in 10 patients (45%). Duration of symptoms ranged from 5 months to 15 years. One patient (Case 17) had undergone a thoracic laminectomy for a calcified central disc at T10–11 15 years before presentation.

Three patients harbored multiple symptomatic discs (Table 1). In one woman (Case 2) with axial pain and radiculomyelopathy, there were three ruptured discs (T8–9, T10–11, and T11–12). The other two patients each had two ruptured discs. In a different patient (Case 1) with a solitary T8–9 herniation, the normal disc above T8–9 was excised first because of incorrect localization. One patient (Case 10) with a central disc had to undergo two operations due to residual centrally located fragments (Fig. 2 upper). The patient was returned to the operating room on postoperative Day 7 for removal of the residual disc. Complete ventral spinal cord decompression was confirmed intraoperatively by using a 70° angle pediatric cystoscope and then postoperatively by using MR imaging (Fig. 2 lower).

Preoperative Planning

Adequate preoperative planning was essential in facilitating the procedure and minimizing surgery-related risks. Preoperative plain radiograms of the entire thoracic and lumbar spine were obtained to identify all 12 thoracic ribs and five lumbar vertebrae. Occasionally, we encountered patients with lumbarized or sacralized vertebrae that might have altered the morphology of the last thoracic rib and affected the correct counting of the ribs. Adequate MR imaging or CT myelography to confirm the presence and location of the offending thoracic disc was essential in the surgical planning. Early in our series, myelography and postmyelography CT studies were routinely performed to determine the extent of spinal cord compression and, most importantly, to define the surrounding bone landmarks, such as the orientation of the pedicles, the angle of the costovertebral junction, and the relationship of the rib to the vertebral bodies. As more experience was gained with this approach, a good-quality preoperative MR image of the thoracic spine was deemed sufficient.

Spinal angiography for localization of the artery of Adamkiewicz was unnecessary because the intercostal neurovascular bundle never had to be sacrificed.

Surgical Procedure

After the patient was placed prone on a radiolucent Wilson frame or chest rolls, a plain radiograph of the tho-
The thoracic spine was obtained for localization. A linear midline incision was made, spanning over three thoracic levels, centering over the affected disc. (For most operations, the least amount of postoperative pain, in our experience, was associated with a clean subperiosteal exposure technique, minimal soft-tissue retraction, and a shorter-duration procedure). The paraspinal muscles were elevated in a subperiosteal fashion on the affected side to expose the lamina, facets, and transverse processes cleanly. For a central disc, the more symptomatic side (whether causing pain or myelopathy) was exposed. The transverse process of the involved level was resected en bloc to uncover the costovertebral junction and to provide access to the costovertebral joint. A high-speed drill (3-mm match-stick burr) was then used to remove the lateral half of the facet and the rostral third of the pedicle. The thoracic pedicle can be identified by following the superior facet caudally in the direction of the pedicle’s inclination in the sagittal plane. The costovertebral joint starts at the lateral aspect of the pedicle. From there, the drilling continued anteriorly into the costovertebral joint itself, the pedicle being used as the landmark for the inferior margin of the disc. The key to the procedure was staying within the costovertebral joint and drilling outward circumferentially to include immediate adjacent structures such as the posterior cortex of the rib head and the lateral endplates above and below the annulus. This limited rachotomy exposed and isolated the affected disc. To minimize the risk of neurological injury during the discectomy, the spinal cord should be in direct visual contact. This was achieved by drilling off the superior edge of the pedicle and carrying this drilling downward into the disc space to include the lateral endplates (Fig. 3). This maneuver exposed the lateral and anterior aspects of the spinal cord. The entire exposure progressed...
from posterior to posterolateral and finally lateral. The surgically created corridor and trajectory was through the costovertebral junction with direct visualization of the disc and the spinal cord (Fig. 4).

For discectomy, the lateral annulus was penetrated using a 3 to 4-mm diamond burr and the disc center was removed to create a cavity ventral to the spinal cord. The posterior annulus and the herniated disc fragment were then pushed downward into the cavity, away from the spinal cord. For visualization of more mesial structures, we used a 30° or 70° angle pediatric endoscope or cystoscope to assist in the removal of central disc fragment and to ensure that the spinal cord had been completely decompressed (Fig. 5).

With this approach, there was no need to remove the rib head. The preservation of the rib protects the pleura, and obviates the need for ligation of the intercostal neurovascular bundle. Additionally the need to insert a chest tube postoperatively is eliminated.

There is controversy over the necessity of performing rhizotomy of the associated nerve root during the procedure. Early in our series, the nerve roots were preserved. However, we later encountered three patients with persistent radicular pain following complete disc excision. We now routinely transect the associated nerve root proximal to the ganglion in all of our cases. Only three of 10 patients in whom rhizotomy was performed experienced transient intercostal numbness, which resolved over 3 months.

Magnification with loupes or surgical microscope was essential to visualize and appreciate the anatomy of this
region. Intraoperative somatosensory or motor evoked potential monitoring was not routinely conducted in these procedures. However, for neuroprotection, we elected to use methylprednisolone (initial intravenous load 30 mg/kg) followed by continuous infusion 5.4 mg/kg/hr), instead of dexamethasone. The infusion was continued for several hours postoperatively until a reliable examination could be performed.

**Results**

No patients were worse postoperatively. Improvement is defined as complete resolution or at least 50% alleviation of preoperative pain and complete withdrawal of narcotic pain relievers. Improvement was achieved in 13 (76%) of 17 patients with axial pain and in 11 (79%) of 14 patients with radicular pain. Myelopathy was improved in 85% of patients. The two patients who did not improve have suffered spastic paraparesis for 15 years or longer. Improvement in sensory and GU symptoms was noted in 88% and 60% of patients, respectively (Fig. 6).

The average operative duration was 200.5 ± 72.6 minutes per level (range 90–360 minutes) and the average blood loss was 231.3 ± 168 ml (range 50–750 ml). The average LOS was 3.8 ± 2.4 days (range 1–10 days). Fifteen patients were discharged home between postoperative Days 1 and 3. Of the patients who remained hospitalized longer, three were at the Veterans’ Affairs hospital and stayed for 7 to 8 days, primarily for psychosocial reasons. The longest LOS was 10 days for two patients: one (Case 10) required a second operation for residual disc and another (Case 17) for uncontrolled hypoglycemia and a urinary tract infection. Eliminating these two patients and those from the Veterans’ Hospital, the average LOS was only 2.5 days. No cases of wound infection, pneumonia, or deep vein thrombosis were recorded in our series.

**Discussion**

The most common presenting symptom in our series was localized thoracic pain (axial pain [77%] and radicular pain [64%]), which was often exacerbated by activity and ameliorated with rest. The second most common symptom was weakness in approximately 59% of the cases. Weakness could take the form of monoparesis or paraparesis and tended to be progressive. Symptomatic GU affected 45% of the cases, with reported dysfunctions varying from urinary hesitation or urgency to overflow incontinence. The least common symptom was hyposthesia (36% of cases). Subjective sensory loss varied widely and could be patchy, dermatomal, or more diffuse with or without a sensory level.

Most patients with herniated thoracic discs are symptomatic for months to years before the correct diagnosis is made. It is not infrequent for patients with herniated thoracic discs to be misdiagnosed with cardiac, pulmonary, or visceral diseases. In previously reported series, as in ours, most patients presented in their third to fifth decade of life.2,4,23,26,29,36,39 Thoracic disc herniation can occur at any level, but upper thoracic disc involvement is much less common.15,39 More than 80% of thoracic disc herniations occur between T-7 and T-12, two thirds of which are posterolateral or lateral in location.2,4,23,26,29,39 Central herniations occur in 22% and multilevel involvement in approximately 15% of cases.8,16,39,44 In our series, central herniation occurred in 18% of the affected discs and multilevel involvement in 14% of the cases.

The treatment strategy for thoracic disc herniation was eloquently described by Stillerman, et al.39 The first line of treatment is always conservative: rest, bracing, nonsteroidal antiinflammatory medications, and physical therapy. Progressive myelopathy or persistent, unrelenting thoracic back pain or radicular pain refractory to conservative treatment is an indication for operation. In the past, surgeons were more hesitant to offer surgical intervention for pain alone when neurological compromise was not apparent. More often than not, these procedures caused...
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Fig. 6. Bar graph showing outcome at 6 months postoperatively. Improvement (light gray) was noted in 13 (76%) of 17 patients with axial pain, 11 (79%) of 14 with radicular pain, 11 (85%) of 13 with myelopathy, seven (88%) of eight with sensory loss, and six (60%) of 10 with GU symptoms.

more pain than that engendered by the disease itself, not to mention the technical demand of these procedures. Surgery-related complications such as pulmonary contusion, atelectasis, pleural effusion, hemothorax, and chylothorax were not uncommon and could prolong the postoperative LOS. In addition, the unpredictable outcome after thoracic disc surgery made this type of therapy less than recommendatory.

In time improvements in thoracic disc surgery were made. The approach was applicable for any thoracic level. The highest treated level in our series was T4–5. The scapular did not have to be mobilized to gain exposure. The lowest level was T11–12. The diaphragm was not encountered in this approach compared with the costotransversectomy approach. Although the surgical corridor was posterolateral, more ventral and central lesions can be visualized with this approach by using a 30° or 70° angle endoscope.

This transcostovertebral approach is truly performed through the costovertebral junction. It is different from the costotransversectomy, the modified costotransversectomy, and lateral extracavitary approaches in many ways. The latter procedures require a “hockey-stick” incision and mobilization of paraspinal musculature mesially toward the spinous process, exposing the underlying ribs. The rib is disarticulated and resected to expose the annulus. This is an extrapleural approach that may require chest tube placement if the pleura is violated. In other procedures such as the transpedicular or transfacet pedicle-sparing approach, a more proximal surgical corridor is made than in this new transcostovertebral approach. In this approach the surgeon starts by making a midline incision and then mobilizes the paraspinal muscle laterally to create a posterolateral surgical corridor through the costovertebral junction. In our series the patients in whom this approach was used experienced less postoperative pain compared with other patients who underwent thoracotomy or costotransversectomy at our institution, probably because our approach reduces muscle retraction and precludes rib resection. Consequently, the duration of the operation and the hospital LOS is much shorter than that associated with other surgical approaches we have used in the past.

Conclusions

This transcostovertebral approach involves six sequential steps, progressing from posterior to posterolateral and lateral: 1) a posterior transversectomy to uncover costovertebral junction; 2) posterior lateral hemifacetectomy to expose the costovertebral joint; 3) posterolateral partial pedicle resection to expose the lateral spinal cord; 4) posterolateral costovertebral joint drill-out to expose the vertebral body; 5) posterolateral lateral rachotomy to expose the lateral annulus; and 6) posterolateral discectomy to excise the disc.

This transcostovertebral approach can be considered an additional option in the spine surgeon’s armamentarium of surgical treatments of thoracic spine lesions. However, as advocated by Stillerman, et al., the treating surgeons should be adroit in multiple surgical approaches to maximize their ability to individualize treatment strategy.

References


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Manuscript received March 27, 2000.
Accepted in final form August 16, 2000.
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