

## Surgical Management of Thoracic Disc Herniation by Costotransversectomy Combined with Laminectomy

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### Abstract

**Background:** patients with symptomatic herniated thoracic discs may require operation for intractable radiculopathy or functionally disabling myelopathy. In the past, laminectomy was the procedure of choice for the treatment of thoracic herniations, but due to high rate of neurological morbidity, several strategies have been developed to excise the disc without manipulating the spinal cord.

**Aim:** The focus of this paper is evaluating costotransversectomy approach in treatment of thoracic disc herniations. **Patient and**

**Methods:** twelve patients presenting with herniated thoracic disc in whom surgery was performed via a costotransversectomy approach combined with laminectomy between year 2017 and year 2021 in neurosurgical department, Minia university, are reviewed. Eight patients presented with myelopathy and four patients with myeloradiculopathy. Radiological diagnosis was accomplished by magnetic resonance imaging. **Results:** Eighty percent of the discs were posterolateral while twenty were lateral. Evidence of calcifications was present in eighty percent of patients. No major

intraoperative complications were observed. The outcome of surgery was excellent in 66.7%, good in 16.7%, fair in 8.3% and poor in 8.3%. Of those with myelopathy, ten regained ambulation and seven regained normal bladder function. No patients with myelopathy experienced neurological worsening. Regarding radiculopathy, 3 patients had postoperative pain relief while in one, it remained unchanged. No patients suffered postoperative spinal instability-related pain or delayed kyphosis. **Conclusions:** The costotransversectomy approach is most applicable to lateral or posterolateral calcified or soft discs and has satisfying results.

**Keywords:** costotransversectomy approach, thoracic spine, intervertebral herniated disc

## Introduction

Herniated thoracic discs are relatively common but rarely require operation. Based on large studies examining radiographic and post-mortem studies, the incidence of asymptomatic thoracic disc herniations is 10 to 37% of population<sup>(1,2)</sup>. Despite the high prevalence of thoracic disc herniations in the general population, they are rarely symptomatic, and of all operations for disc herniations only 2% are performed in the thoracic spine<sup>(1)</sup>. Because patients with herniated thoracic discs present with a variety of symptoms, diagnosis is often unexpected or delayed<sup>(3)</sup>. Pain localized to the back is the most common initial symptom,<sup>(4,2)</sup> and the pain is frequently midline but may be unilateral or bilateral. Some patients present with more characteristic radicular complaints. The pain may be constant or intermittent, and it may be exacerbated by activity, coughing, sneezing, or a Valsalva-type manoeuvre. Occasionally, the pain mimics visceral pain. Patients with thoracic disc herniation have been diagnosed with cholecystitis, pancreatitis, and cardiac/intrathoracic disorders<sup>(5)</sup>. Pain that radiates to the groin or testicle has been described by patients with T11-T12 herniations. Sensory

disturbances are also frequent, occurring in 24 to 61% of patients<sup>(6,7)</sup>. Motor disturbances or myelopathy can be detected in roughly 60% of these patients, and symptoms of bladder dysfunction occur in approximately 24%<sup>(8)</sup>.

In the 1950s, laminectomy was performed to excise herniated thoracic discs; however, it resulted in greater than 70% of patients suffering significant postoperative deficits, the majority of whom became paralyzed<sup>(4,5,8)</sup>. Several theories exist to explain the poor results associated with standard laminectomy approach. It is thought that the manipulation required for removal of the disc ventral to the spinal cord may produce mechanical injury and potentially interfere with the spinal cord blood supply. There is also evidence that even minor kyphotic deformities produced by laminectomy can cause tethering of the spinal cord over incompletely removed disc or osteophyte and, in turn, lead to neurological deficits<sup>(9)</sup>.

Multiple operative approaches have been developed to treat thoracic disc herniations to overcome the significant neurological morbidity associated with a strictly posterior laminectomy. These approaches are

currently categorized as anterior (transthoracic<sup>(10)</sup> transsternal<sup>(11)</sup>, and thoracoscopic<sup>(11)</sup>). Lateral (lateral extra cavitory<sup>(12)</sup> and costotransversectomy<sup>(13)</sup>, and posterolateral (transpedicular<sup>(6,14)</sup> and trans facet pedicle sparing<sup>(6)</sup>). The authors of numerous surgical series have demonstrated significantly improved neurological outcomes, pain relief, and postoperative spinal stability with these varied approaches compared with laminectomy.

Costotransversectomy combined with laminectomy was used in this study to treat patients with thoracic disc herniations.

## **Patients and Methods**

This is a prospective study done between 2017 and 2021, in which 12 patients underwent costotransversectomy combined with laminectomy for thoracic disc excision in Neurosurgery Department, Minia University Hospital. All patients were subjected to thorough clinical examination. Neuroimaging studies included magnetic resonance imaging in all cases. Results of surgery were analysed. In this study the outcome system<sup>(15)</sup> used was as follows: 1) Excellent (asymptomatic, full activity), 2) Good (slight leg spasticity or weakness, return to work), 3) Fair (mild to moderate leg spasticity or weakness, return to part-

time work), 4) Poor (no improvement), and 5) Failed (worse than before surgery). This outcome classification system is beneficial to the surgeon in that it considers both relief of presenting signs and symptoms and the patient's postoperative functional status. All patients were followed for at least one year in outpatient clinic.

An informed written consent was taken from each patient prior to the operation. This consent was done according to the guidelines of Faculty of Medicine Research Ethics Committee (FMREC), Minia University, El-Minia, Egypt.

## **Surgical procedure**

The procedure is done with the patient under general anaesthesia. A prophylactic antibiotic is given just prior to the surgery. The patient is placed on the prone position on the operating table. The procedure is usually done on the patient's left side unless the lesion is to the right of the midline which mandates a right-sided approach. The approach from the left is technically easier for the right-handed surgeon. After the patient has been positioned on the operating table, the appropriate rib to be resected is identified by radiography and/or fluoroscopy and marked with methylene blue. Either types of skin incision can be used (an

oblique or semilunar incision centred over the rib to be resected), we used the semilunar incision in this study. The surgeon continues by transecting the trapezius or latissimus dorsi muscle depending on the level of the thoracic spine. The paraspinal muscles are exposed, separated subperiosteally from the laminae, and transected and retracted superiorly and inferiorly. The ribs, laminae, facet joints, and transverse processes are visualized at this point. The proximal 5-6 cm of the selected rib is resected after stripping off the periosteal covering as well as any other soft tissues. The transverse process and the head of the rib are then removed. The spinal canal is exposed by doing a complete unilateral hemilaminectomy of the two adjacent laminae. The facet joint is removed entirely. The lateral aspect of the dural sac and spinal cord is seen at this point. The disc space can be seen and palpated. The pleura is easily separated from the lateral wall of the vertebral bodies and disc space and is retracted laterally. The nerve root and intercostal neurovascular bundle which has been separated from the rib is left intact whenever possible. After that, for a herniated disc, it is best to drill out the pedicles and adjacent vertebral bodies next to the disc, therefore creating a cavity where

the disc material could be curetted down and extracted without manipulation of the spinal cord. Similarly, bony fragments in the anterior aspect of the spinal canal can be removed by thinning it down with the high-speed drill and by downward pressure with downward angled curettes. This surgical exposure gives such a clear, direct view of the dural sac that the surgeon does not have to move or manipulate the spinal cord to remove the pathological lesion. To close the wound, the different muscles and fascial layers are approximated with heavy sutures. A drain is used for 24 hours postoperatively. No problem with wound healing has been encountered in any case.

### **Statistical Analysis**

Data were prepared and coded to facilitate data handling. Microsoft Access and data analysis was achieved using Statistical Package of Social Science (SPSS) software version 20 in windows 10.

For qualitative data, simple descriptive analysis in the form of numbers and percentages; for quantitative parametric data, arithmetic means as a measure of central tendency and standard deviations as a measure of dispersion were manifested. The study's quantitative data was first

checked for normality using the One-Sample Kolmogorov-Smirnov test.

## **Results**

The mean patients' age was 34 years (range 25-58 years); there were 9 men and 3 women. With a male to female ratio of three to one. Eight patients presented with myelopathy and four patients presented with myeloradiculopathy. Precipitating events were identified in 10 patients and included falls (six cases) heavy lifting (three cases), and twisting motion (one case). The duration of symptoms from onset to the time of diagnosis ranged from 8 months to 3.5 years (mean. 23 months).

Neuroimaging studies included magnetic resonance imaging in all cases. Disc herniations were seen throughout the thoracic spine, most commonly at T11-12 (nine patients), at T10-T11 (two patients), and at T6-T7 (one patient). In nine patients (75%), the discs were posterolateral and in three patients (25%). The disc herniation was lateral. Pure central discs were not encountered. Evidence of calcifications was present in 8 patients (66.7%). Cord oedema or myelomalacia was found in MRI in ten patients (83.3%). At surgery, 12 cases had disc herniations which were found to be soft while in 8 cases the herniated discs were

calcified or combined with osteophytes. All could be easily removed with the curettes. No intradural herniations were evident. No instability resulted because most of the structure of the pedicles remained intact. The estimated blood loss ranged from 100 to 800cc with an average blood loss of 350cc. The length of operation ranged from 2 to 3.5 hours with an average operating time of 160 minutes.

The outcome of surgery was excellent in 66.7%, good in 16.7%, fair in 8.3%, poor in 8.3% and no patient experienced neurological worsening. Of those with myelopathy, ten regained ambulation (83.3%) and seven regained normal bladder function. No patient with myelopathy experienced permanent neurological worsening. Regarding radiculopathy, three patients had postoperative pain relief while only one, remained unchanged. Three minor complications (25%) occurred. Complications included *Staphylococcus aureus* deep wound infection (one case), asymptomatic pseudo-meningocele (one case), and transient neurological worsening (one case). No patient suffered postoperative spinal instability-related pain or delayed kyphosis.

**Table 1:** Summary of clinical data of studied cases.

Pt no.	Sex/age (yr)	Precipitating event	Symptom duration (yr)	Clinical presentation	Neuroimaging studies				Surgical complications	Surgical outcome
					Disc level	Disc site	calcification	Cord O or M		
1	M/46	FFH	1	Myelopathy	T10-11	contralateral	Absent	Present		Excellent
2	M/34	heavy lifting	3	Myelopathy	T11-12	Laterall	Present	Absent		Excellent
3	F/40	twisting motion	2	Myeloradiculopathy	T11-12	Contralateral	Present	Present		Good
4	F/46	FFH	1	Myelopathy	T6-7	contralateral	Present	Absent		Excellent
5	M/43	Heavy lifting	2	Myelopathy	T10-11	Contralateral	Present	Present	pseudomeningocele	good
6	M/35	FFH	4	Myeloradiculopathy	T11-12	Contralateral	absent	present		Excellent
7	F/58	FFH	3	Myelopathy	T10-11	Contralateral	Present	present		Excellent
8	M/41	Unknown	1	Myelopathy	T11-12	Contralateral	Absent	present		Poor
9	M/28	FFH	3	Myelopathy	T11-12	Laterall	Present	Present		Excellent
10	M/42	Unknown	1	Myeloradiculopathy	T10-11	Contralateral	Present	Present	Wound infection	Excellent
11	M/36	Heavy lifting	1	Myelopathy	T11-12	Contralateral	present	Present		Excellent
12	M/33	FFH	2	myeloradiculopathy	T11-12	lateral	absent	Present	Transient weakness	fair

**Table 2:** results of the study

	No of patients	percentage
<b>Gender</b>		
Male	9	75%
Female	3	25%
<b>Clinical presentation</b>		
Myelopathy	8	66.7%
myeloradiculopathy	4	33.3%
<b>Precipitating factors</b>		
FFH	6	50%
Heavy lifting	3	25%
Twisting motion	1	8.3%
Unknown	2	16.7%
<b>Neuroimaging studies</b>		
<b>Disc level</b>		
T11-12	9	75%
T10-11	2	16.7%
T6-7	1	8.3%
<b>Disc site</b>		
Contralateral	9	75%
Lateral	3	25%
<b>Calcification in disc</b>	8	66.7%
<b>Cord oedema or myelomalacia</b>	10	83.3%
<b>Postoperative outcome</b>		
<b>Myelopathy</b>		
Improved	10	83.3%
Unchanged	2	16.7%
<b>Bladder function</b>		
Improved	7	58.3%
Unchanged	5	41.7%
<b>Radiculopathy</b>		
Improved	3	75%
Unchanged	1	25%
<b>Complications</b>		
Deep wound infection	1	8.3%
Pseudomeningocele	1	8.3%
Wound infection	1	8.3%
<b>Surgical outcome</b>		
Excellent	8	66.7%
Good	2	16.7%
Fair	1	8.3%
Poor	1	8.3%
failed	0	0%

**Table 3:** Incidence of mortality and morbidity based on surgical approach after (McCORMICK et.al, 2000)<sup>(14)</sup>

Approach	No. of patients	Total mortality(%)	Postop instability	Pulmonary embolism	Pleural effusion	Misdiagnosis	Postop neuroradiological deterioration (%)	Intercostal neuralgia
Laminectomy	63	8 (13%)	0	1(1.6)	0	0	0	0
Transpedicular	41	0	0	0	0	0	0	0
Transfacet pedicle sparing	23	0	1 (4.6)	0	0	0	0	0
Costotransvers ectomy	55	0	0	0	1 (1.8)	1(1.8)	1(1.8)	0
Lateral extracavitary	72	1 (1.4)	0	0	0	0	0	2 (2.8)
transthoracic	140	0	3 (2.1)	2(2.1)	2 (1.4)	2(1.4)	2(1.4)	10(7.1)

### Illustrative cases

**Case I:** This 46-year-old woman presented with more than 1 year history of back pain and a 6-months history of lower extremity weakness leading to paraparesis and precipitancy. A workup with MR imaging revealed a large right sided T6-7 posterolateral calcified disc herniation with severe spinal cord deformation. Intraoperatively, the calcified disc was noted to be posterolateral and calcified. MRI was obtained postoperatively, to confirm successful disc resection (Fig. 6). Postoperatively, the patient experienced resolution of her back pain, with marked improvement in lower extremity strength and she became ambulatory with better control of micturition. The outcome was excellent.

**Case 2:** This otherwise healthy 35-year-old man presented with a 5-year history of mid-thoracic axial pain. This condition worsened progressively, and he developed numbness and tingling involving his left side down to the leg. He was diagnosed at another institution as having a T11-12-disc herniation with deformation of the spinal cord, which was noted on MR imaging, and conservative treatment was recommended. When his symptoms became disabling, he was referred to us for a second opinion. A left T11 costotransversectomy with resection of the soft T11-T12 lateral disc herniation. Postoperative imaging studies revealed good thoracic disc resection, and the patient experienced complete resolution of his axial pain and dysesthesias. The outcome was excellent.



**Fig.1:** T2 wieghted mriimage with out contrast sagittal view showing T6-7 disc herniation



**Fig 2:** intraoperative image showing the identification of facets and transverse process and costovertebral junction.



**Fig 3:** intraoperative image showing costotransversectomy



**Fig 4:** postoperative axial CT image showing costotransversectomy with laminectomy



**Fig 5:** postoperative MRI t2 sagittal view showing discectomy of T6-T7 disc and laminectomy

## Discussion

Whereas incidental thoracic disc herniations are common, symptomatic ones are rare. This was shown in a previously done prospective study<sup>(17)</sup> in which a 20 patients with 48 thoracic disc herniations were followed; they performed serial magnetic resonance imaging studies and clinical follow up examinations. All patients remained asymptomatic during a median follow-up period of 26 months. Twenty-one-disc herniations were small (0-10% canal compromise), 20 medium (10-20% canal compromise), and seven large (more than 20% canal compromise). Of the 41 small- or medium- sized disc herniations, 37 remained the same or decreased in size and four

increased in size. Of the seven large-sized herniations, three remained stable and four decreased in size. Because the great majority of thoracic herniations remained stable or decreased in size and because no clinical symptoms developed over time, it is difficult to recommend prophylactic surgery for patients with asymptomatic disc herniations<sup>(1,16)</sup>. No predictors currently exist to indicate which patients with incidentally discovered disc herniations will develop symptoms<sup>(6)</sup>. Symptomatic disc herniations are often treated surgically.

Review of literature revealed that the indications for operation were myelopathy in 70 of cases, intractable radiculopathy in

24 of cases, and back pain in 6 of cases<sup>(17)</sup>. These data are like those demonstrated in the present series of symptomatic thoracic disc herniations, in which 66.7% of patients underwent surgery for myelopathy and 33.3% for myeloradiculopathy. Asymptomatic myelopathy may be observed, but the surgeon should maintain a low threshold to operate for progressive symptoms or myelopathy with functional impairment<sup>(17)</sup>.

Most (75%) of symptomatic thoracic disc herniations involve the lower four-disc levels (T8-9 to T11-12); the most frequently affected level is T11-T12<sup>(3)</sup>. Only 4% of herniations affect the upper two-disc levels. Most herniations are paracentral, and calcification is a common finding.

In the present study, Disc herniations were seen most at T11-12 (75%), at T10-11 (16.7%) and at T6-7 (8.3%). Seventy five percent of the discs were posterolateral, and twenty five percent were lateral. Pure central discs were not encountered. Evidence of calcifications was present in 66.7% of patients in this study.

Thoracic disc herniation also appears to be a disorder affecting middle-aged individuals. 80% of thoracic disc herniations were noted to occur between the third and

fifth decade of life<sup>(14)</sup> and this is similar to the incidence in the present study. Neurological outcomes in series in which the costotransversectomy approach is used are very similar to those obtained using the anterior and other posterolateral approaches<sup>(10)</sup>. A potential disadvantage to the costotransversectomy approach is that it entails damage to the radicular vessels. The possible adverse effect of sectioning these vessels has long been a concern for many surgeons. It is well established that the thoracic spinal cord is a watershed vascular zone. The artery of Adamkiewicz (arteria magna radicularis) usually arises on the left side at T8-L2<sup>(6)</sup>. Based on this anatomical fact, some surgeons have suggested obtaining an angiogram if the possibility exists for any division of left-sided thoracic radicular vessels<sup>(8)</sup>.

The costotransversectomy approach is useful for lateral or posterolateral disc herniations with either a soft or calcified consistency<sup>(13)</sup> and this was the basis for the present study. The costotransversectomy approach can also be used for central calcified discs, but an anterior approach improves exposure of the anterior dura mater<sup>(10)</sup>. In a strictly costotransversectomy approach, it is difficult to resect a central calcified disc because the dura mater and

spinal cord are draped over the mass and disc excision requires manipulation of the spinal dura for exposure. Additionally, the central discs are often adherent to the anterior dura or are intradural <sup>(2)</sup> making dissection difficult.

The surgery related complications of paresis and paralysis have become relatively rare since laminectomy has been essentially abandoned (Table 3); in fact, only five cases of postoperative neurological deterioration have since then been reported in the literature: one after a transthoracic approach <sup>(2,15)</sup> three after a costotransversectomy <sup>(6,13)</sup> and one after a lateral extracavitary approach <sup>(2)</sup>. Each of the different approaches has its own relative advantages and disadvantages. Whereas the transpedicular and transfacet pedicle-sparing approaches have the advantage of being much less extensive procedures, visibility of the midline of the spinal canal is very limited and removal of centrally located discs can be problematic <sup>(17)</sup>. Whereas dorsolateral approaches, such as costotransversectomy and the lateral extracavitary approach provide greater levels of access and visibility of the thoracic disc disease and the spinal cord, their disadvantage is that they necessitate greater muscle and thoracic rib dissections, and the

potential morbidity attendant on such approaches is greater. The transthoracic approach allows direct access to the disc disease and the ventral spine over several vertebral levels; however, the disadvantages include its extensive nature, particularly at the thoracolumbar junction where the diaphragm attaches, and the potential pulmonary and mediastinal complications <sup>(9)</sup>.

Of the 55 patients reported to have undergone disc excision by costotransversectomy in the literature <sup>(14,11,17)</sup>, there were two major complications (paraplegia and discitis) in (6%), and three minor complications (pleural effusion, misdiagnosis, wrong level) (6%). In present series, complications occurred in 25% of cases, all of which are considered minor. 16 series were reviewed in one study <sup>(9)</sup>, patients underwent discectomy via the transthoracic, transpedicular, lateral extra-cavitary, or endoscopic approach <sup>(9)</sup>. Overall, improved pain status was demonstrated in 176 (82%) of 216 patients who presented with pain, and myelopathy was improved in 233 (89%) of 263 patients who presented with this symptom <sup>(9)</sup>. In a study comparing two factors, the duration of surgery and length of hospital stay (LOS), in patients who underwent thoracoscopy with those in patients who underwent conventional open

surgery<sup>(8)</sup>. In the latter series, thoracoscopic discectomy resulted in considerable reductions in both operative time and blood loss compared with open surgery. Moreover, satisfaction was quite higher in patients in whom thoracoscopy was performed. However, the costotransversectomy approach avoids the need for extensive muscle dissection, single lung ventilation, and chest tube placement as well as atelectasis associated with the anterior approaches, <sup>(8)</sup>. Additionally, major complications associated with the anterior or lateral approach range from 4 to 13%. These include permanent neurological worsening and discitis <sup>(5,8,11)</sup>.

## Conclusions

The costotransversectomy approach is useful for excision of lateral or posterolateral thoracic disc herniations, regardless of whether they are calcified or soft. Central calcified discs may best be approached via an anterior approach that provides superior exposure to the anterior dura. Complication rates are acceptable, but there is a risk of neurological worsening with all these approaches. Great diligence in avoiding application of pressure to the spinal cord as well as the complete excision of all disc

material have reduced the rate of neurological morbidity associated with laminectomy.

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