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Research Article

Management of Thoracic Disc Herniation by Costotransversectomy with Laminectomy

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Abstract

Background: Patients who experience symptoms from herniated thoracic discs may need to undergo surgery due to severe radiculopathy or myelopathy that significantly impairs their functionality. Historically, laminectomy has been the preferred surgical intervention for managing thoracic herniations. However, the technique has been associated with a significant incidence of morbidity. As a result, many approaches have been evolved to remove the herniated disc without affecting the spinal cord's structure. **Objective:** The primary objective of this study is to assess the effectiveness of the costotransversectomy approach in the management of thoracic disc herniations. **Methods:** This is a retrospective study reviewing 12 patients who were diagnosed with herniated thoracic disc and subsequently underwent surgical intervention using a costotransversectomy approach in conjunction with laminectomy. The surgeries were performed between the years 2017 and 2021 at the neurosurgery department of Minia University. **Results:** eighty percent of the herniated discs were in the posterolateral region, while the remaining twenty percent were situated in the lateral region. Calcifications were observed in 80% of the patients. There were no significant intraoperative problems experienced. The surgical outcomes were deemed excellent in 66.7% of cases, good in 16.7% of cases, fair in 8.3% of cases, and poor in 8.3% of cases. Out of the individuals diagnosed with myelopathy, a total of ten individuals were able to restore the ability to walk, while seven individuals were able to regain normal bladder function. Conclusion: The costotransversectomy technique demonstrates its greatest suitability for addressing lateral or posterolateral calcified or soft discs, yielding satisfactory outcomes. The costotransversectomy approach is a surgical technique commonly used for accessing the thoracic spine in cases with intervertebral herniated disc.

Keywords: thoracic disc herniation, costotransversectomy, myelopathy, laminectomy

Introduction

Herniated thoracic discs are a prevalent medical condition, although surgical intervention is seldom necessary. According to extensive research using radiographic and postmortem analyses, the prevalence of asymptomatic thoracic disc herniations ranges from 10% to 37% among the general population[(1,2)]. Although thoracic disc herniations are commonly found in the general population, they are infrequently associated with symptoms. In fact, only a small proportion, around 2%, of all disc herniation surgeries are conducted specifically in the thoracic spine[(1)]. The diagnosis of herniated thoracic discs is frequently unforeseen or postponed due to the diverse range of symptoms exhibited by patients[(3)]. The most prevalent initial symptom is pain that is specifically localized to the back.

This discomfort is often found along the midline, however it can also occur on one side or both sides. Certain patients exhibit more distinct radicular symptoms. The discomfort has the potential to persist consistently or occur intermittently, and it can be intensified by physical exertion, coughing, sneezing, or engaging in a Valsalva maneuver. At times, the

sensation bears resemblance to visceral pain. Patients who are afflicted with thoracic disc herniation have received a diagnosis of cholecystitis, pancreatitis, and cardiac/ intra-thoracic problems[5]. Patients with herniations at the T11-T12 level have reported experiencing pain that extends to the groin or testicular region. Sensory abnormalities are commonly observed, with a prevalence ranging from 24% to 61% among patients. Motor abnormalities or myelopathy can be identified in nearly 60% of patients, while symptoms of bladder dysfunction manifest in around 24% [8].

During the 1950s, the surgical procedure known as laminectomy was utilized for the purpose of removing herniated thoracic discs. However, this intervention led to a considerable occurrence of postoperative impairments in over 70% of patients, with the majority of these individuals experiencing paralysis [4, 5, 8]. There are other theories that have been proposed in order to elucidate the unsatisfactory outcomes that are often observed with the conventional laminectomy technique. There is a belief that the manipulation necessary for the extraction of the disc located ventral to the spinal cord could result in mechanical harm and potentially disrupt the blood supply to the spinal cord. Moreover, there exists data suggesting that even slight kyphotic abnormalities resulting from laminectomy procedures might induce the tethering of the spinal cord over incompletely removed disc or osteophyte. Consequently, this tethering can subsequently give rise to neurological impairments [9].

Numerous surgical techniques have been devised to address thoracic disc herniations in order to mitigate the considerable neurological complications associated with a solely posterior laminectomy. Presently, the existing techniques are classified as anterior, specifically transthoracic[10], transsternal[11], and thoracoscopic[11]. The surgical approaches mentioned include lateral extracavitary[12] and costotransversectomy[13], as well as posterolateral approaches such as transpedicular[6,14] and transfacet pedicle sparing[6]. Multiple studies conducted by various authors in the field of surgery have shown that different surgical techniques yield much better results in terms of neurological outcomes, pain alleviation, and postoperative spinal stability when compared to laminectomy.

In this study, the treatment approach employed was the combination of costotransversectomy and laminectomy for the management of patients diagnosed with thoracic disc herniations.

Methods:

This study is a prospective investigation conducted from 2017 to 2021, whereby a total of 12 patients received a surgical procedure known as costotransversectomy combined with laminectomy for the purpose of thoracic disc excision. The study was carried out in the Neurosurgery Department of Minia University Hospital. A comprehensive clinical examination was performed on all individuals. All cases in the neuroimaging investigations incorporated the use of magnetic resonance imaging. The findings of the surgical procedure were subjected to analysis. The outcome system [15] employed in this study consisted of the following categories: 1) Excellent, indicating asymptomatic condition and full activity; 2) Good, indicating slight leg spasticity or weakness with ability to return to work; 3) Fair, indicating mild to moderate leg spasticity or weakness with ability to return to part-time work; 4) Poor, indicating no improvement; and 5) Failed, indicating a worsening of symptoms compared to pre-surgery. The utilization of this outcome classification method is advantageous for the surgeon as it takes into account not only the alleviation of initial indications and symptoms but also the patient's functional state following the surgical procedure. All patients were monitored for a minimum duration of one year at the outpatient clinic.

Prior to the surgical procedure, a comprehensive written agreement was obtained from each patient, ensuring that they were adequately informed about the nature and potential risks of the operation. The consent for this study was obtained in accordance with the rules set forth by the Faculty of Medicine Research Ethics Committee (FMREC) at Minia University, located in El-Minia, Egypt.

Surgical procedure:

The procedure is performed with the patient under the influence of general anesthesia. A preoperative administration of prophylactic antibiotics is administered immediately before to the commencement of surgical procedures.

The patient is positioned in a prone orientation on the surgical table. Typically, the treatment is performed on the patient's left side, unless the lesion is located to the right of the midline, in which case a right-sided approach is necessary. The leftward technique presents a technically simpler option for surgeons who are right-handed. Once the patient has been properly positioned on the operating table, the identification of the rib to be resected is accomplished with the use of radiography and/or fluoroscopy. This rib is then marked using methylene blue. In this investigation, we utilized the semilunar incision, which is one of the two options available for skin incision. The alternative option is an oblique incision that is centered over the rib to be removed. The surgeon proceeds with the transection of either the trapezius or latissimus dorsi muscle, depending on the specific level of the dorsal spine. Muscles are carefully detached from the laminae by dissecting beneath the periosteum, and afterwards divided and moved upwards and downwards. At this juncture, the ribs, laminae, facet joints, and transverse processes are observed as shown in Fig 1. The periosteal covering and any surrounding soft tissues are removed before resecting the proximal 5-6 cm of the chosen rib. Subsequently, the transverse process and the head of the rib are excised. The exposure of the spinal canal is achieved through the performance of a comprehensive unilateral hemilaminectomy procedure targeting the two neighbouring laminae.

The complete removal of the facet joint is undertaken. At this juncture, the observer is able to visualize the lateral aspect of the dural sac and spinal cord. The disc space is observable and can be examined through palpation. The pleura can be readily detached from the lateral wall of the vertebral bodies and disc space, and then displaced in a lateral direction. Whenever feasible, the nerve root and intercostal neurovascular bundle, which have been detached from the rib, are preserved in their entirety. Subsequently, in the case of a herniated disc, the recommended approach involves the drilling of the pedicles and adjacent vertebral bodies next to the disc. This procedure effectively generates a cavity, facilitating the currettage and extraction of the disc material without the need for manipulation of the spinal cord. In a similar vein, the extraction of osseous fragments located in the anterior region of the spinal canal can be achieved through the process of reducing its thickness using a high-speed drill, coupled with the application of downward force utilizing downward-angled currettes. The surgical approach described provides a comprehensive and unobstructed visual access to the dural sac, eliminating the need for any manipulation or displacement of the spinal cord during the excision of the diseased lesion. In order to achieve wound closure, the various muscles and fascial layers are brought together using robust sutures. A drainage system is employed for a duration of 24 hours following the surgical procedure. There have been no reported issues observed in any situation pertaining to wound healing.

The present study aims to conduct a comprehensive statistical analysis in order to examine the relationships and patterns within the collected data.

The data were appropriately prepared and coded to enhance data management. Subsequently, the data were entered into Microsoft Access for storage and analysis. The Statistical Package of Social Science (SPSS) software version 20, operating on Windows 10, was utilized for conducting the data analysis.

The analysis of qualitative data involved the use of numerical representations such as numbers and percentages to describe the data. In the case of quantitative parametric data, measures of central tendency, such as arithmetic means, and measures of dispersion, such as standard deviations, were employed.

Results

as shown in table (1) and (2), the average age of the patients was 34 years, with a range of 25 to 58 years. The study included 9 male participants and 3 female participants. With a male-to-female ratio of 3:1. A total of eight individuals had symptoms of myelopathy, whereas four patients displayed symptoms of myeloradiculopathy. Ten patients were discovered to have experienced precipitating events, which encompassed falls in six cases, hard lifting in three cases, and a twisting action in one case. The period of symptom manifestation from the initial occurrence to the point of diagnosis exhibited a range of 8 months to 3.5 years, with a mean duration of 23 months.

All cases in the neuroimaging investigations incorporated the use of magnetic resonance imaging. The presence of disc herniations was observed across the thoracic spine, with the highest frequency occurring at the Tll-12 level in nine patients. Additionally, disc herniations were identified at the T10-Tll level in two patients, and at the T6-T7 level in one patient. In the study, the discs were found to be located in a posterolateral position in nine patients, accounting for 75% of the cases. Conversely, in three patients, representing 25% of the sample, the discs were found to be located laterally, no instances of pure center discs were seen. Eight individuals (66.7%) had evidence of calcifications. Cord edema or myelomalacia was observed in the magnetic resonance imaging (MRI) scans of ten patients, accounting for 83.3% of the sample.

During the surgical procedure, it was observed that out of the total 20 instances, 12 cases had disc herniations that were identified as soft, however in the other 8 cases, the herniated discs were either calcified or accompanied by osteophytes. The removal of all could be facilitated with the use of curettes. There were no observable intradural herniations. The absence of instability was attributed to the preservation of the majority of the pedicle structure. The recorded blood loss varied between 100 and 800 cubic centimeters (cc), with a mean blood loss of 350cc. The duration of the surgical procedures varied between 2 and 3.5 hours, with a mean operating time of 160 minutes.

The surgical outcomes were deemed outstanding in 66.7% of cases, good in 16.7% of cases, and fair in 8.3% of cases. A total of 8.3% of the population under study exhibited a low socioeconomic status, whereas none of the patients included in the sample reported any instances of neurological deterioration. Out of the individuals diagnosed with myelopathy, a total of 10 individuals were able to regain the ability to walk, accounting for 83.3% of the sample. Additionally, seven individuals were able to restore full bladder function. There were no instances of persistent neurological deterioration observed in patients with myelopathy. In relation to the condition of radiculopathy, it was seen that three patients experienced alleviation of postoperative pain, whereas in one patient, the discomfort remained unaltered. A total of three mild problems, accounting for 25% of the cases, were observed. The observed complications encompassed a deep wound infection caused by Staphylococcus aureus in one case, an asymptomatic pseudomeningocele in another case, and temporary neurological deterioration in a third case. There were no instances of postoperative spinal instability-related discomfort or delayed kyphosis observed in any of the patients.

Table 1 : Summary of clinical data of studied cases.

Pt no.	Sex/age (yr)	Duration of disease (yr)	Clinically	Neuroimaging studies				complications	outcome
				level	site	calcification	Edema or malacia		
1	Male 46	1	Myelopathic	T10-11	contr alate ral	-	+		Excellent
2	Male 34	3	Myelopathic	T11-12	Lateral	+	-		Excellent
3	Female 40	2	Myeloradiculo pathic	T11-12	Cont ralat eral	+	+		Good
4	Female 46	1	Myelopathic	T6-7	contr alate ral	+	-		Excellent
5	Male 43	2	Myelopathic	T10-11	Cont ralat eral	+	+	Csf leak	good
6	Male 35	4	Myeloradiculo pathic	T11-12	Cont ralat eral	-	+		Excellent
7	Female 58	3	Myelopathic	T10-11	Cont ralat eral	+	+		Excellent
8	Male 41	1	Myelopathic	T11-12	Cont ralat eral	-	+		Poor
9	Male 28	3	Myelopathic	T11-12	Late ral	+	+		Excellent
10	Male 42	1	Myeloradicu-lopathic	T10-11	Cont ralat eral	+	+	Wound infection	Excellent
11	Male 36	1	Myelopathic	T11-12	Cont ralat eral	+	+		Excellent
12	Male 33	2	Myeloradicu-lopathic	T11-12	lateral	-	+	Temporary weakness	fair

Table 2 : results of the study

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

Fig. (1): schematic drawing of costotransversectomy [(10)]

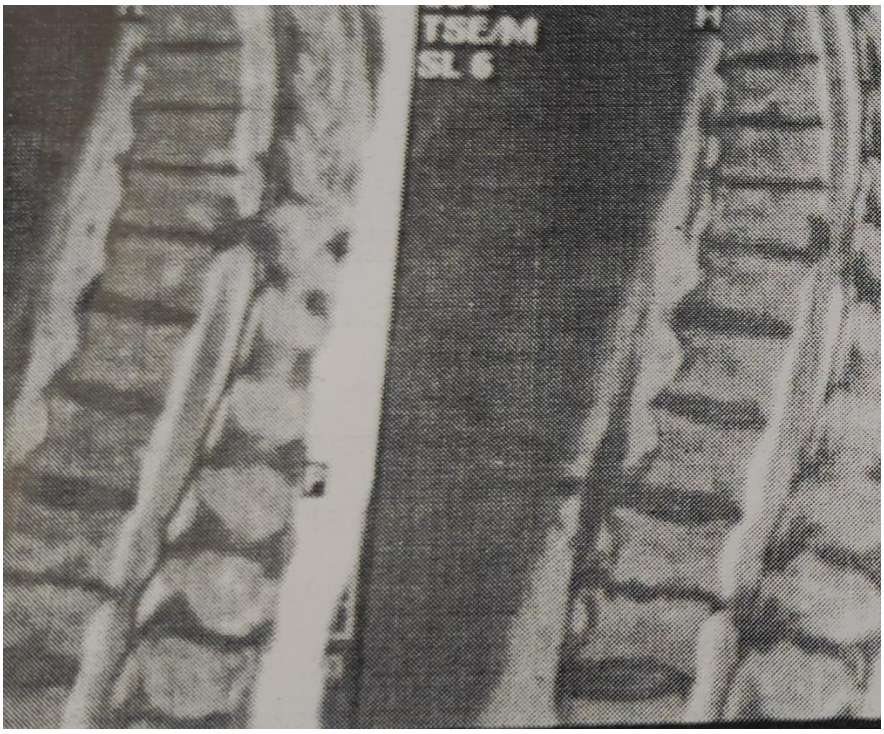

Fig. (2): MRI T2 w image showing T6-7 disc herniation

Fig. (3) intraop image showing costotransversectomy of T6

Fig. (4) postop axial CT

Fig. (5) postop MRI T2 w saggital view

Case presentation:

Case I: The patient, a 46-year-old female, exhibited chronic back pain lasting for over a year and experienced lower extremity weakness for a period of six months, resulting in paraparesis and precipitancy. A comprehensive evaluation utilizing magnetic resonance imaging (MRI). A significant calcified disc herniation was observed on the right side at the T6-7 level (fig 2-5), resulting in distortion of the spinal cord. During the surgical procedure, it was observed that the disc had been calcified and was located in a posterolateral position. A postoperative magnetic resonance imaging (MRI) scan was acquired in order to validate the efficacy of the discectomy procedure, as depicted in Figure 2. Following the surgical procedure, the patient exhibited postoperative relief of her back discomfort, accompanied by significant improvement in lower extremity strength. Additionally, she achieved the ability to walk independently and shown improved control over the process of micturition. The result was really satisfactory.

Case 2: A 35-year-old male with no known health issues presented with a chronic mid-thoracic axial pain that had been ongoing for a period of 5 years. The patient's health exhibited a progressive deterioration, resulting in the manifestation of numbness and tingling sensations extending from the left side of his body down to his leg. The patient received a diagnosis of a Tll-12-disc herniation with spinal cord distortion at a different medical facility. This condition was observed using magnetic resonance imaging (MRI), and the advised course of action was conservative treatment. Upon the manifestation of incapacitating symptoms, the individual was directed to our institution in order to have an alternative evaluation. The surgical procedure performed was a left T11 costotransversectomy, involving the removal of the costotransverse joint at the T11 level. Additionally, a resection of the soft lateral disc herniation at the T11-T12 level was conducted. The postoperative imaging examinations demonstrated successful thoracic disc excision, leading to the patient's total remission of axial discomfort and dysesthesias. The result was really satisfactory.

Discussion

While inadvertent thoracic disc herniations are frequently observed, the occurrence of symptomatic cases is infrequent. This finding was demonstrated in a previously conducted study[17], where in a cohort of 20 patients with 48 thoracic disc herniations was monitored. The researchers conducted sequential magnetic resonance imaging assessments and clinical follow-up tests. Throughout a median follow-up duration of 26 months, all patients exhibited no symptoms. A total of 21 disc herniations exhibited small degrees of canal compromise, ranging from 0% to 10%. Additionally, 20 disc herniations shown medium levels of canal compromise, ranging from 10% to 20%. Furthermore, seven disc herniations displayed substantial degrees of canal compromise, exceeding 20%. Out of the total of 41 disc herniations classified as small- or medium-sized, 37 exhibited either no change or a reduction in size, while the remaining four demonstrated an increase in size. Out of the seven herniations of considerable magnitude, three exhibited stability while the remaining four experienced a reduction in size. Due to the fact that a significant majority of thoracic herniations exhibited stability or reduction in size, and the absence of clinical symptoms over time, it becomes challenging to advocate for preventative surgical intervention in cases of asymptomatic disc herniations[1,16]. At present, there are no existing predictors that can accurately determine whether patients with incidentally detected disc herniations would subsequently experience symptoms[6]. Surgical intervention is frequently employed as a treatment modality for symptomatic disc herniations.

The literature review identified that the surgical indications consisted of myelopathy in 70% of instances, intractable radiculopathy in 24% of cases, and back discomfort in 6% of cases. The data presented in this study show similarities to the findings observed in the study of Awwad et al.,[1] Specifically, 66.7% of patients required surgery due to myelopathy, while 33.3% underwent surgery for myeloradiculopathy. The presence of asymptomatic myelopathy may be noted, however, it is advisable for the surgeon to adopt a conservative approach and consider surgical intervention when there is evidence of progressive symptoms or myelopathy accompanied by functional impairment [17].

The majority (75%) of symptomatic thoracic disc herniations often occur in the last 4 thoracic discs, specifically from T8-9 to T11-12. Among these levels, the most commonly affected one is T11-T12[3]. Merely 4% occur in the upper two-disc levels. The majority of herniations exhibit a paracentral distribution, with calcification being observed as a prevalent characteristic.

In the present study, Disc herniations were seen most commonly at T11-12 (75%), at Tl0-11 (16.7%) and at T6-7 (8.3%). The distribution of discs in the sample was such that 75% were classified as posterolateral, while the remaining 25% were categorized as lateral. No instances of pure center discs were seen. The study revealed that 66.7% of patients had evidence of calcifications.

Thoracic disc herniation is observed as a condition that predominantly impacts individuals in the middle-age demographic. The present investigation observed a similar rate of thoracic disc herniations occurring between the third and fifth decade of life, consistent with previous findings indicating that 80% of such herniations occur within this age range[14]. The neurological effects observed in studies employing the costotransversectomy strategy exhibit a high degree of similarity to those achieved through the utilization of anterior and alternative posterolateral approaches[10]. One potential drawback associated with the costotransversectomy method is the risk for injury to the radicular arteries. The potential negative consequences associated with the division of these veins has been a subject of considerable apprehension among numerous surgeons. The notion that the thoracic spinal cord functions as a watershed vascular zone has been widely accepted in the academic literature. The Adamkiewicz artery, also known as the arteria magna radicularis, often originates on the left side inside the thoracic to lumbar region spanning from T8 to L2[6]. Based on this anatomical observation, certain surgeons have proposed the utilization of an angiography in cases where there is a potential for division of left-sided thoracic radicular arteries[8].

The utilization of the costotransversectomy technique proves to be beneficial in cases of lateral or posterolateral herniations, regardless of whether the herniation exhibits a soft or

calcified consistency. This premise served as the foundation for the current investigation. The costotransversectomy method may also be employed for central calcified discs; however, an anterior approach offers enhanced visualization of the anterior dura mater[10]. In the context of a costotransversectomy technique, the resection of a centrally calcified disc presents challenges due to the anatomical positioning of the dura mater and spinal cord, which are situated over the disc mass. The excision of the disc necessitates the manipulation of the spinal dura in order to achieve adequate exposure. Moreover, it is frequently observed that the central discs exhibit adherence to the anterior dura or are located within the dural space, hence posing challenges during dissection[2].

The incidence of paresis and paralysis as complications of surgery has significantly decreased due to the decreasing use of laminectomy (as shown in Table 3). In fact, there have been only five reported cases of postoperative neurological deterioration in the literature since then. These cases include one instance following a transthoracic approach[2,15], three cases after a costotransversectomy[6,13], and one case after a lateral extracavitary approach[2]. Each of the several methodologies possesses its own inherent strengths and weaknesses. While the transpedicular and transfacet pedicle-sparing techniques provide the benefit of being less invasive procedures, they have restricted sight of the midline of the spinal canal and can pose challenges when removing centrally placed discs[17]. While dorsolateral approaches, such as costotransversectomy and the lateral extra-cavitary approach, offer enhanced visualization and accessibility of thoracic discs the dura, they are accompanied by the drawback of requiring more extensive muscle and thoracic rib dissections. Consequently, the potential morbidity associated with these approaches is increased. The transthoracic approach provides a direct means of accessing both the disc disease and the ventral spine across multiple vertebral levels. However, it is important to note that this approach has certain drawbacks. One such disadvantage is its extensive nature, particularly in the region of the thoracolumbar junction where the diaphragm is attached. Additionally, there is a risk of encountering pulmonary and mediastinal complications associated with this approach[9].

Among the 55 patients who were documented to have received disc excision with costotransversectomy in the existing literature[14,11,17], a total of two significant problems, namely paraplegia and discitis, were recorded, accounting for approximately 6% of the cases. Additionally, three minor complications, including pleural effusion, misdiagnosis, and wrong level surgery, were seen, also representing 6% of the cases. In the current series, a total of 25% of cases experienced problems, all of which were classified as minor. The study examined a total of 16 series, as reported by Wood et al.,[9], where patients received discectomy procedures using various approaches including transthoracic, transpedicular, lateral extra-cavitary, or endoscopic techniques, it was found that a majority of patients, namely 82% of 216 individuals who first reported pain, experienced an improvement in their pain status. Similarly, among the 263 patients who arrived with myelopathy, 89% of them showed improvement in this symptom. In a comparative study, the researchers examined the relationship between the duration of operation and the length of hospital stay (LOS) in patients who received thoracoscopy, as compared to those who underwent standard open surgery.[10] In the later series, it was seen that thoracoscopic discectomy led to significant reductions in both operative time and blood loss when compared to open surgery. Furthermore, it was observed that patients who underwent thoracoscopy exhibited a much greater level of satisfaction. Nevertheless, the costotransversectomy approach offers the advantage of minimizing the requirement for extensive muscle dissection, single lung ventilation, chest tube placement, and atelectasis commonly observed in anterior approaches. Furthermore, the anterior or lateral approaches are associated with a significant range of major complications, ranging from 4 to 13%.[8] Some potential complications associated with this condition are long-term neurological deterioration and discitis[5,8,11].

Conclusion

Costotransversectomy is a valuable technique for the removal of lateral or posterolateral thoracic disc herniations, irrespective of their

consistency, whether it calcified or soft. The optimal method for addressing central calcified discs is through an anterior approach, as it offers enhanced visibility of the anterior dura. The rates of complications associated with these procedures are deemed tolerable; nonetheless, it is important to note that there exists a potential danger of neurological deterioration across all of these methods. The implementation of meticulous care to prevent compression on the spinal cord, coupled with the thorough removal of all disc material, has resulted in a decrease in the incidence of neurological complications related to laminectomy.

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