Thoracoscopic Discectomy

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Introduction

Thoracic disc herniation (TDH) is less common than lumbar or cervical disc herniation, but it can always lead to serious adverse neurological consequences if not properly treated. Thoracotomy has been accepted as a standard procedure for the proper treatment of thoracic disc lesions, which can provide optimal ventral exposure. Since Mack and Regan described a technique of video-assisted thoracic surgery in 1993, consequence studies have supported thoracoscopic surgery showing less morbidity, less postoperative pain, quicker recovery times, and a lower incidence of intercostal neuralgia than open techniques [1–3]. The goal of thoracoscopic discectomy is to remove the thoracic herniated disc as a classical open procedure, while simultaneously reducing approach-related tissue damage.

The large hollow potential cavity of the chest provides a natural working passage for endoscopy, and thoracoscopic spine surgery includes excellent visualization of critical anatomical structures, the level of which is equal to that of open thoracotomy. Because of these advantages, among the various types of minimally invasive spine surgeries, thoracoscopic surgery is becoming more widely accepted and increasingly utilized.

Indications

Surgical indications include myelopathy related to spinal cord compression due to thoracic disc herniation, and radiculopathy causing persistent and severe thoracic radiating pain that does not respond to conservative treatment.

Contraindications include severe pleural adhesion due to prior thoracotomy or infectious disease such as thoracic empyema, inability to tolerate single-lung ventilation due to cardiac or pulmonary disease.

Approach selection depends on the anatomical location of the disc herniation. In the absence of special consideration of location at the lower thoracic level, the right approach is generally preferred because there is no interference with the aorta. However, if there is a pathology on the right side or lower than the level of T10–11, the left approach is chosen. If the aortic contour prevents the thoracoscopic approach to the lesion and the contralateral thoracoscopic approach is not possible, or if the herniated disc is above the T3–4 level or below the T11–12 level, an open surgical method is recommended.

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Surgical Technique

Thoracoscopic techniques are performed with single-lung ventilation using a double-lumen endotracheal tube under the general anesthesia.

The patient is placed in the lateral decubitus position with the access side facing upward and bent at the thoracolumbar junction to obtain a widened intercostal space. C-arm fluoroscopy is used to verify that the spine is perpendicular to the operating table, and draw the operating disc and adjacent vertebral body contours with ink.

Three portals are placed in a triangular pattern on the chest wall. The portal for the endoscope is positioned at the imaginary viewing zone, near the vertebral body, drawn above or below the level of the lesion. The 30° angle endoscope provides enhanced visualization to work through the working ports. The other two portals are positioned in the anterior axillary line. The main working portal is positioned perpendicular to the operated disc to allow convenient handling of the drill and other surgical instruments. The suction/irrigation portal is positioned near the main working portal in a triangular pattern. If lung or diaphragm retraction is needed, a fan retractor can be inserted to reduce interference with the surgeon's instrument movements (Figs. 1 and 2).

Fig. 2 Intraoperative endoscopic portal image

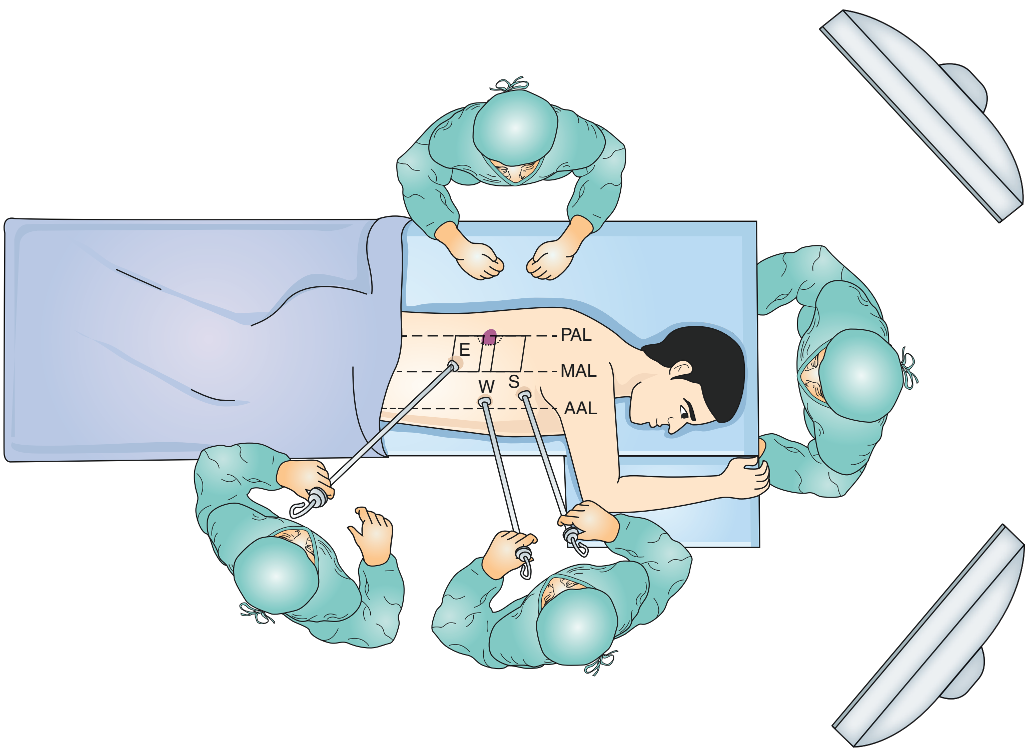

Fig. 1 Illustration of operative setup for thoracoscopic discectomy. AAL, anterior axillary line; MAL, middle axillary line; PAL, posterior axillary line; E, portal for endoscope; S, portal for suction; W, working portal (Neurosurg Focus. 2000 9(4):E9. Treatment of thoracic disc herniation: evolution toward the minimally invasive thoracoscopic technique)

Fig. 3 Initial thoracoscopic view after single-lung ventilation

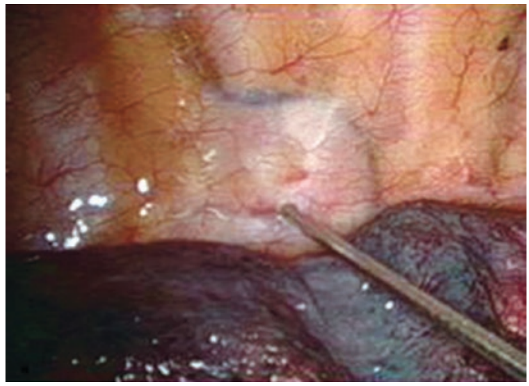

Fig. 4 Steinmann pin in the disc space to confirm the location on C-arm view

After the single-lung ventilation is completed, the first portal for the endoscope is placed. The parietal pleura are exposed and entered using blunt dissection through the subcutaneous tissues and intercostal muscle. After the endoscope is introduced through a trocar, the thoracic cavity is inspected and the subsequent trocars are inserted under the direct endoscopic visualization. The endoscope image is manipulated so that the spine is parallel to the bottom edge of the monitor. Once the portals are placed, the lung is retracted anteriorly. Additional lung retraction can be achieved manually by rotation of the operating table to allow the lung to fall away from the vertebral column (Fig. 3).

The level of the lesion is confirmed with internal rib counting in the endoscopic view and a Steinmann pin is inserted into the pathologic disc space under C-arm guidance. The parietal pleura is incised over the rib head and the disc space, and the segmental vessels can be mobilized, ligated, and divided with a bipolar cautery device or endoscopic clip if necessary. The rib head is an essential landmark for maintaining the anatomical orientation during surgery (Fig. 4).

After the neurovascular bundle, costotransverse ligaments and soft tissues are detached from the rib, the proximal 2 cm of the rib and rib head are removed using a drill and Kerrison rongeurs to expose the lateral surface of the pedicle and neural foramen (Fig. 5).

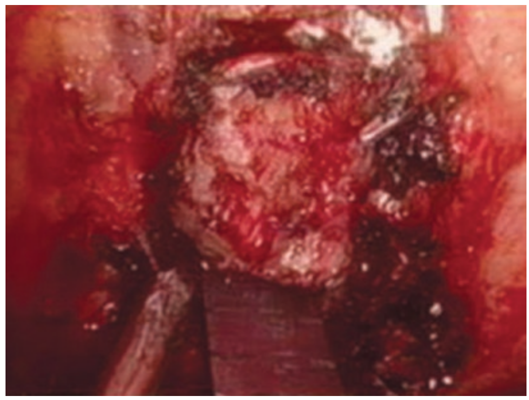

Fig. 5 Rib and rib head is removed to reveal the pedicle

The cephalad half of the pedicle is drilled until the lateral spinal canal is exposed and the dura of the spinal cord is visualized. To expose the ventral surface of the dura, a pyramidal cavity should be made in the vertebral body, using a drill to remove the compressed disc material from the epidural space. The width and shape of the bony cavity are determined according to the size and characteristics of disc pathology, but should be adequately determined to reach the contralateral vertebrae in order to expose uncompressed normal dura and visualize the entire ventral surface of the dura. The cortical bone on the ventral side of the spinal canal should remain intact to protect the spinal cord until drilling is completed. If the disc fragment has been migrated to cephalad or caudally, additional drilling is required for complete decompression (Figs. 6 and 7).

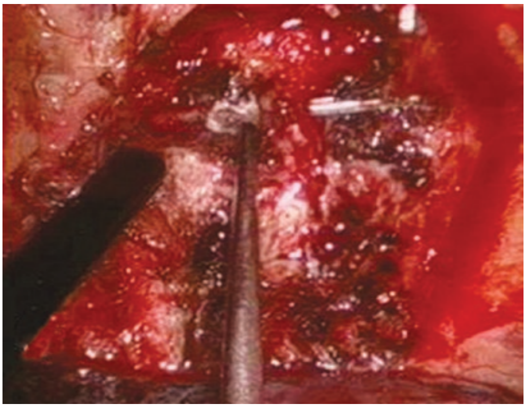

Fig. 6 Exposure of lateral surface of dura

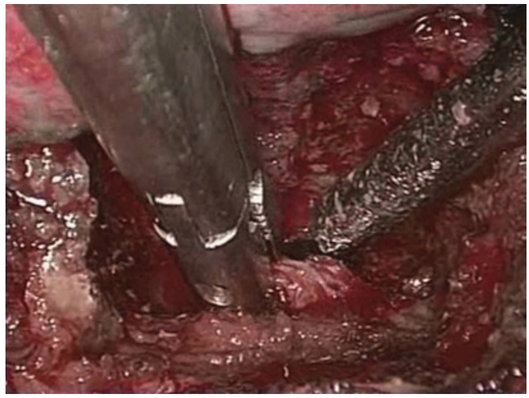

Fig. 8 Discectomy is performed

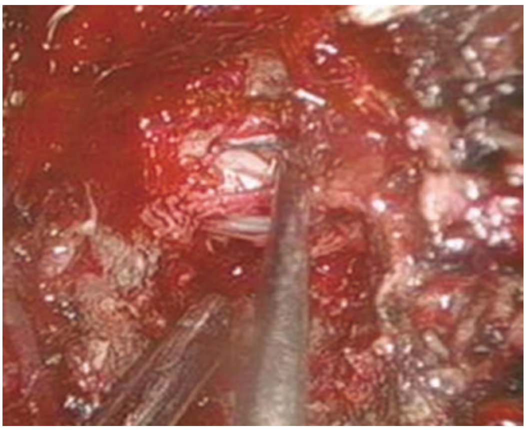

Fig. 7 Exposure of ventral surface of dura after decompression

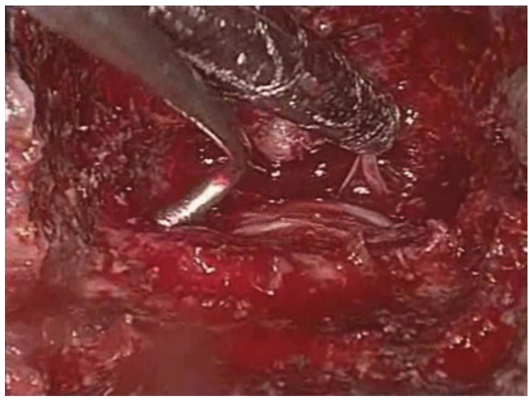

Fig. 9 Confirm the sufficient nerve decompression

In case of hemostasis is needed due to bleeding from the cancellous bone, it can be controlled by applying bone wax to the endoscopic cotton tip applicator.

The posterior longitudinal ligament is identified and is opened with a blunt-tip probe and the spinal canal floor is removed with sharp curettes or small Kerrison rongeurs, beginning at the site where the pedicle was initially removed. This often requires pulling soft disc material or cracking calcified disc into the defect created by the bony decompression. In particular, when the herniated disc and the dura are adhesive, the herniated disc may be removed using a Holmium: YAG laser to avoid dural damage due to excessive exfoliation. There is a possibility of mechanically induced cord damage, unnecessary dura tearing, and incomplete decompression while removing the compressed disc material. The ventral aspect of the spinal canal and spinal cord is completely decompressed from a ventrolateral endoscopic exposure (Figs. 8 and 9).

Before closing the incision, it is necessary to perform epidural hemostasis, irrigation of bone or disc fragments within the thoracic cavity, and lung reinflation. A chest tube is placed through the posterior portal with endoscopic guidance. The endoscopic ports are then removed, and the incisions are closed in anatomic layers with absorbable sutures. A chest radiograph is obtained to ensure lung inflation. The chest tube is removed when drainage diminishes to <100 mL/day, typically within 24–48 h. Maintenance of the chest tube is not needed in some patients.

Even during thoracoscopic discectomy, if the patient's pulmonary function is poor and onelung ventilation cannot be tolerated for a long time, excessive bleeding due to vascular injury cannot be adequately controlled through endoscopic instruments, or if the diaphragm is positioned too high to proper surgical procedure in the lower thoracic surgery, it should be converted to open thoracotomy.

Postoperative Consideration

Complications of thoracoscopic discectomy were uncommon, most of them were transient and not life threatening. Complications that are frequently encountered include atelectasis, pneumonia, pleural fluid accumulation, and intercostal neuralgia.

In several studies, there were complications such as atelectasis and pneumonia, but they were not associated with any particular approach [4, 5]. Atelectasis can be avoided by intermittent intraoperative lung inflation and adequate endotracheal suctioning. Transient pulmonary edema of the dependent lung side was observed after lengthy surgery in the lateral decubitus position, which is not a true complication but normal convalescence resulting from ventilation–perfusion mismatch.

Once an iatrogenic subarachnoid pleural fistula is present, routine postoperative respiratory care, which includes chest tube suction, encourages deep breathing, and both coughing for bronchial toilet and the semi-Fowler position, should be restricted. As a result, long-term conservative treatment for subarachnoid pleural fistula is susceptible to the occurrence of atelectasis or pneumonia.

Continuous cerebrospinal fluid (CSF) leakage into the thoracic cavity is an unfavorable condition for dural healing due to a negative pleural pressure of the chest tube drainage environment. In addition, excessive CSF loss may result in intracranial hypotension [6, 7]. If CSF leakage occurs, it can be overcome by removing the chest tube early and performing lumbar CSF drainage. But the authors suspect that lumbar drainage is effective for the management of dural tears that occur during thoracic surgery as that during posterior approach spinal surgery. In our clinical experience, because the CSF space had already collapsed, the lumbar puncture was difficult and the amount of lumbar drainage was insignificant. We experienced a reduction in chest tube drainage through a double layer sealing method without lumbar drainage. The closure of subarachnoid pleural fistula depends on the intraoperative confirmatory sealing method rather than a pressure gradient between the CSF space and the pleural space. Therefore, if CSF leakage persists for more than 2 weeks, a surgical reattempt with a thoracoscope for additional sealing is more effective.

Intercostal neuralgia is a temporary and minor problem. This can be prevented by minimizing nerve contusion through a sufficient amount of dissection of the port insertion site and directly handling surgical instruments without a trocar, or at least with a flexible trocar.

Other problems that can occur besides complications include wrong level surgery and incomplete discectomy [8, 9].

Preoperative pathology is usually counted from cranial to caudal on cervicothoracic MR images. However, on C-arm fluoroscopy, the surgical level is identified from the lumbosacrum due to shoulder interference. If lumbarization or sacralization is present, accurate counting can be difficult. The authors use CT images of the whole cervico-thoraco-lumbar (CTL) spine to confirm the potential for disc calcification or intradural disc herniation and to determine the correct surgical level in comparison with MRI. If you pay attention to identifying osteophytes and other landmarks, as well as counting the spinal level and ribs before surgery, you can avoid misidentification of surgical level after thoracic discectomy. In addition, intraoperative needle localization films and fluoroscopy can be used to determine the correct spinal level.

Incomplete discectomy may arise from insufficiency in-depth perception or from interruption of the procedure because of an intraoperative spinal cord injury. This can be prevented by preoperative measurements and intraoperative confirmation using a radiopaque marker. It is true that thoracoscopic discectomy needs a steep learning curve to be familiar with anatomical space and handling of endoscopic instruments. But in our experience, hybrid technique with thoracoscopy and mini-thoracotomy using a small baby sternal retractor may be a practical transition in the early learning phase. Also, spinal cord monitoring system (NMEP) and

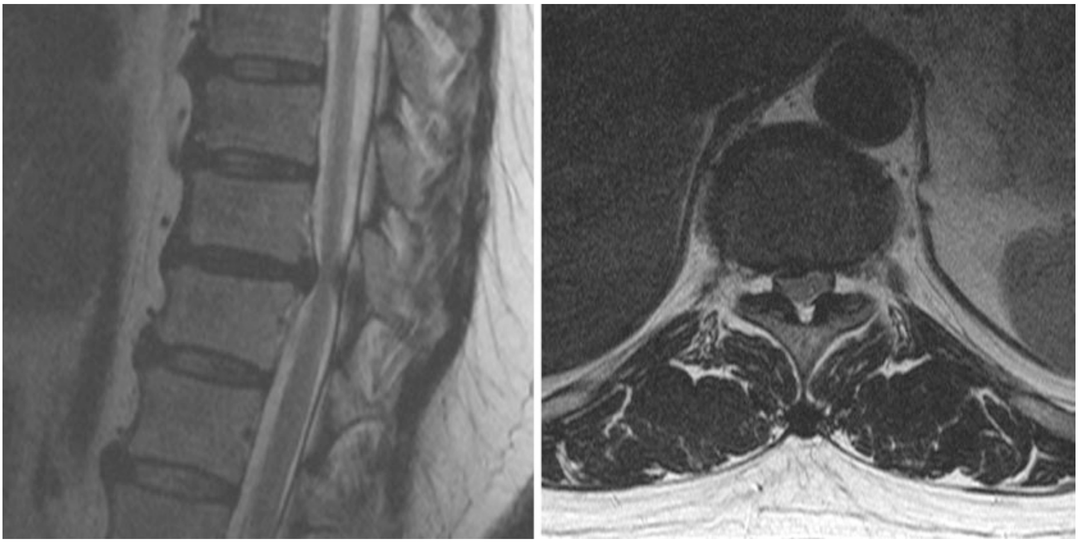

Fig. 10 Preoperative MR images

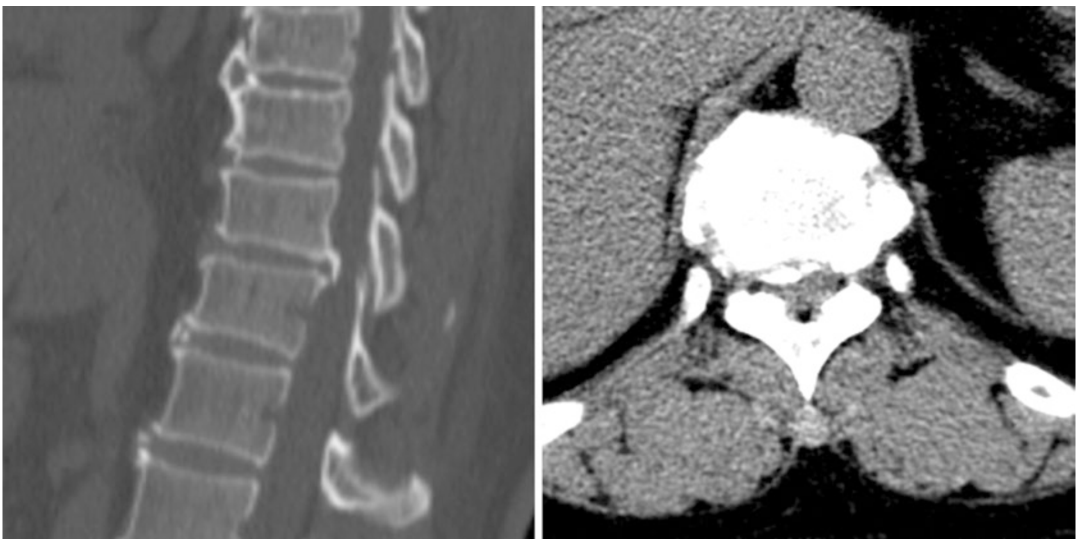

Fig. 11 Preoperative CT images

three-dimensional endoscopy may be helpful to increase the safety.

Case Illustration

A 51-year-old woman presented with progressively worsening whole back, left shoulder and left chest pain for 1 year.

Magnetic resonance imaging scans revealed a left-sided, T10–11 disc herniation with spinal cord compression combined with ossification of ligamentum flavum (Fig. 10). Computed Tomography scans showed partial calcification of the posterior vertebral endplate and within the extruded disc material (Fig. 11). On the myelogram images, a signal block was observed (Fig. 12).

A thoracoscopic discectomy was performed at the T10–11 level. After surgery, the patient was discharged 7 days later. Herniated discs were well removed on postop MRI (Fig. 13), and no abnormal findings

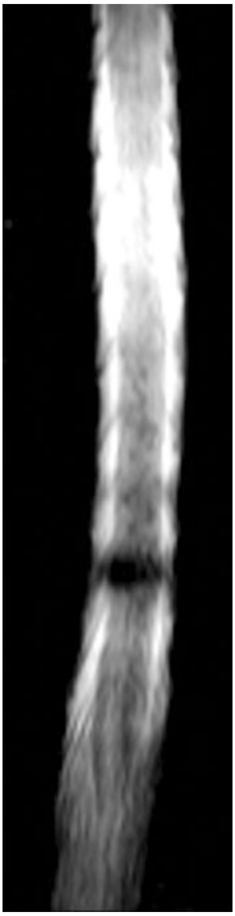

Fig. 12 Preoperative myelogram

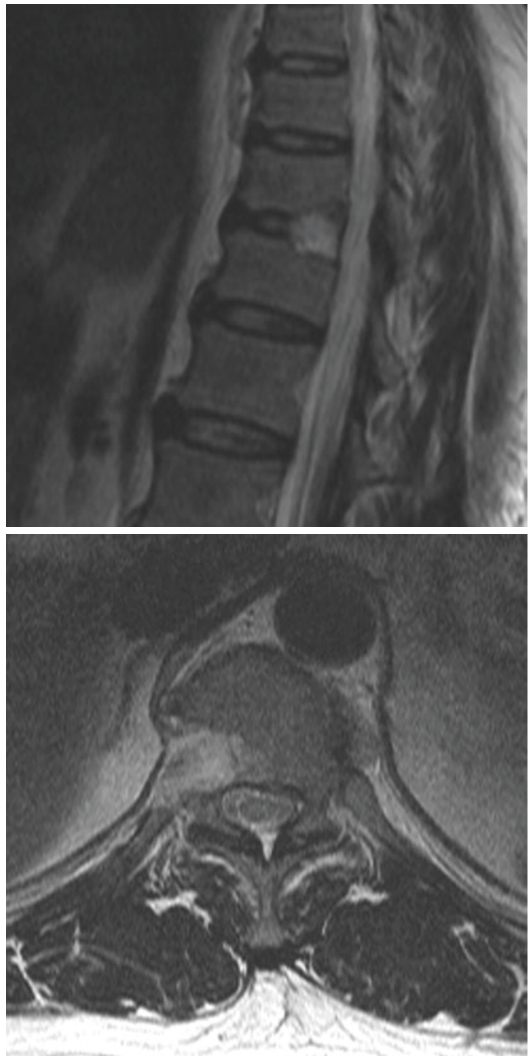

Fig. 13 Postoperative MR images

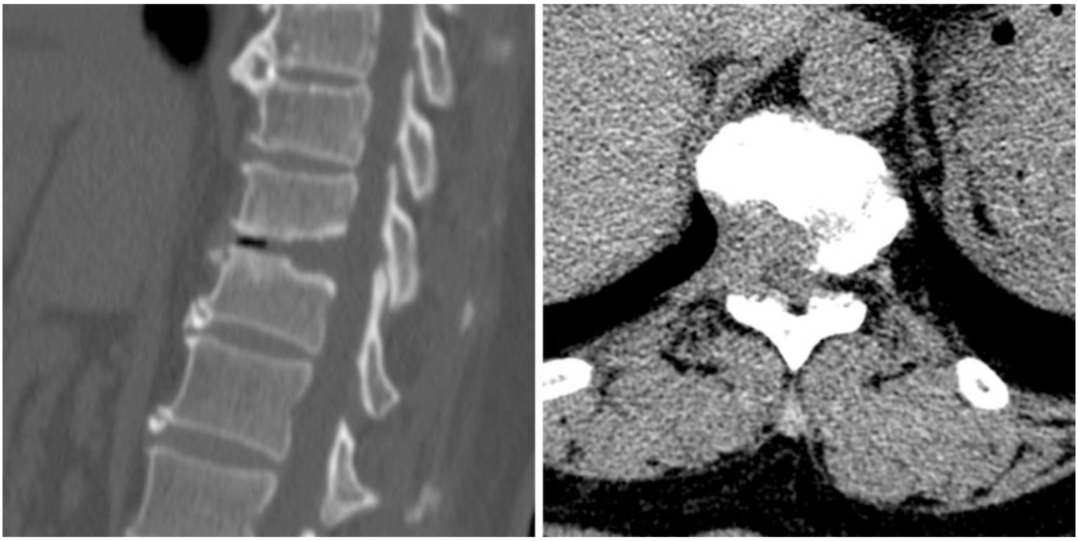

Fig. 14 Postoperative CT images were taken 6 months later

were observed on CT images taken 6 months later (Fig. 14).

Summary

Thoracoscopic discectomy of the herniated thoracic discs is minimally invasive technique, which enables surgeons to treat herniated thoracic discs directly. However, it requires experimental experience for the anterior thoracic region and an adequate degree of training for the safe and effective use of thoracoscopic instruments. Thoracoscopic discectomy is a technically feasible and is an effective surgical method, which can be an alternative to conventional surgical techniques based on acceptable results.

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