



Anterior/Anterolateral Thoracic Access and Stabilization from Posterior Approach, Transpedicular, Costotransversectomy, Lateral Extracavitary Approaches via Minimally Invasive Approaches, Minimal Access and Tubular Access

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Introduction

Minimally invasive spine surgery (MISS) involves accessing the spine through small corridors and achieving the same results as in open surgery, thereby minimizing damage to other tissues [1].

The main areas of opportunity for MISS include reduced blood loss during operation, decreased postoperative recovery time and pain, and less disruption to the paraspinal muscles and ligaments that contribute to the maintenance of proper spine biomechanics, all of which are important advantages since they could reduce complications in patients undergoing surgery for spinal tumors [1].

Tumors associated with the spinal cord can have devastating effects on patient function and

quality of life. They have been traditionally approached with large open surgeries and fusion procedures with the objective of providing oncological control, decompression, and stabilization to ultimately improve both neurological and oncological prognosis. However, in the past years, the use of MISS has been on the rise mainly due to its ability to decrease the amount of surgical trauma, which translates into improved recovery and return to productive life. We also have to consider that oncologic patients have different perioperative complications than degenerative or deformity patients, such that posterior MISS approaches may be better tolerated for them.

In this chapter, we summarize the less disruptive approaches that are available in treating thoracic tumor pathologies (Fig. 16.1).

Preoperative Evaluation

As a general rule, all spinal tumor cases which will undergo MISS must have at least a preoperative contrasted MRI, a CT scan of the area of interest, and scoliosis films in order to evaluate and ultimately compare their sagittal alignment.

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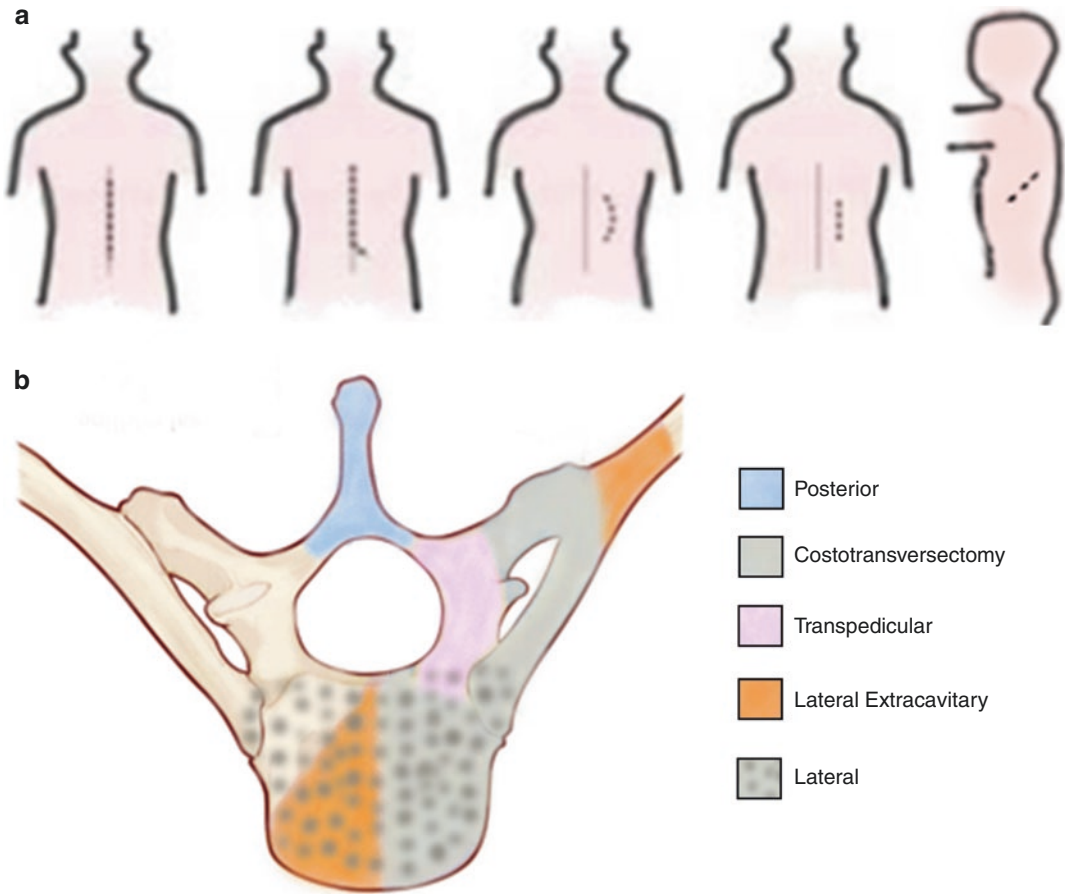


Fig. 16.1 (a) Types of positions and incisions (dotted lines) for thoracic approaches. (b) Surgical scope for the posterior thoracic surgical approaches

In patients in whom metastasis is suspected, a thorough oncological evaluation of the primary site should be performed in case there is no neurological dysfunction that requires immediate decompression of the spinal cord. The use of corticosteroids has been standard in such patients as a temporizing measure to improve or stabilize neurologic function until definitive treatment. Corticosteroids may result in a rapid improvement of neurological function, but their long-term benefits are limited, and there is no evidence that they improve survival [2].

Since surgery for spine tumors appears to be associated with a higher incidence of surgical site infections (SSIs) than non-tumor spine surgery

[3], we recommend the use of intraoperative and postoperative antibiotics.

The spinal neoplastic instability score has proven to be useful in the surgical decision-making process and as a prognostic tool and is recommended [4].

Every patient should be examined and stratified using the American Spinal Injury Association (ASIA) classification before undergoing surgery. Neurophysiological monitoring is not mandatory but it is recommended; motor- and somatosensory-evoked potentials are also useful and sometimes set a baseline for the neurological activity before the actual surgical procedure.

Surgical Techniques

Mini-Open Transpedicular Approach

Indications

- Biopsy
- Dorsal, ipsilateral, and laterally located lesions

Patient Positioning

After anesthetic induction, the patient is positioned in a prone position over a Jackson table. Preoperative x-rays are obtained to localize the indexed spinous process and the corresponding pedicle for the indexed level; alternatively, intraoperative CT with navigation can be used. Percutaneous pedicle screws can be placed two levels above and below the affected vertebral body, depending on surgeons' preference. We prefer to place the percutaneous screws using a navigated guide tube and "total navigation" or sometimes using K-wires and fluoroscopy or using a free-hand technique and fluoroscopic confirmation.

Surgical Details and Special Considerations

Transpedicular corpectomy is performed through a midline approach, and a complete 360° decompression is the primary goal. The uniqueness of

this approach in the thoracic spine is that the rib head is left intact [5].

The skin is incised in the midline along with the fascia over the indexed level. A tubular retractor system is then placed and docked over the articulating process of the level of interest, and confirmation is obtained using either navigation or intraoperative fluoroscopy.

A laminectomy with complete removal of the superior articulating process is performed. The ligamentum flavum can be preserved during the laminectomy and during the drilling process to prevent incidental durotomy.

We laterally preserve the rib heads; the discs above and below the corpectomy level are identified and marked. Identification of the pedicle with either navigation, fluoroscopy, or palpation is performed. Using a high-speed drill, a small window at the posterior cortex of the pedicle is opened and the high-speed drill is used until the "eggshell" is left (Figs. 16.2 and 16.3). After reaching the posterior vertebral body wall, an angled curette is used to carefully fracture the medial wall out laterally, exposing the lateral margin of the thecal sac. At this point, if necessary, a small window can be opened over the annulus of the disc right over its posterolateral surface and a partial discectomy can be done using pituitary rongeurs; this cavity can be used to tuck away structures that need to be removed

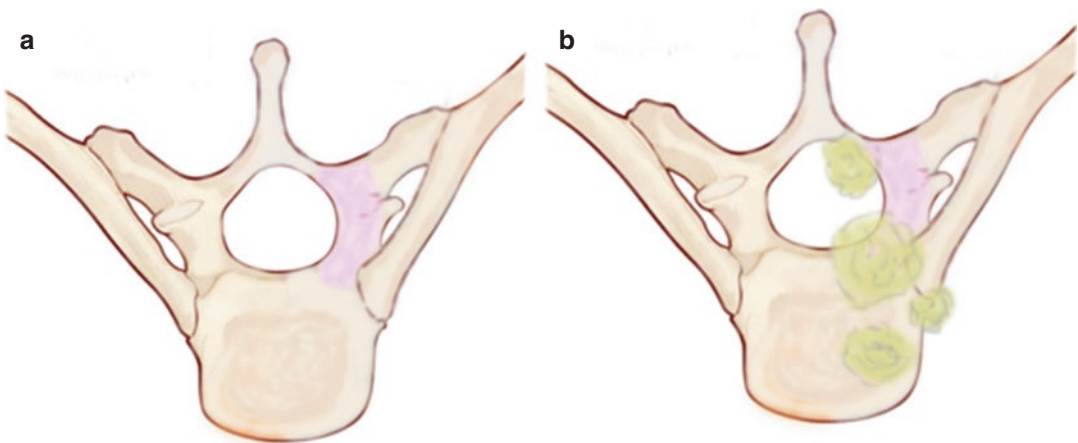


Fig. 16.2 (a) Surgical corridor of the transpedicular approach (pink area). (b) Surgical corridor of the transpedicular approach (pink area) to access tumors posterior and anterior to the spinal canal

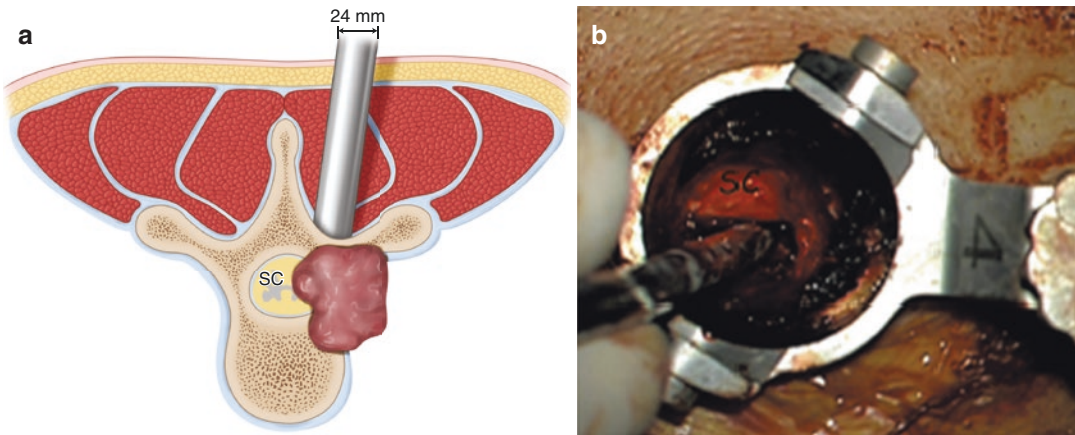


Fig. 16.3 Minimally invasive transpedicular approach. (a) Illustration of retractor positioning. (b) Intraoperative transpedicular decompression. (Reprinted with permission from Zairi et al. [7])

from the midline to avoid displacing or putting pressure on the spinal cord.

The posterior longitudinal ligament is separated from the dura very carefully; sometimes, if dural sac compression exists, adhesions may be present and incidental dural tears may complicate the procedure. Now, the discectomy is completed, the tumor is removed, and the endplate preparation is performed. The expandable cage is inserted in its collapsed configuration from lateral to medial and then moved medially and anteriorly. The cage is expanded until even contact with the superior and inferior endplate is achieved.

Once the corpectomy is completed and the cage has been put in place, a temporary rod on the contralateral side is placed and loosely secured. Finally, the construct is completed by inserting and tightening the definitive rods in place.

Several modifications to this technique have been adopted. An example is the open vs mini-open approach cohort by Chou et al. using their previously described trapdoor technique for rib osteotomy [6], which generated favorable results for the mini-open group in terms of estimated blood loss during surgery. However, these results must be interpreted with caution because there was a significant difference in age groups, where the MISS option was offered more frequently to younger patients [5].

MISS Costotransversectomy Approach

Indications

- Dorsal and laterally located lesions
- Centrally located lesions with soft consistency
- Paraspinal nerve-sheath tumors

Patient Positioning

The patient is placed in prone position on a Jackson table, and the level of interest is marked under fluoroscopic guidance or neuronavigation.

Neuromonitoring of somatosensory-evoked potentials and motor-evoked potentials is of paramount importance for this approach.

For this specific procedure, the most common complication is neurological deterioration, followed by hemo/pneumothorax. For the latter, special considerations must be taken by the anesthesiology team, including the use of divergent endotracheal tubes for ventilation and for deflating the lung on the side of the approach.

Surgical Details and Special Considerations

A 2.5-cm longitudinal skin incision is performed 3–5 cm lateral to the midline and ipsilateral to the tumor. The paramedian musculature can be retracted laterally. After the lateral transverse process is identified, a K-wire is inserted into the

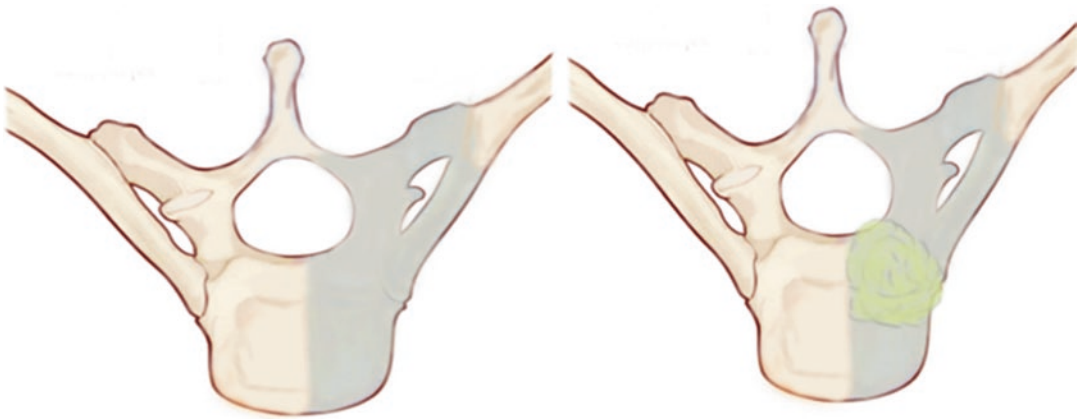


Fig. 16.4 Surgical corridor for the costotransversectomy approach

bone under fluoroscopic control to be docked at the costotransverse process junction. After this, a series of tubular retractors is guided into the area of interest which involves the interlaminar space, adjacent laminae, transverse process, and the adjacent rib (Fig. 16.4).

The transverse process and the ribs are resected using a high-speed drill and/or Kerrison rongeurs in order to achieve better visualization. From this approach, it is possible to verify the integrity of the nerve root as well as the decompression of the thecal sac. Once the goal of decompression or biopsy has been achieved, the tubular or blade retractor is removed and the fascia and skin are closed.

MISS Lateral Extracavitary Approach

Patient Positioning

After anesthetic induction, the patient is positioned prone in a Jackson table over a frame. Fluoroscopic guidance is used to identify the level of the lesion, and the skin incision is marked 4–5 cm lateral to the midline.

Surgical Details and Special Considerations

After the incision is made, blunt dissection, usually with the surgeon's finger, is performed all the way to the transverse process in an oblique lateral

extracavitary trajectory in order to insert a working portal. Percutaneous pedicle screw insertion above and below the corpectomy level is performed using 3-D navigation or fluoroscopy and K-wires.

The accurate position of the screws is confirmed by AP and lateral x-rays. The patient is then rotated away from the surgeon to compensate for the obliquity of the approach. The surgical microscope is introduced to the field, the inferior transverse process and facet are freed, and the transverse process is removed using a high-speed drill. The lateral aspect of the laminae is decompressed from lateral to medial with a high-speed drill and Kerrison rongeurs. At this point, the ligamentum flavum becomes visible and is removed in order to access the spinal canal to perform the required operation. The oblique trajectory allows for an excellent bilateral decompression of the cord through a unilateral approach.

This approach allows for an excellent visibility of the vertebral body and discs. The rib heads are preserved. The pedicles at the pathological level are removed. The discs above and below the vertebral body are identified. A high-speed drill is used to begin the corpectomy on one side. After a significant amount of vertebral body has been removed, a holding rod is placed and locked. If a rib head is maintained as trapdoor, no pleural dissection will be necessary.

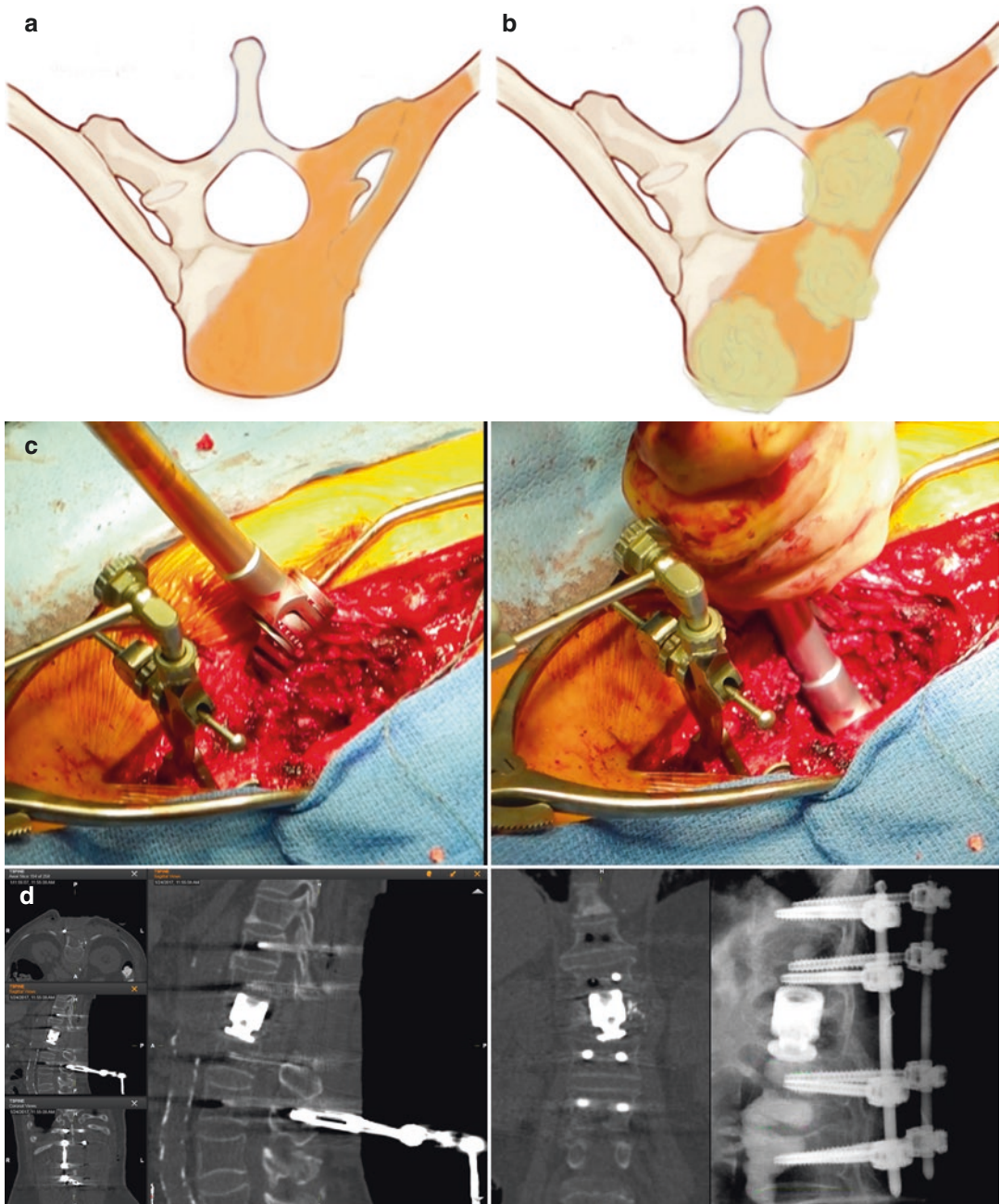


Fig. 16.5 (a, b) Surgical corridor for the thoracic lateral extracavitary approach. (c) Intraoperative images of the insertion of the collapsed expandable cage through the lat-

eral corridor. (d) Intraoperative navigation images of the cage placement and final location on fluoroscopic images

Depending on the type of operation, an expandable cage can be introduced and expanded to fit once positioned (Fig. 16.5).

The contralateral rod is then put in place and fixed, and additional crosslinks are placed for circumferential arthrodesis.

Lateral Approach

Patient Positioning

The patient is intubated using a dual-lumen tube to allow for selective bronchi ventilation and in case it is necessary to collapse the lung on the operative side (see Fig. 16.5). The patient is placed in the lateral position with the side of the targeted pathology facing up. If the pathology is located near the midline, the right side is preferred in order to reduce the risk of vascular injury.

Surgical Details and Special Considerations

Under fluoroscopic guidance, the skin is marked on the level of interest; the incision is marked parallel to the contour of the rib cage. The incision is then made and subperiosteal blunt dissection is done with preservation of the neurovascular bundle located under each rib. The parietal pleura is opened, and the first dilator is swept along the rib to approach the level of the pathology. If necessary, 3–4 cm of the rib can be resected to achieve maximal exposure. Sometimes this part of the procedure is performed by cardio-thoracic surgeons.

The dilators are then progressively placed until the necessary exposure is achieved, and the microscope is placed over the operating field.

With this approach, the placement of cages or corpectomy implants can be easily performed.

After resection of pathology and stabilization are achieved, a chest tube is placed and closure of the fascia and skin is performed.

Postoperative Care

- Obtain immediate postoperative chest x-rays to rule out pneumothorax or hemothorax.
- Strict pain control to prevent shallow ventilation postoperative is mandatory.
- Frequent and scheduled neurological checks for 24-h postoperative window. Patients should be evaluated in the immediate postoperative period in all aspects of the ASIA classification to establish if any additional damage

occurred during the surgery despite the neurophysiological monitoring.

- Urgent MRI should be considered if new neurological symptoms are present.
- Routine postoperative imaging is not required.
- Corticosteroid dose should be tapered down in the weeks following surgical management of the spinal tumor to avoid complications related to its use [2].

Conclusion

MISS posterolateral approaches to the thoracic spine for tumor surgery are feasible and safe if certain rules are followed. For instance, if subtotal resections are the goal, the posterior, transpedicular, extracavitary, and lateral approaches are good options. However, for pathologies extending anteriorly and closer to the midline, only the lateral extracavitary or lateral approaches are recommended.

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