Anterior/Anterolateral Thoracic Access and Stabilization from Posterior Approach: Transpedicular, Costotransversectomy, Lateral Extracavitary Approaches: Standard Intralesional Resection

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Introduction

Surgical approaches to the anterior thoracic spine have evolved over the last century. As early as 1894, Menard developed the costotransversectomy (CT) for the treatment of Pott's disease [1]. Until 1976, when Larson popularized the lateral extracavitary approach (LECA), the most commonly performed procedure for ventral lesions remained a laminectomy. With the advent of the LECA, greater access to ventral lesions led to less morbidity and improved outcomes in ventral thoracic spine lesions [2]. Today surgeons have improved and expanded on surgical methods enabling virtually complete access to the ventral thoracic spine through dorsal approaches.

In consideration of dorsal versus ventral approaches to the anterior thoracic spine, the goal of surgery is paramount. Most tumors of the spine are metastases; therefore, debulking through intralesional (piecemeal) resection of the tumor, not en bloc resection, is the primary goal with gross total resection when possible. Resection of the tumor mass enables us to achieve three aims. First, it allows for stabilization of the spine. The compressive load carried by the vertebral body increases from 9% of total body weight at T1 to 47% of body weight at T12 [3]. Removal and replacement of a weakened anterior column restores biomechanical stability. This at minimum prevents progressive collapse in patients with pathologic fractures and can be used to correct kyphotic deformity. Cages or allograft struts are often used to achieve anterior column support. Second, the removal of the lesion reduces tumor burden creating a corridor between the neural structures and tumor. Third, to halt or reverse neurologic deterioration from compression of neural structures. In selecting a corridor, the surgeon must weigh surgical morbidity versus attainable outcomes.

While surgical decompression with radiotherapy is superior to radiotherapy alone in maintaining function [4], the decision to operate can be guided by the NOMS framework [5, 6]. Neurologic (N) considerations include the degree of myelopathy, functional radiculopathy, and epidural spinal cord compression [7]. When

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D. M. Sciubba (ed.), *Spinal Tumor Surgery*, https://doi.org/10.1007/978-3-319-98422-3_14

possible, pain should be separated into biological and mechanical sources. Oncologic (O) considerations center primarily on the radiologic sensitivity of the tumor. For example, myeloma and lymphoma are considered radiosensitive; breast as moderately sensitive; colon and non-small-cell lung cancer as moderately resistant; and thyroid, renal, sarcoma, and melanoma as resistant [8]. Assessment of mechanical (M) instability includes movement-related pain and involved levels. Systemic (S) disease burden encompasses the extent of disease throughout the body as well as associated co-morbidities. With this framework in mind, resection is often recommended when there is high-grade epidural compression, radioresistance, mechanical radiculopathy or back pain, and instability and when the patient is able to tolerate surgery [5]. In cases with significant canal involvement for a tumor otherwise suitable for radiotherapy, surgery may be performed to separate the spinal cord from the tumor for subsequent stereotactic radiosurgery without damage to the cord [9]. This "separation surgery" enables the administration of adjuvant radiation therapy. In most institutions, the radiation oncologists request between 1 and 3 mm of cerebrospinal fluid (CSF) signal between the spinal cord and tumor margin to enable them to deliver complete lesional coverage with radiotherapy [7].

Access to the ventral thoracic spine has been historically accomplished through a variety of approaches with the main approaches being transthoracic or some combination of laminectomy (L) plus transpedicular (TP), costotransversectomy (CT) , or lateral extracavitary (LECA). Of these four approaches, the last three are posterior and can be thought of as in continuity with each other, and each extends upon a standard laminectomy (L) (Fig. 14.1). As the surgeon requires more anterior exposure, the dissection progresses from removal of the lamina (L), to pars and pedicle (TP), to removal of the transverse process and proximal rib (less than 4–6 cm) (CT), to a LECA in which extensive rib (beyond 6 cm) dissection is employed to enable contralateral access to ventral pathology from a unilateral posterior exposure (Figs. 14.2, 14.3, and 14.4) [10]. This may be accomplished in a traditional open or mini-open manner (Fig. 14.5).

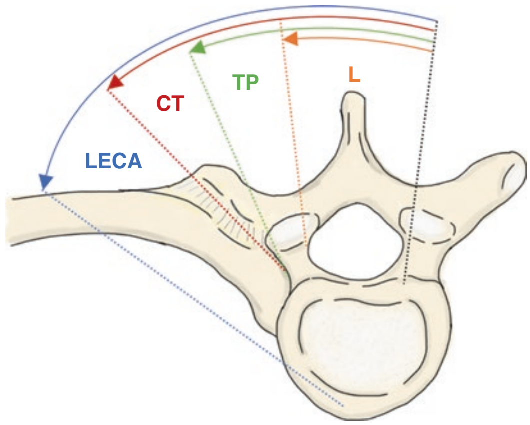


Fig. 14.1 Axial illustration of thoracic vertebral body and rib with various posterior approaches overlaid: lateral extracavitary approach (LECA), transpedicular (TP), and costotransversectomy (CT). Each of these extends the standard laminectomy (L). LECA provides greater access to the ventral aspect of the vertebral body, while TP and CT may be sufficient for more limited lesions

Case Description

For illustration, we present a 30-year-old female with a history of breast cancer who presented to clinic with progressive thoracic back pain radiating down her left flank through the T7 dermatome. Imaging revealed a lesion at T6–T7 with spinal cord effacement but without cord signal change (Fig. 14.6). Since the lesion was eccentric to the left and involved the ribs with significant invasion of the vertebral body, the decision was made to perform a lateral extracavitary approach from the left taking the T6–T7 ribs and over half the vertebral bodies. Preoperative angiography was not indicated due to the eccentricity of pathology. Because of her kyphosis and involvement of two levels, instrumentation was planned from T3 to T9 (three above, two below). On the day of surgery, her neurologic exam had further declined to a T6 sensory level with motor movements of 1–2 out of 5 in her bilateral lower extremities.

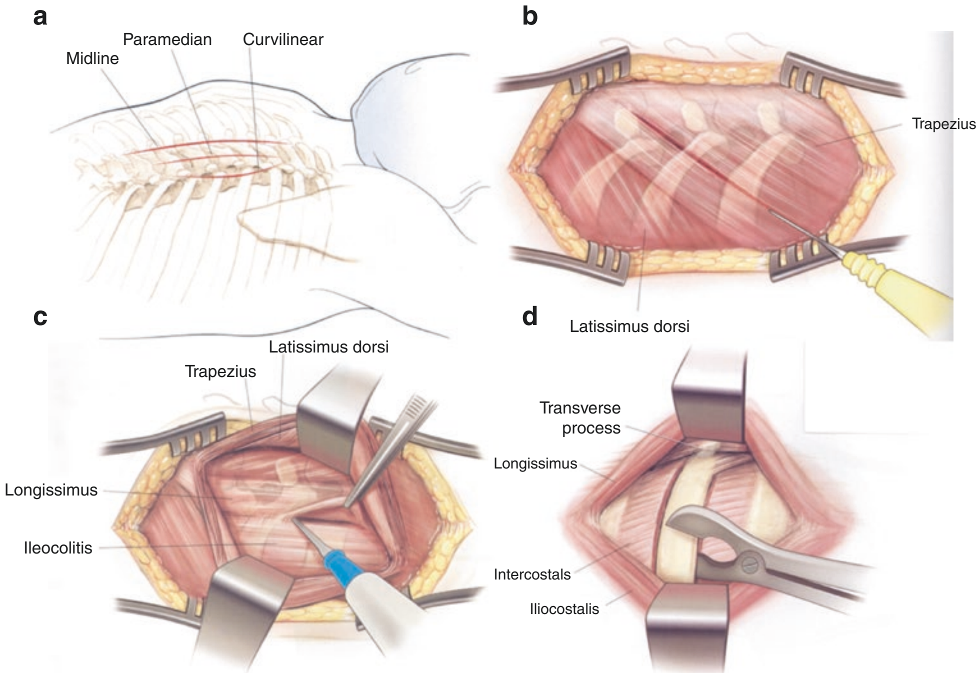
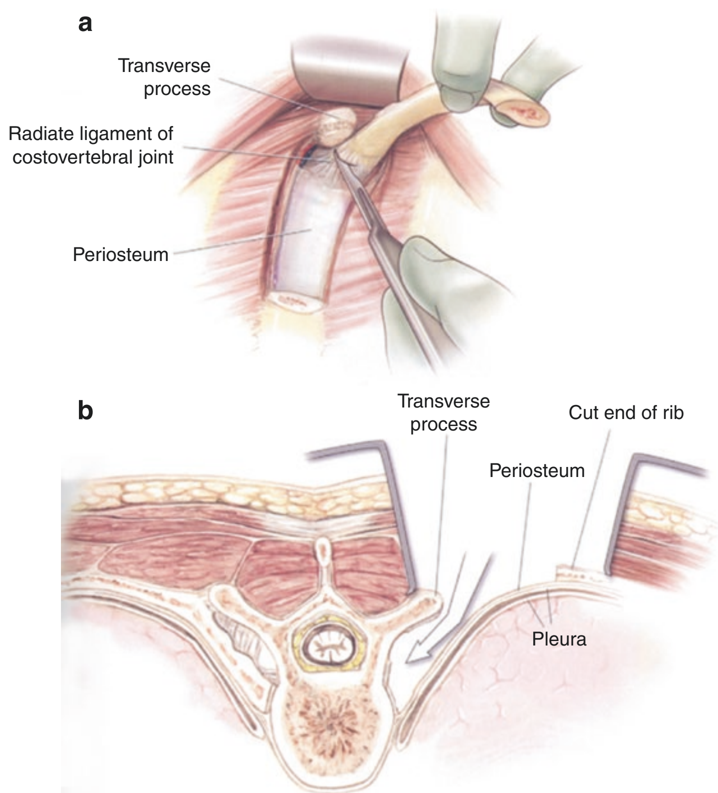


Fig. 14.2 Skin incision and rib exposure for lateral extracavitary approach to the thoracic spine (**a**–**d**). (Reprinted with permission from Miller et al. [14].)

Fig. 14.3 Lateral extracavitary approach. A. Rib disarticulation. B. Extracavitary retraction. (Reprinted with permission from Miller et al. [14].)



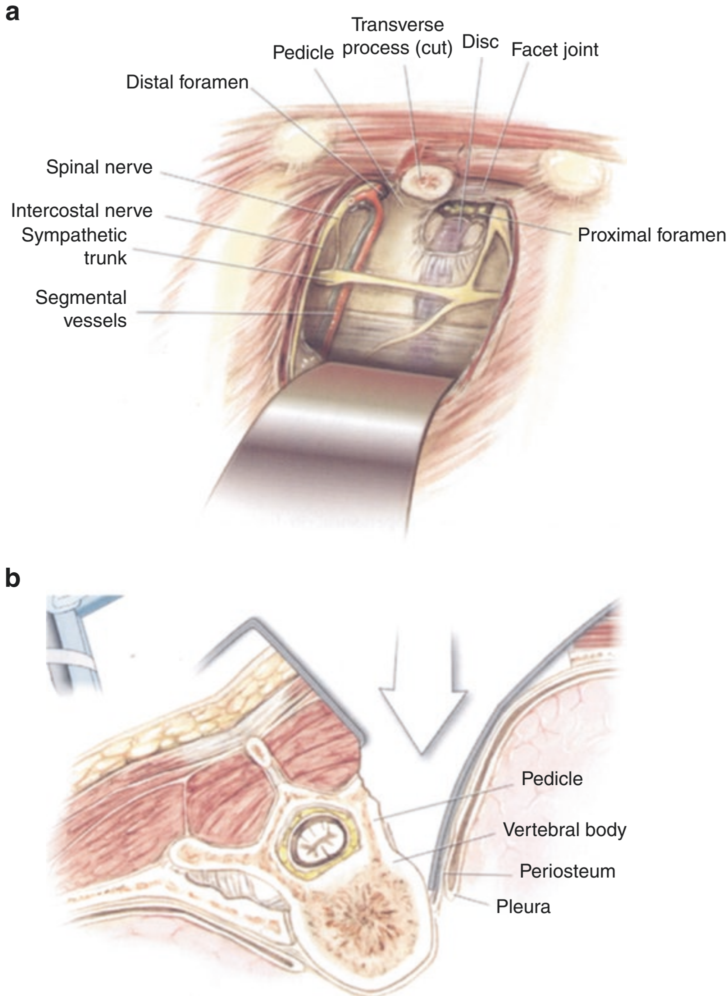


Fig. 14.4 Lateral extracavitary retraction to expose the thoracic vertebral body (**a**, **b**). (Reprinted with permission from Miller et al. [14].)

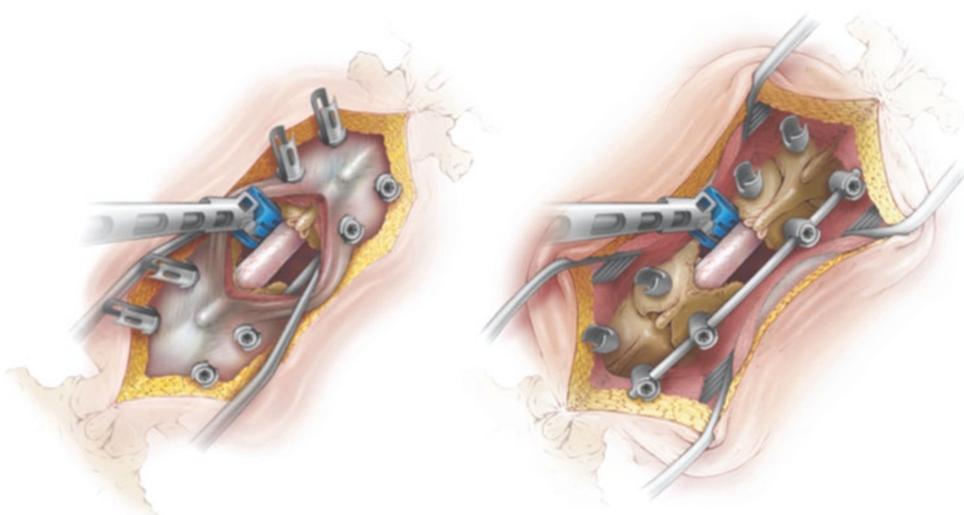


Fig. 14.5 Mini-open and open anterior column reconstruction for thoracic tumor resection. (Reprinted with permission from Lau and Chou [15])

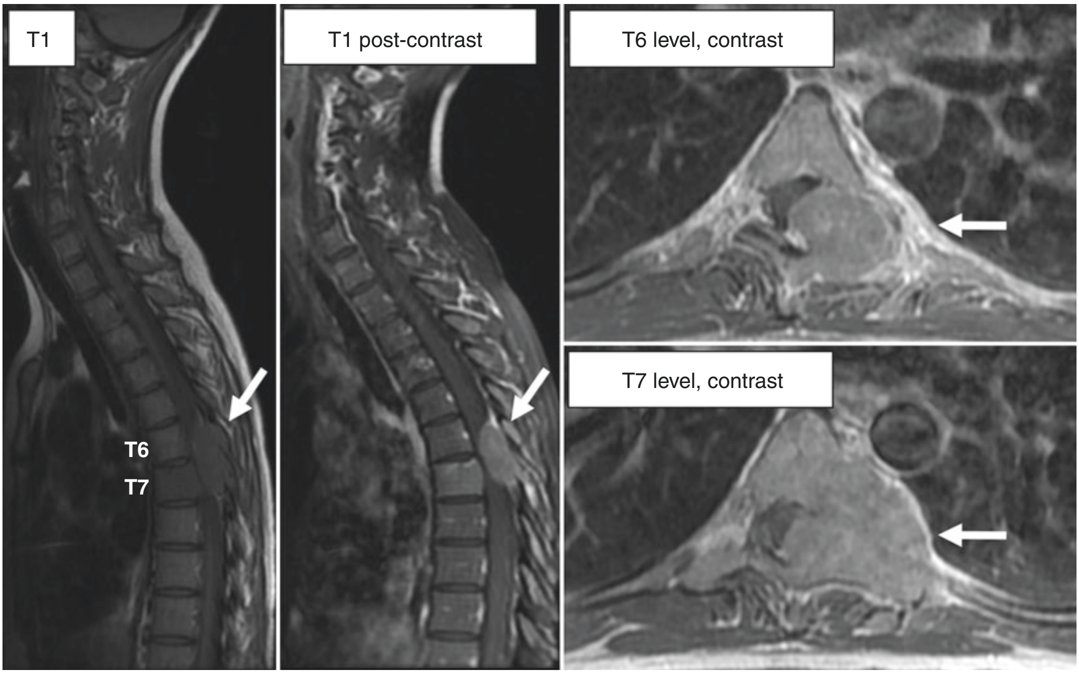


Fig. 14.6 Preoperative MRI of patient with metastatic breast cancer to T6–T7. Sagittal pre−/post-contrast images (left panels) show the lesion posterior to the canal (arrows). Axial T1 cuts at each vertebral level (T6 top, T7 bottom) show extent of tumor involvement into the vertebral body

Procedure

Outline of Steps

The following steps are carried out for the LECA procedure:

- Preoperative image review and surgical planning
- Positioning
- Neuromonitoring
- Incision
- Pedicle screws
- Transverse process dissection
- Rib dissection and resection
- Laminectomy
- Pars and facets
- Temporary rod placement
- Coring out pedicle
- Nerve root sacrifice for wider access
- Corpectomy
- Cage placement
- Complete instrumented fusion

Preoperative Image Review and Surgical Planning

The preparation of a posterior approach for anterior access of the thoracic spine requires careful review of the patient's MRI and CT scan. One needs to determine how much bone needs to be removed, the laterality of the approach to the anterior spine, and how much stabilization is required. In certain situations, a preoperative angiogram may be appropriate as well. For instance, for lesions in the T6–T9 region, the artery of Adamkiewicz should be identified, both its level and laterality to avoid injury if approached from that side. In ~20% of thoracic spinal metastasis, the lesion occurs at the level of Adamkiewicz [11]. Second, for patients where you suspect renal cell carcinoma, thyroid cancer, or other bloody metastases, preoperative embolization can greatly reduce intraoperative bleeding. We recommend admitting the patient for embolization the day before surgery so collateral circulation does not have time to develop.

Positioning

Position the patient on a rotating Jackson table with thigh and hip pads. This is a critical step because this rotation (25–40°) provides enhanced visualization necessary for cross-midline resections without the need for additional lateral dissection to achieve line of sight. Further, Jackson tables are less dense (less radio-opaque), and hence they improve intraoperative imaging and ease of location via fluoroscopy. For larger patients, a minimum of two circumferential straps are required to secure the patient from falling or slipping at higher-angle rotations. In high thoracic lesions (T1–T6), we prefer to tuck the arms. Placing the patient with arms extended forces the surgeon to cantilever their body over the arm board in an uncomfortable position.

Neuromonitoring

Neuromonitoring, both motor-evoked potential (MEP) and somatosensory-evoked potential (SSEP), is highly recommended for cases where the nerve root is to be sacrificed or deformity corrections are planned. We also include anal sphincter EMG as it is very sensitive to neurological changes. In the surgical description below, we describe their use in preparing to sacrifice the nerve root.

Localization

Localization can be extremely challenging in the thoracic spine. Preoperative assessment of upright plain films and CT should be carefully reviewed. Count the total number of ribs and lumbar vertebra to note any abnormalities. Rib numbers and morphologically unique deformities can be useful to ensure correct levels are identified. It may be necessary to incrementally count up from T12/L1 or down from T1 with several fluoroscopy shots, optionally resting a radiopaque instrument on the patient's back or inserting a spinal needle down to the spinous process for landmarks. In some cases, the index level will have a pathological fracture easily recognized on lateral fluoroscopy. In obese or muscular patients, intraoperative rib counting can be especially difficult. Consider using lateral fluoroscopy counting from the sacral prominence to be sure.

Incision

The incision is marked linearly over the midline and centered on the level of metastasis (index level). Retract the skin in a diamond shape, with the apex over the rib at the index level. This diamond shape allows for the largest corridor of approach over the index body once the rib and transverse process have been removed. The incision can be extended to enable further lateral retraction to see down the surgical corridor. In contrast to the "hockey-stick" incision [10], this midline incision does not transect the paraspinal muscles which improve postoperative pain and recovery. With the use of a rotating bed, we have found this midline incision adequate for visualization throughout the case.

Pedicle Screw Placement

Pedicle screws are placed in standard fashion before dissecting the transverse process and rib to minimize blood loss. Screws are placed a minimum of two levels above and below the index level. Thoracic pedicle screws can be placed free hand, under fluoro, or using O-arm navigation depending on comfort level. Free-hand screws are started by removing the cortex from the junction of the transverse process (TP) and the lamina 3 mm medial to the lateral margin of the pars and beneath the inferior facet of the level above. This hole places the starting point of the pedicle probe within the inferior aspect of the pedicle. This cortex can be most easily removed with a Leksell rongeur or if comfortable a high-speed drill. If the bite is placed correctly, cancellous bone will be visible with bleeding emanating most briskly from the pedicle. The starting point of your Lenke ball-tip probe should be placed in this location. An angle perpendicular to the lamina and in the sagittal plane and medialized about 15° should be used with gentle pressure to bore through the pedicle into the body; this tract should be palpated for breaches and tapped followed by screw placement. Fluoroscopy can be of great assistance in patients with small pedicles in finding the cranial to caudal starting position and orientation of trajectory for screw placement. When available, an O-arm can be helpful to avoid intraoperative breaches from the pedicle. Juxtapedicular or extrapedicular screw placement can be considered acceptable in the case where the screws breach laterally and the patient has small pedicles. This type of screw trajectory is typically used in pediatrics and scoliosis, particularly at the T4–T8 levels where the pedicles are the most narrow. In the case where there is a lateral breach, making additional passes in order to obtain a true transpedicular trajectory can further weaken the bone and result in low pull-out strength [12, 13].

Bone Removal

The approach and setup for corpectomy proceeds in the following order: resection of transverse process, rib, and lamina, coring out of the pedicles, removal of inferior facet of the index level, and removal of the superior facet of the thoracic body one level below.

Rib Dissection

The midline incision allows for a completely subperiosteal dissection and avoids transecting the erector spinae musculature as is often done with curvilinear or “hockey-stick” incisions classically described [10]. Limiting muscular dissection reduces blood loss, pain, length of stay, and recovery needs. The subperiosteal dissection begins from the spinous process carried down and over the lamina to the pars and up over the lateral aspect of the transverse process. This is repeated bilaterally at the index level as well as two above and two below, e.g., five total levels if a single-index level. Additional fixation may require a longer exposure. After removal of the muscular attachment to the lateral aspect of the TP at the index level, the tops of the TP itself can be removed with a rongeur Leksell. This allows for easier musculature dissection and retraction of and over the ribs. This maneuver with aggressive removal of the TP will also help detach the TP from the rib by cutting through the costotransverse ligament connecting the transverse costal facet of the TP and the tubercle of the rib. Use bone wax for hemostasis on any open bone surfaces. At the index level, the dissection will continue lateral and inferior to the transverse process so as to expose the connected rib. The rib should be dissected in the same subperiosteal plane pushing the erector spinae musculature lateral in one clean layer. This lateral dissection should be continued until you reach the angle of the rib (the most posterior inflection). This is typically 4–6 cm lateral to the transverse process.

Rib Resection

Once screws have been placed the rib is exposed out to the angle in the same subperiosteal plane. Circumferential dissection of the soft tissue is needed for rib removal. At the angle, dissect the periosteum off the rib edge superiorly and inferiorly using a Penfield 1. At the margins, switch to a curved curette to remove the periosteal plane over the edge and under the rib. The neurovascular bundle will be displaced from the costal groove without injury and you will not violate the pleura. It is critical that the hot electrocautery not be used over the margin of the rib edge to avoid damage to the neurovascular bundle. Once you have circumferential exposure, a Doyen rib stripper can be used to separate the remaining soft tissue from the rib proximally. If the patient has bulky musculature, it may be necessary to perform a partial rib exposure and release the musculature at adjacent level ribs. This allows additional lateral retraction without resorting to transection of the erector spinae.

At the superior rib margin, the pleura will lie just deep to the intercostal musculature, and it can be easy to create a plural defect. If a defect occurs, it is possible to repair first by removal of the rib as part of the surgery followed by primary repair using a 4.0 Vicryl suture. If necessary, a muscle patch can also be sutured similar to a dural patch. Once the pleura is mostly closed, you can place a small red rubber catheter into the thoracic cavity purse string around the catheter. A Valsalva maneuver will force the air from the pleural space. Once evacuated, pull the red rubber and synch the purse string. Serial chest X-rays should be followed postoperatively. The patient will likely have a small pneumothorax; however, as long as no violation of the visceral pleura occurs, the small pneumothorax will remain stable and should require no further intervention and resolve spontaneously.

At the inferior rib margin, the neurovascular bundle is located within the costal grove. The structures are in the order superior to inferior: vein, artery, nerve. At this margin, it can be easy to cause significant bleeding if either the vein or artery is injured. These arteries are fed via the posterior intercostal artery from the aorta and the anterior intercostal arteries via the internal thoracic/internal mammary artery.

Rib Disarticulation

After the soft tissue is dissected circumferentially, the rib can be removed. At the angle (distal cut), use a Kerrison 4 or 5 punch to cleanly cut through the rib. We find this preferable to a rib cutter that can be cumbersome and cause pleural defects. Use bone wax to seal the distal stump.

The proximal rib articulates posteriorly at two locations. First, the costotransverse ligament connects the transverse costal facet of the transverse process to the tubercle of the rib. This is easily cut during the removal of the transverse process as described above. Second, radiate ligaments connect the rib head to the superior and inferior costal facets of the vertebra (costovertebral joint). This is the final attachment of the rib to the body after the completion of the above steps. To free the rib, dissect between the rib and the body of the vertebra using a Penfield 4. Using firm but controlled pressure allows for disruption of this ligament from the vertebral bodies. Once free, the rib can be posteriorly elevated and the final periosteal layer on the underside close to the body can be further dissected using a Kittner and Penfield 1. If completed properly, the rib will freely elevate from the cavity without damage to the neurovascular bundle or tear in the pleura.

Laminectomy

In unilateral approaches, the laminectomy should be completed with no more than half of the pars removed from the contralateral side of the exposure. This will ensure increased stability of the posterior elements, with ample room for a posterior fusion bed if desired. In bilateral approaches or to accomplish a more complete corpectomy, a bilateral laminectomy can be carried lateral through both pars. The removal of lamina should also be carried out in the adjacent levels to provide further decompression and the room needed for ventral decompression.

Pars and Facets

By drilling through of the pars, the inferior facet of the index level will be detached (Gill fragment). In cases of severe compression, rotational removal of this fragment is not safe and should not be attempted. These freed fragments should be carefully removed using a Kerrison. Once the inferior facet is removed, the superior facet of the inferior body should be drilled to expose the neuroforamen at the index level. If residual transverse process remains, this can be removed with a Leksell or as part of the pedicle resection using a 3-mm drill.

Temporary Rod

Once pedicle screws are placed and before proceeding with the destabilizing facetectomy and corpectomy, it is important to place a temporary rod on the contralateral side from the ventral approach. If this is not in place prior to anterior and middle column removal, the patient's spine may collapse on the table and kink their spinal cord resulting in devastating neurologic injury. The rod does not require final tightening. The rod can be moved from one side to another side if a bilateral corpectomy approach is desired; however, a second rod must be placed prior to the first rod removal when switching sides. At all times, there must be at least one rod for support.

Transpedicular Resection

Once the neuroforamen is completely exposed, a 3-mm drill bit can be used to burr down the cancellous cavity of the pedicle. This drilling can continue into the body of the bone. Once the cancellous bone is removed, drilling can be continued circumferentially until the bone is egg shelled. The remaining cancellous bone can be outfractured away from the cord or removed with a mastoid rongeur.

Corpectomy

At this point, all dorsal elements obstructing the ventral pathology have been completely removed. The corpectomy proceeds in stages: sacrifice nerve root for greater access, radiographic identification of resection limits, completion of a periosteal dissection, removal of tumor mass, and placement of graft.

Nerve Root

In order to perform a resection of the ventral tumor and place an anterior construct, it is necessary to sacrifice a nerve root at the level of the lesion (Fig. 14.7). Each posterior intercostal artery supplies a spinal artery; this joins the nerve root and contributes to the anterior and posterior radicular artery. These segmental radicular arteries join the anterior and posterior spinal arteries feeding the spinal cord. To sacrifice a root, there are several steps. First, ensure mean arterial pressure is greater than 90 mmHg during this aspect of the case. An arterial line is essential (not cuff pressure). Prior to manipulating the vascular supply, assess baseline MEP and SSEP readings. Instead of proceeding to cut the nerve root, use silk tie to temporarily ligate the candidate nerve root. Neuromonitoring should be observed for a minimum of 5 min to ensure blood supply lost from the radicular artery within the root is not critical for spinal cord perfusion. If no changes are seen in MEPs, or SSEPs, permanent ligation should be safe. It is important to ligate the nerve proximal to the dorsal root ganglion (pre-DRG). Cutting the nerve root pre-DRG removes the nerve cell bodies, while transecting post-DRG causes permanent radiculopathy from the retained body. If significant neuromonitoring changes are seen, cut the suture to free the nerve root and switch to the contralateral side.

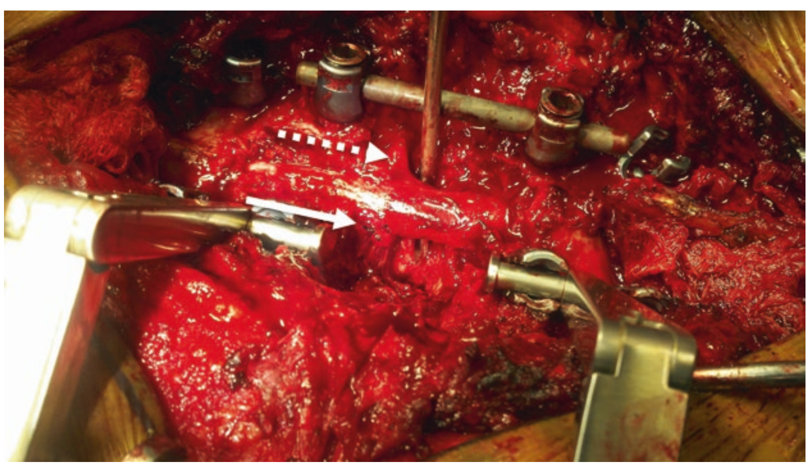


Fig. 14.7 Nerve root ligation (solid arrow), retraction from pedicle tulips, and contralateral temporary rod. For additional bone removal and better cage placement, optionally approach from the contralateral side while leaving the contralateral nerve intact (dashed arrow)

Boundary Localization

Once the nerve root is mobilized, it is critical to identify the resection boundaries. In the cranial/caudal axis, use a lateral fluoroscopic view placing Penfield 4 in the disc space above and below the index level to mark the endplates of the cranial and caudal bodies. In metastatic disease, a fractured body at the index level can cause conformational changes that greatly displace these margins. These gross deformities can lead to inadvertently entering and damaging the endplates of the adjacent body.

Boundary Dissection

Once the cranial/caudal limits are identified, dissection of the periosteal plane must be completed to ensure a safe anterior (ventral) displacement of the pleura and vascular structures during resection. In the same plane created from the removal of the rib, gently dissect along vertebral body until the ventral midline is reached using a Kittner and Penfield 1 as needed. This will displace the aorta and pleura away from the bone. Once free, a retractor system can be placed between the bone and the viscera to protect these structures from your drill.

Resection of Vertebral Body

After defining the ventral, cranial, and caudal margins, and once a rod is in place for structural support, it is then possible to begin resection of the vertebral body/tumor mass. In soft tumors, a pituitary can be used to begin debulking the mass centrally. Once the bulk of the tumor is removed, curettes can be used to fracture the mass ventral to the cord into the resection cavity. In areas where the tumor is firm or significant bone remains, a high-speed drill is employed to remove the mass. As your dissection progresses, the line of sight is maintained through rotation of the Jackson table up to 30°. Through rotating the table, a larger exposure with greater rib resection is avoided. In this process we aim to remove the bulk of the mass and vertebral body. We prefer to leave a rim of bone in the contralateral and ventral sides to protect the contralateral pleura and vascular structures. To remove the contralateral tumor from an ipsilateral costotransverse or LECA corridor, a dental mirror can be used to see under and around the spinal cord (Fig. 14.8). In addition to visualization under the cord, these circular mirrors can also be used as a probe, if turned perpendicular, to ensure the cavity is large enough for cage placement.

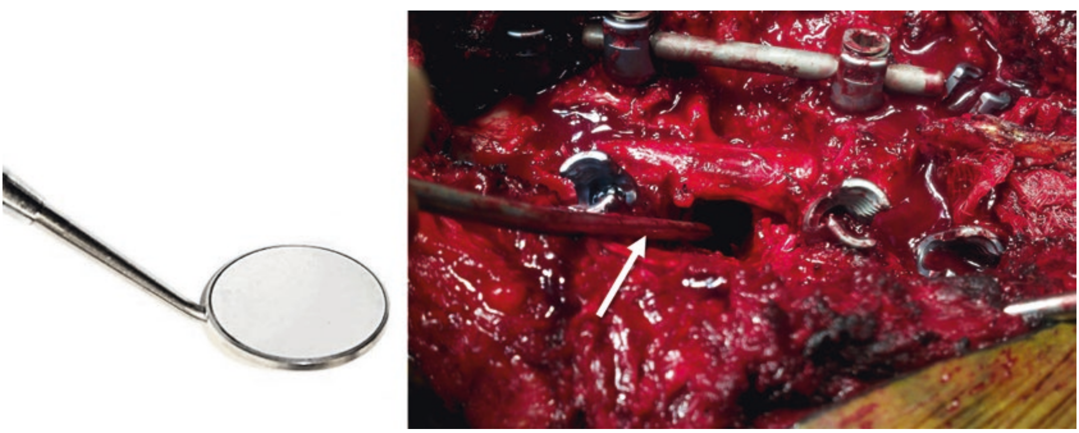


Fig. 14.8 Use a standard dental mirror (left) to visualize the cavity contralateral and posterior bone (right). White solid arrow indicates mirror placed in the space. Turned sideways, this tool doubles as a circular probe with the diameter of the mirror as your cage width. This step will allow you to verify that the corpectomy site is sufficient to fit the cage

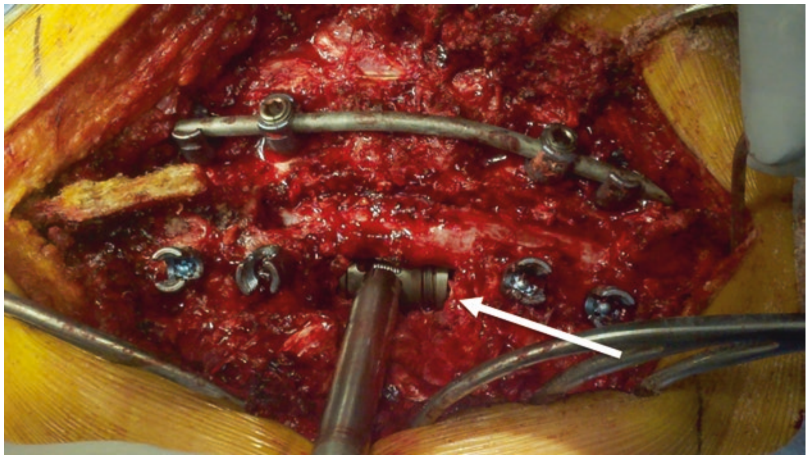


Fig. 14.9 Placement of a two-level expandable cage (arrow) with temporary rod placement shown. Cage selection is critically important to correct any kyphotic deformity from the pathological fracture

Fusion and Cage Placement

Since resection is often followed by radiation therapy, every effort must be made to prepare the fusion beds and obtain good purchase in hardware placement. Once the tumor is removed/debulked, proper endplate preparation is required. This ensures seating the cage, graft, and a fusion bed. A curette should be used to remove all disc and ligamentous material from the endplate of the bodies above and below the index level.

Cage Placement

We prefer to use a packed titanium expandable cage when possible; this allows for deformity correction typically seen in these patients. Neuromonitoring should be used while expanding the cage; if changes are noted, less distraction will be required. In cases where there is endplate damage, a metal expandable cage will often subside and the deformity will worsen over time. In our experience in these cases, a solid strut graft of humerus or tibia packed with bone is preferred for the anterior construct. In these cases, the bone will incorporate better and we have less subsidence with progressive kyphosis. To pack our cages or strut graft we prefer to have the rib graft removed during access, which is typically not involved in the tumor. Placement of the cage should be midline within the anterior column, without any of the cage seen in the posterior limit of the body in a lateral X-ray (Fig. 14.9).

Posterior Instrumentation

Once the cage is placed and expanded, the final rods should be placed one at a time. This is particularly true in patients with iatrogenic pars defects from the exposure. If a strut graft was used, the rods should be compressed to ensure it is under pressure and will not retropulse into the spinal cord. Place and finally tighten the posterior rods and locking screws. In patients with unilateral removal of rib, it is not necessary to place a cross-link.

A final Valsalva should be performed to check the nerve root stump as well as the ventral dura for leaks.

Case Follow-Up

Pathology from the patient presented at the start of the chapter was estrogen receptor-positive metastatic carcinoma. She underwent a T6–T7 LECA with instrumented fusion from T3 to T9. The procedure required only ipsilateral nerve root sacrifice. Her postoperative course was uneventful, and she was transferred on day 7 to acute rehabilitation. Adjuvant therapy included external beam radiation and continued tamoxifen.

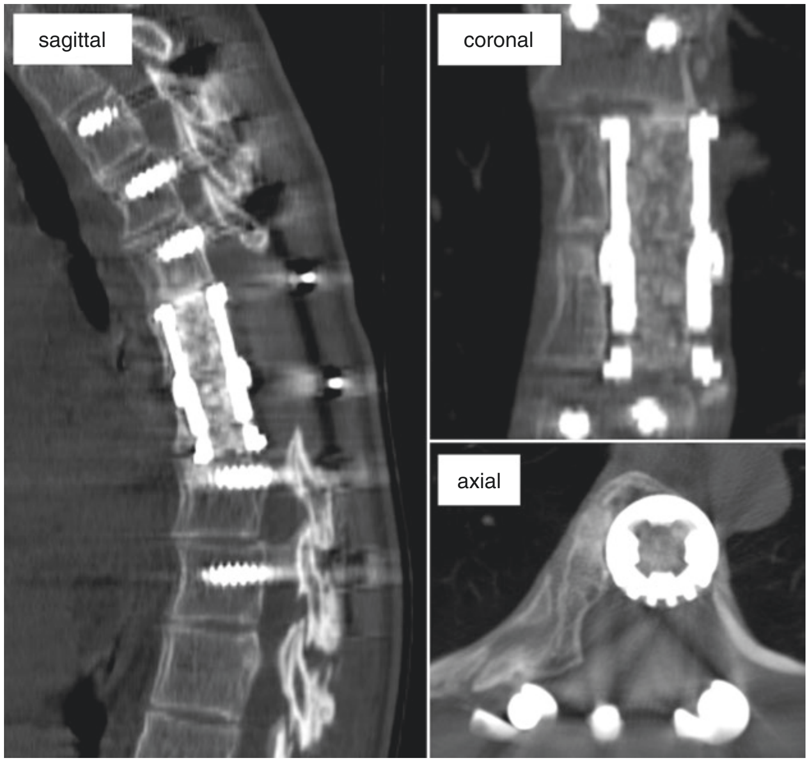


Fig. 14.10 Follow-up CT at 1 year showing good hardware placement and progression of bony formation in the interbody cage at T6–T7

At 5 months, she had significant return of strength in her lower extremities and was ambulating without assistance. A 6-month PET scan was negative in the thoracic region. At 1-year follow-up, the patient had good hardware placement and progression of bony fusion (Fig. 14.10).

Discussion and Conclusion

Mastering the lateral extracavitary approach is a technical and critical skill needed for resection of large ventral lesions. The techniques described above allow for the maximal exposure of the contralateral spine through a posterior ipsilateral approach. Near-complete vertebrectomy can be performed safely through this technique. Limitations to LECA include visualization of the contralateral vertebral body, sacrifice of the ipsilateral nerve root, and temporary destabilization of the spine. The visual limitations are dependent on the approach angle. Muscular or obese patients typically restrict your vision, even with extensive soft tissue dissection and rib resection. In morbidly obese patients, this approach may not be feasible and transthoracic exposures may prove to be more practical. Requirements of ipsilateral nerve root ligations can lead to spinal cord stroke. Due to this, neuromonitoring is critical, and preoperative angiograms are recommended for both identification of artery of Adamkiewicz and preoperative embolization from T6 to T9. Through exposure and resection using LECA, significant removal of bone in both anterior and posterior elements occurs. Operative consideration for both temporary and permanent hardware is needed, and a postsurgical goal of fusion should be a primary surgical aim. In our experience, with good endplate preparation and placement of appropriate construct/graft, these patients will have a high rate of fusion, despite receiving postoperative adjuvant chemotherapy and radiation.

Using the techniques for LECA, the extent of exposure can be scaled back for smaller lesions eccentric to a side. With reduction in total rib removal (less than 4 cm), the approach would be defined as a costotransversectomy, which enables partial exposure across midline. If the approach is restricted to removal of the transverse process, lamina, and pedicle, the approach would be defined as transpedicular, which limits resection of lesions to the lateral recess of the spinal canal. Transpedicular approaches are a typical approach used for calcified thoracic discs. These approaches should be viewed as in a continuum, and by utilizing the same incision a surgeon should be able to expand or restrict the extent of dissection to ensure adequate visualization to accomplish the goals of surgery without jeopardizing critical structures.

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