Minimally Invasive Lateral Approach to Thoracic and Lumbar Spine: For Discectomy and Corpectomy for Trauma, Tumor, Infection, and Deformity

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Anterior access to the spinal column is a powerful tool in the armamentarium of spine surgeons. Direct decompression of anteriorly based compressive pathology is expedient at the level of the spinal cord, conus medullaris, and cauda equina. Anterior column reconstruction provides ideal restoration of alignment and provides robust stability and longevity of the fusion construct. Traditional transthoracic, thoracoabdominal, and retroperitoneal approaches to the spine involve large incisions and considerable morbidity. Minimally invasive surgical approaches to the thoracic and lumbar spine are safe and effective with potentially decreased morbidity. This chapter discusses the indications, technique, and outcomes of minimally invasive surgical lateral approach to the thoracolumbar spine for the treatment of disk and vertebral level pathologies including disk herniation, fracture, infection, tumor, and deformity.
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Introduction

The anterior approach to the spinal column through a laterally based incision is a well-described, reliable technique for addressing various pathologies of the spinal column at the thoracolumbar junction.[1] Historically, anterior exposure of the thoracolumbar spine involved significant soft tissue and muscle dissection, and carried significant postsurgical morbidity (Fig. 1). Thus, with improved understanding of the surgical anatomy, and the advent of newer retraction systems, the minimally invasive lateral retropleural and retroperitoneal access has become a safe and effective technique for many spine surgeons to access the anterior column for decompression and stability with decreased morbidity.

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All case examples are surgical patients treated by Dr Javidan and have consented to use their cases for educational purposes.
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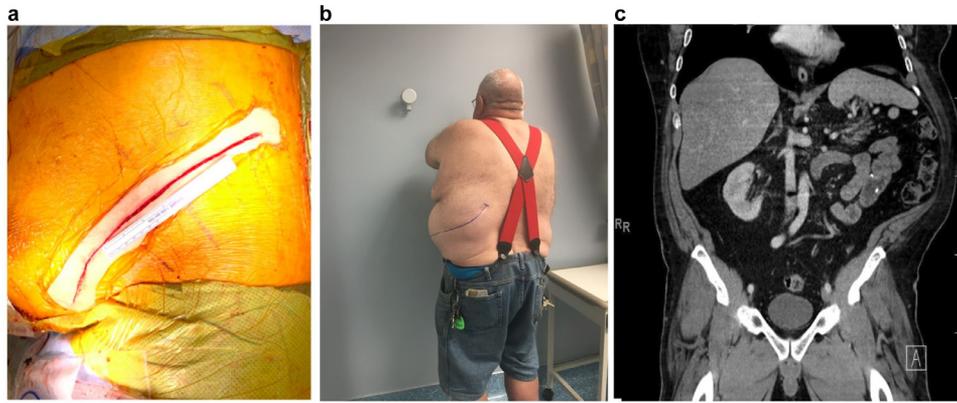
Advantages/Disadvantages

The surgical goals for thoracolumbar discectomy and corpectomy, regardless of the type of approach are to minimize collateral tissue damage while allowing for safe and appropriate access to the middle and anterior spinal columns. The advent of minimally invasive surgical (MIS) techniques and instruments allows surgeons to perform the surgical exposure in such a way that offers a measurable decrease in morbidity and more rapid functional recovery, all with adequate accomplishment of the intended surgical goal with a low complication rate.[2,3] There are several advantages of the MIS approach to the thoracic and lumbar spine. These include appreciably smaller cosmetic incision (Fig. 2), decreased blood loss, decreased dissection and denervation of abdominal musculature, avoiding dissection and denervation of the diaphragm, and possible avoidance of need for chest tube. Studies have also demonstrated shorter hospitalizations and favorable complication rates.[4] Additional advantages of this approach include excellent anterior column reconstruction and decreased risk to the spinal cord.[5]

The disadvantages of the approach are the learning curve of the surgical approach, as well as the complexity of the retropleural dissection and technical demands on the surgeon during decompression using minimally invasive instruments.[4] Some

Figure 1 (a) Open thoracoabdominal incision, left flank, >30 cm incision. (b) Clinical photograph. Patient with open thoracoabdominal incision with left abdominal wall herniation. (c). CT scan, coronal, patient in (b) with open thoracoabdominal incision with left abdominal wall herniation observed on CT.
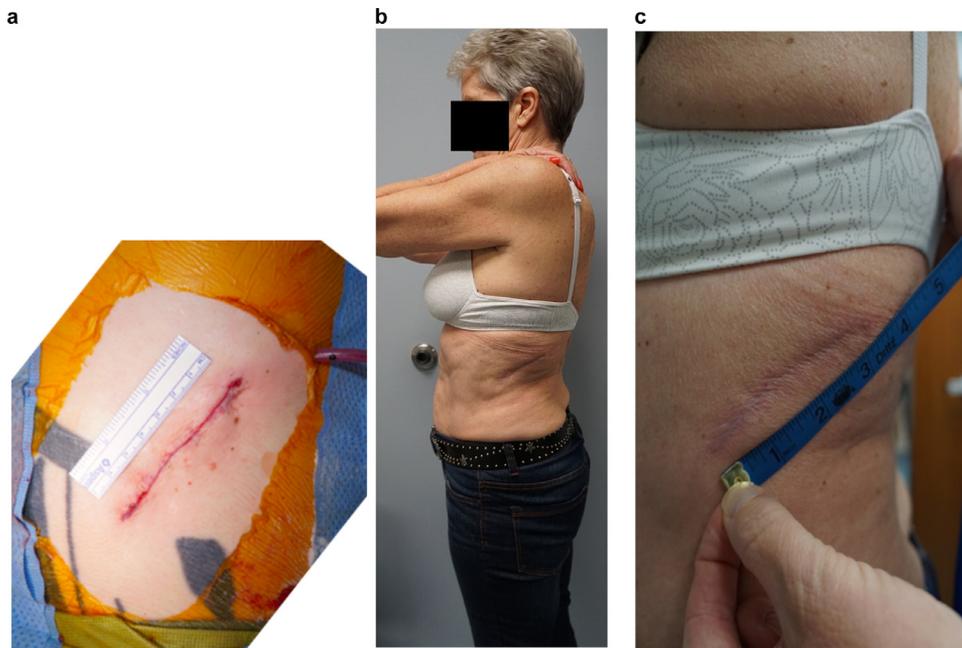

Figure 2 (a) Minimally invasive lateral approach with 6 cm incision. (b, c) Clinical photographs of minimally invasive lateral approach with 6 cm incision.

technical challenges include performing dural repair from this approach, control of bleeding from segmental arteries, and infrequent need for chest tube placement postoperatively.

prior retroperitoneal surgery, extensive radiation, disorders of the great vessels, or patients with severe pulmonary disease with compromised pulmonary function.

Indications/Contraindications

The most common indication for partial corpectomy and discectomy and vertebrectomy at the thoracolumbar junction (T10-L2) includes spinal cord, conus medullaris, and cauda equina compression caused by anterior-based pathology. Lumbar corpectomy may also be utilized in deformity correction for segmental kyphosis as seen in post-traumatic kyphosis, as well as severe kyphoscoliosis. As reported in the literature, the most common clinical scenarios for this approach include trauma, tumor, thoracic disk disease, infection and spinal deformity.[6] Relative contraindications include

Case Example 1

Discectomy for Conus Level Disk Bulge

A 51-year-old female with no significant past medical history presented with several months of worsening back and leg pain with associated bilateral lower extremity paresthesias. Patient reported intermittent difficulty with bladder function for several weeks and complained of abdominal fullness. A bladder scan following emptying was greater than 900 mL. Patients MRI is shown in Figure 3. She was indicated for direct anterior-based decompression at the level of the conus (L1-2) via a lateral retropleural approach.
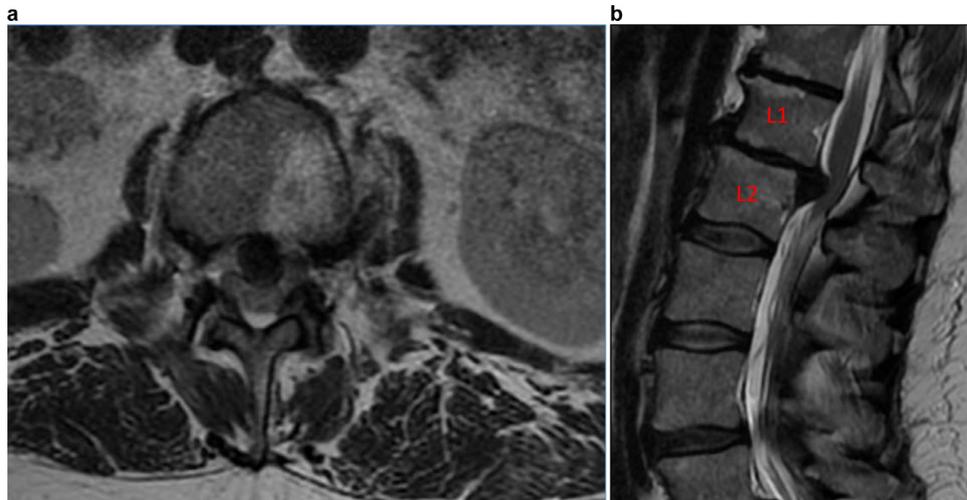
Figure 3 (a) Axial T2 MRI demonstrating severe compression of conus medullaris. (b) Sagittal T2 MRI demonstrating large disk protrusion with severe compression of conus medullaris.

Patients with thoracic and thoracolumbar disk herniation at the level of the spinal cord and conus medullaris will frequently present with myelopathic symptoms, radiculopathy, back pain, and/or bowel/bladder dysfunction. The treatment of thoracic disk herniations with lateral access surgery through a minimally invasive incision has been shown to be safe and effective.[7] Preoperatively, magnetic resonance imaging (MRI) is used to localize the pathology and the location of compression. Additional computed tomographic (CT) evaluation is beneficial at to better characterize the nature and chronicity of the disk herniation. For instance, a chronic herniation may exhibit disk material changes consistent with ossification, and thus an anterior approach may be preferable depending on the location of the osteophyte. In preparing for surgical treatment of thoracic-level disk herniations through a minimally invasive approach, the authors recommend having a radiopaque marker placed via CT guidance preoperatively at the level of the pathology to help ensure appropriate intraoperative localization of the operative level (Fig. 4).[8] The senior author has had several patient referrals from outside hospitals with aborted attempts for lateral thoracic disk approach due to inability to localize pathology and establish spinal levels intraoperatively.

Technique

For thoracolumbar disk herniations, the patient is transferred to lateral decubitus position with the patient's back in the middle of the bed because the surgery will require visualization from both ventral and dorsal aspects of the torso (Fig. 5). The authors recommend dissection, approach, and osteotomy to be done while standing on the dorsal aspect of the patient, and to complete the intracanal decompression
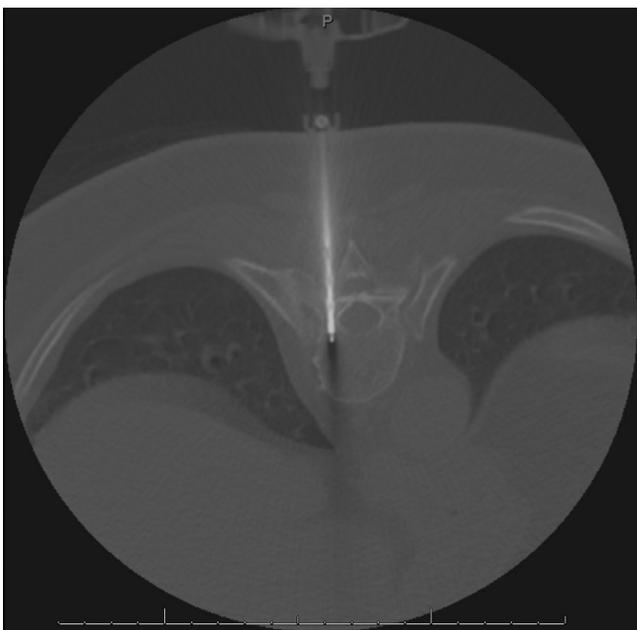

Figure 4 Axial CT image demonstrating placement of radiopaque marker.

Figure 5 Lateral decubitus positioning with appropriate placement on table and secured with tape.
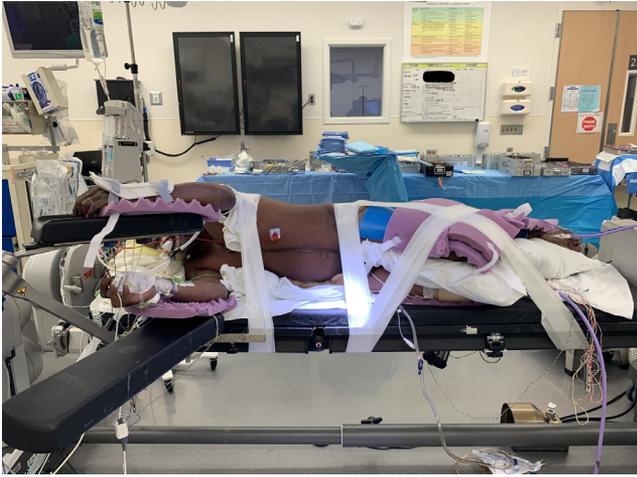
Figure 6 Lateral decubitus positioning with appropriate placement on table and secured with tape.

while standing on the ventral aspect of the patient. The hips are centered at the break in the bed, an axillary roll is placed under the down shoulder, and the head is bolstered to maintain an inline cervical spine. The upper arm is placed onto a holder and positioned out of the way of the image intensifier. The down leg is padded to protect the peroneal nerve, and a

pillow is situated between the legs. The torso and hips are secured in place with 3-inch silk tape and then the legs are secured with the hips and knees flexed (Figs. 6 and 8). Next, the image intensifier is set to 0 degrees, and the bed is adjusted and rotated to identify the operative level and to ensure perfect orthogonal views can be obtained (Fig. 7). The vertebral bodies and disk spaces are identified using a radiopaque crosshair tool, and the skin is marked.

A 6-cm incision is made in line with the rib overlying the disk or vertebrae of interest. The skin is incised, dissection is carried through the subcutaneous tissue using bipolar cautery for hemostasis. The latissimus dorsi, external oblique, internal oblique, and transverse abdominus muscles are encountered, split, and divided during the approach. At the level of the intercostal muscles, the rib is identified, and subperiosteal dissection of the rib is performed. A 6-cm segment of the rib is exposed, and elevators are used to create a plane between the rib and the inferior border where the neurovascular bundle resides. A gauze sponge can be passed between the rib and the endothoracic fascia and passed side-to-side to create a safe soft-tissue plane to prevent injury to the neurovascular bundle (Fig. 8a). Once this layer is developed, the rib segment is harvested for autograft, and the bone ends are capped with wax for hemostasis (Fig. 8b). The endothoracic fascia and the parietal pleura are now separated and a plane
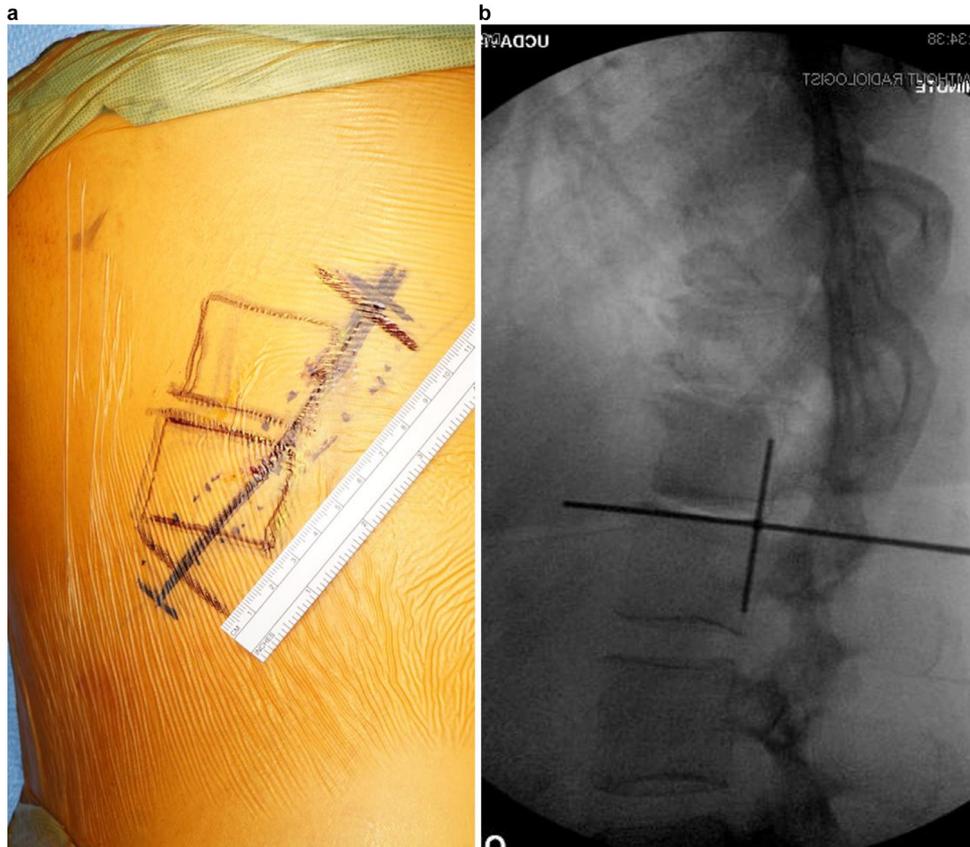

Figure 7 (a) Intraoperative skin marking superior and inferior vertebral bodies, overlying rib, and placement of incision. (b) Intraoperative localization using fluoroscopic imaging. Single image of using crosshair marker placed at disk space and posterior margin of vertebral body is sufficient for skin marking. This image should be acquired after perfect AP and lateral fluoroscopic images after level of interests attained.
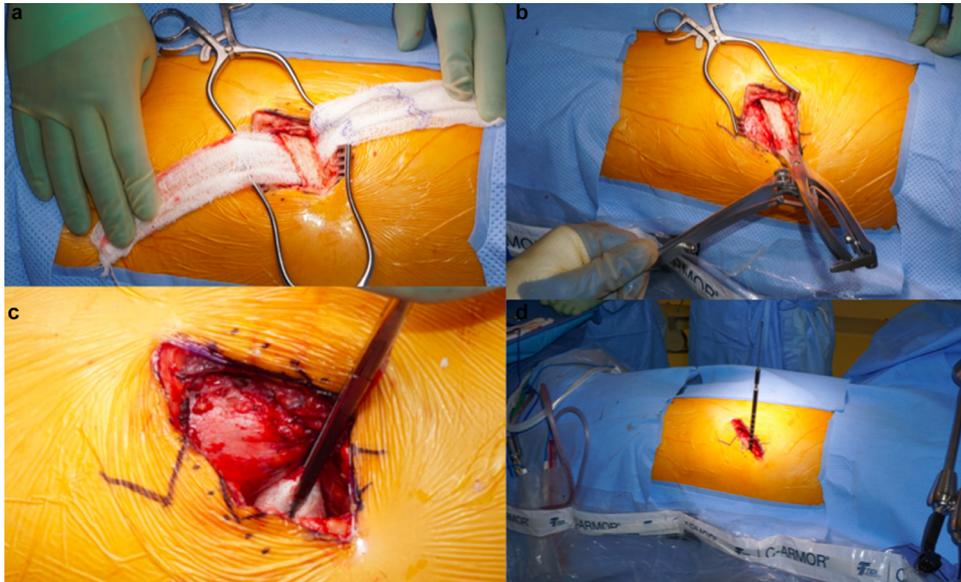
Figure 8 (a) Clinical photograph minimally invasive retro pleural approach with sub periosteal dissection of rib with placement of Ray-Tec on the undersurface. (b) Placement of rib cutter. (c) Development of retropleural space using blunt dissection at the pleura diaphragmatic interface. (d) Placement of dilator with wire fixation for confirmation of intraoperative level and measurement of blade length.

between the 2 layers is developed bluntly with the surgeon's finger. It is helpful to identify the muscular diaphragm distally and proceed with creating the retropleural plane at the juncture to prevent pleural violation, as this tissue is more robust than the pleura (Fig. 8c). Using a Kitner, push the rolled edge of the pleura over the rib head, and lateral aspect of the vertebral body, and then lever a Cobb over the anterior

vertebral body to place and secure a fan retractor blade. If necessary, ligate the segmental vessels at the mid-section of the body, and avoid sectioning too close to the aorta because this can lead to uncontrolled bleeding. Have hemostatic clips available for vascular control. If you encounter profuse bleeding, apply pressure with a Kitner, isolate the vessel using long hemostats, and tie the vessel with 2-0 silk suture and reinforce with a hemostatic clip.

The layer is developed all the way until the lateral vertebral body is encountered, and the disk spaces are identified. Localizing images are taken with a dilator and wire at the level of the disk or vertebrae, and then following confirmation of the disk level, the table mounted retractor is advanced into the space and secured (Fig. 8d and Table 1).

The discectomy is performed using standard lateral interbody disk preparation methods. Once the discectomy is completed, a trial may be placed into the anterior one-third of the disk space to help with expansion of the disk space for the posterior decompression. At this point in the procedure, the surgeon should move to the side of the patient's abdomen to complete the decompression. Two triangular osteotomies are performed of the posterior vertebral wall angled cephalad and posterior along the inferior endplate, and caudal and posterior to the superior endplate (Figs. 9b and 10). The bone and disk material are removed, and the decompression is checked for completeness (Fig. 10). Following the decompression, the trial can be removed, and an appropriately sized interbody spacer can be placed into the disk space. The harvested rib autograft is used for fusion. Depending on need for stability, a side plate with screw fixation or posterior pedicle screw construct can be placed.

During closure, special attention should be directed at ensuring no violations to the visceral pleura are present, which would warrant placement of a chest tube. If there are incidental defects to the parietal pleura, these may be repaired with an

Table 1 Surgical Pearls

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Use pre-op marker for localization (especially for discectomy and thoracic level pathology)	Have IR place radiopaque marker intraop localization
Identify the rib over the disc/vertebra of interest and harvest it	Placement of retractor in interval between ribs can cause neuralgia. Internal fixation of rib is also not recommended and necessary
Use large rectangular footprint cage	Cage footprint overlaying the apophyseal ring of the vertebrae reduces subsidence
Do NOT over-expand and expandable cage; easy to do in multi-level vertebrectomy	Over-expansion is a frequent mistake, err toward under-expansion, the spinal column can always be shortened if going to the back
Perform a full contralateral annular release at the disk level when using a rectangular cage	If full annular release is not performed the cage will advance into proper position
Develop the retropleural plane by pushing the thick muscular diaphragm anteriorly rather than the paper thin pleura	When dissecting the pleura, use blunt finger dissection and kitners and proceed slowly
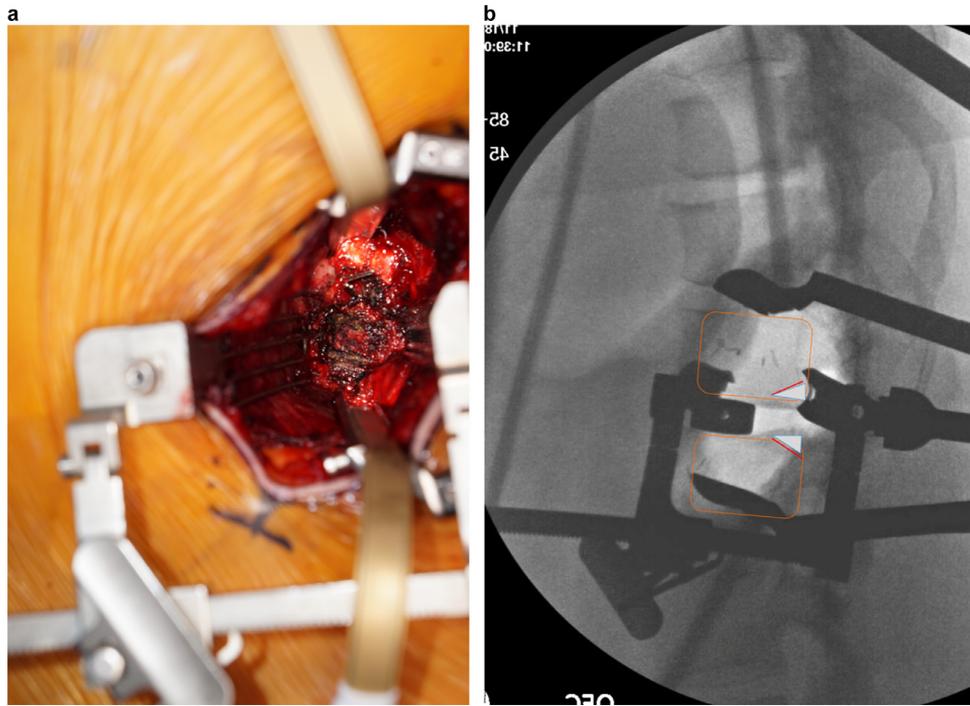
Figure 9 (a) Intraoperative photograph with placements of minimally invasive retractor including "egg-beater" blade to retract pleura and diaphragm anteriorly. (b) Corresponding fluoroscopy image of the placement of retractor.
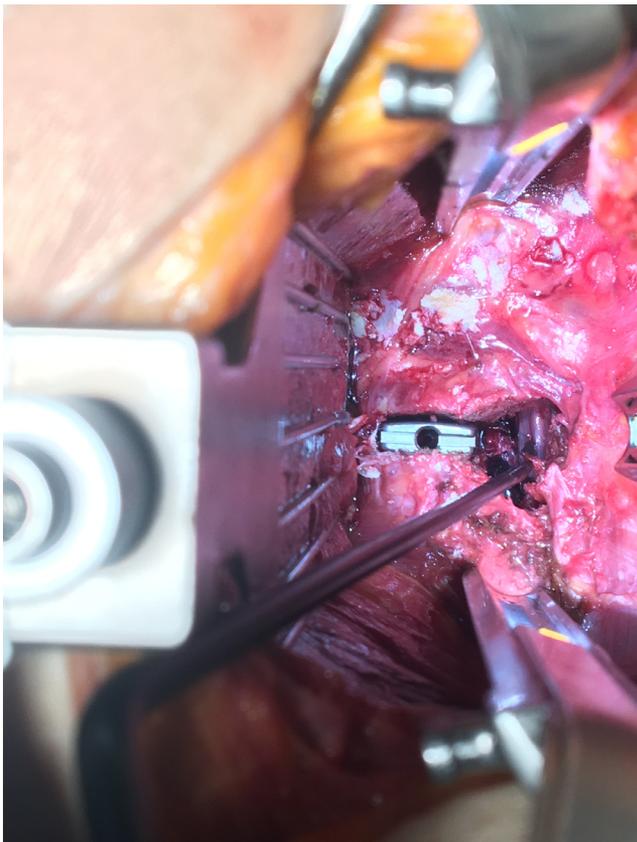

Figure 10 Clinical photograph visualizing canal decompression. MIS Penfield probe is retracting the anterior surface of the dura. The interbody trial has been placed anteriorly and superior and inferior corner osteotomies have been performed to gain access to the anterior spinal canal.

absorbable suture. The wound is irrigated and a 19 French Blake drain is placed in the retropleural space. The endothoracic fascia is approximated, the intercostal muscles are sutured closed, and hemostasis is checked once again. Injection of local anesthetic can be performed for opioid sparing analgesia postoperatively. Fig. 11a-f compares pre-op and post MRI and X-rays of case example 1 demonstrating adequte decompration on MRI and reduction of lesthesis on xrays.

Postoperative Management

The patient is admitted to the surgical ward with continuous pulse oximetry ordered as well as instructions for use of an incentive spirometer. Postoperative prophylactic antibiotics are administered, and the patients are routinely evaluated by a physical therapist and encouraged to walk immediately postoperatively. A 19 French Blake drain is inserted prior to closure and placed to bulb suction overnight to prevent fluid collection formation. A chest radiograph is obtained postoperatively to ensure no pneumothorax is present. Patients do not routinely receive bracing and standing scoliosis films are obtained prior to discharge.

Outcomes

Postoperative MRI of the patient demonstrates adequate decompression of the conus (Fig. 11c,d) and x-ray (Fig. 11f) demonstrate the final construct. The patient had complete resolution of symptoms postoperatively and now for 2 years. The largest series of postoperative outcomes were reported by Uribe et al in a multicenter case series which showed an 80% excellent or good clinical outcomes score, with hospital length of stay averaging 5 days.[7] Deviren et al reported on a series of
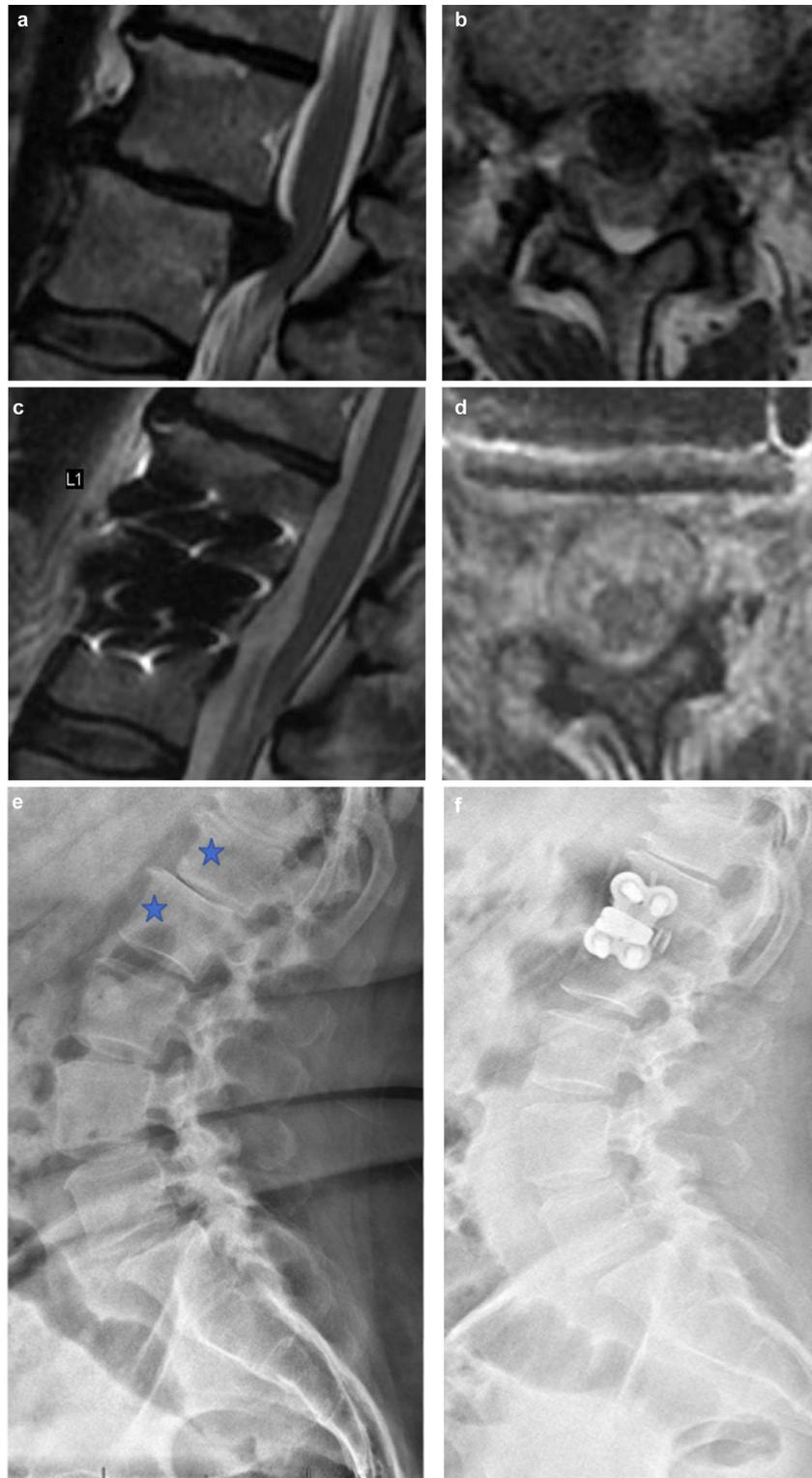
Figure 11 (a, b) Sagittal and axial T2 MRI of case example 1 demonstrating large disk protrusion with severe compression of conus medullaris. (c, d) Postoperative sagittal and axial T2 MRI of case example 1 demonstrating adequate canal decompression. (e) Preoperative x-ray demonstrating disk height collapse and retrolisthesis. (f) Postoperative x-ray demonstrating interbody graft placement and anterior fixation with lateral plate placement. Rib autograph is placed posterior to interbody graft.
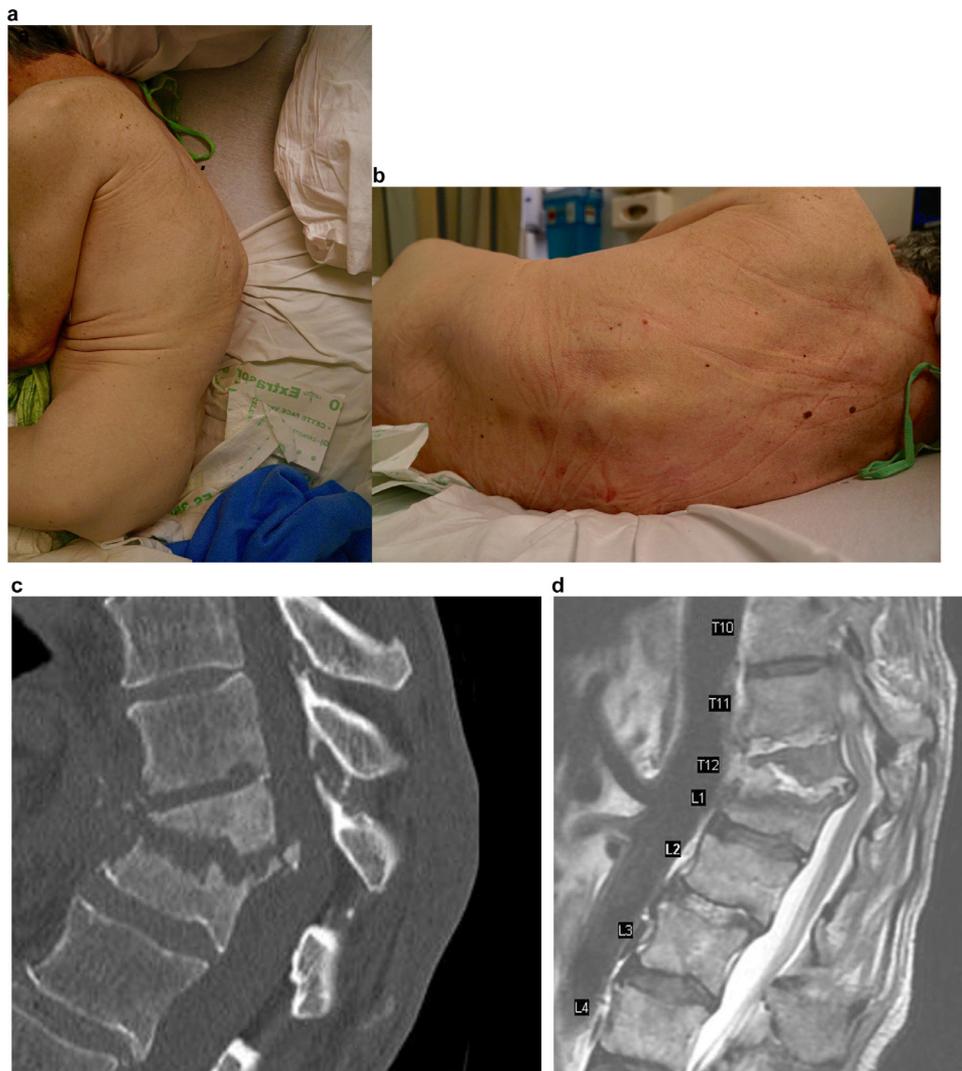
Figure 12 (a, b) Clinical photograph of case example 2 demonstrating patient with severe thoracolumbar focal kyphosis. (c, d) Sagittal CT scan (a) and T2 MRI (b) of case example 2, demonstrating severe erosion and kyphotic collapse of T12 and L1 vertebral bodies with bone fragments protruding into the canal severe compression of the spinal cord.

12 patients treated with transthoracic, transpleural approach, and reported 80% improvement in visual analog scores with a 5-day average hospital length of stay.[9] Kasliwal et al reported average hospital length of stay of 2.6 days, and more than 50% improvements in visual analog scores in their series of 7 patients.[10] Nacar et al reported on a case series of 33 patients treated with minimally invasive retropleural approaches for thoracic disk herniations and found hospital length of stay averaged 5 days, and 90% of patients with myelopathy had improvement in symptoms, with a more than 50% improvement in visual analog scores.[11]

Case Example 2
Vertebrectomy for Spondylodiscitis

A 68-year-old male transferred for acute kyphotic deformity (Fig. 12a,b) and inability to walk and MSSA bacteremia was found to have T12 and L1 spondylodiscitis and resultant collapse with spinal cord compression (Fig. 12b-d). He had an intractable back pain and deformity and global lower extremity weakness with 3-4 out 5 muscle grade in the lower extremities. A CT-guided biopsy grew *Staphylococcus aureus*. He was indicated for irrigation and debridement for source control, canal decompression for severe cord-level compression, as well as anterior column reconstruction for deformity correction and stability, as well as maintenance of neurologic function.

Patients who fail conservative treatment for spondylodiscitis include those with functional pain that is improved with recumbency, those with progressive neurologic deficits, or those with persistent blood cultures and failure of appropriate nonsurgical treatment. Obtaining source control of the infection must be the primary surgical goal; the mainstay of treatment being local debridement and irrigation, but also stabilization of the diseased segment of the spine. Pathologic motion is a harbinger for conservative treatment failure and continued infection. Work up of patients should include a thorough history and physical examination, blood cultures, obtaining baseline inflammatory indices, CT imaging of the spine to assess the bony architecture, and MRI of the area with and without contrast to determine the extent of
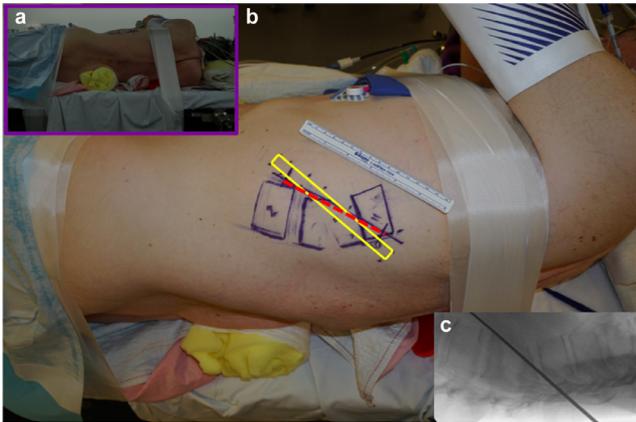
Figure 13 (a, b) Clinical photograph of positioning the patient in case example 2 with foam pad under mid lumbar area. Vertebral body and rib are marked over the skin. The yellow marking outlines the rib and the red line demonstrates trajectory of the skin incision. (c) Lateral fluoroscopy image targeting eroded vertebral bodies with marker demonstrating trajectory of overlying rib.

the infection (Fig. 12c,d). In the setting of anterior column collapse and debilitating back pain, targeted treatment will include local control of the infection by removal of necrotic bone and disk material as well as evacuation of any abscesses, followed by anterior column reconstruction with segmental instrumentation and fusion. Studies have shown that the lateral retroperitoneal approach is a reliable, safe, and efficacious in this setting.[12-14]

Technique

The perioperative setup for this procedure is similar to the previous case. If no canal decompression is necessary, position the patient's back close to the edge of the bed to help minimize the need for the surgeon to lean forward. The positioning, the

operating room setup, and the presurgical planning are similar with some exceptions. A foam roll placed under the downside flank may help stabilize the thoracolumbar segment (Fig. 13a, b). In preoperative planning, it is important to anticipate the 3-dimensional nature of the deformity and knowing the sagittal alignment goals will help ensure appropriate reconstruction of the anterior column. Subsidence of cylindrical cages is a concern in this setting, and thus the authors recommend placement use of implants that span the width of the apophyseal ring of the vertebral body, as this has been shown to have lower subsidence rates.[15,16]

After advancement of the retractor at the designated level, confirmation of the operative level with the image intensifier should be performed. The segmental vessel(s) overlying the vertebral body should be dissected and ligated. An osteotome can be used to section the vertebral body, and all necrotic bone and disk material are removed piecemeal. The bone and soft-tissue specimens should be sent for culture as well as histologic examination. A series of curettes and rongeurs will be utilized to disengage and remove debris, working ventrally first. Upon successful removal of ventral debris, the posterior debris abutting the spinal canal can be removed with curettes directed away from the spinal canal and into the ventral cavity (Fig. 14a).

Once the debridement and irrigation are completed, the anterior column should be reconstructed using an appropriately sized interbody cage or graft. Surgeons must be very cautious of over expansion when using expandable cages (Fig. 14b). An anteriorly directed force applied at the apex of a kyphotic deformity at the level of the spinous processes can improve the space available for positioning. Static and expandable titanium cages have also been used with success in single-stage surgery. The use of titanium cages with wide foot print may provide better anterior column support compared to allograft with low rates of subsidence when supplemented with posterior pedicle screw fixation.[17] Also, it
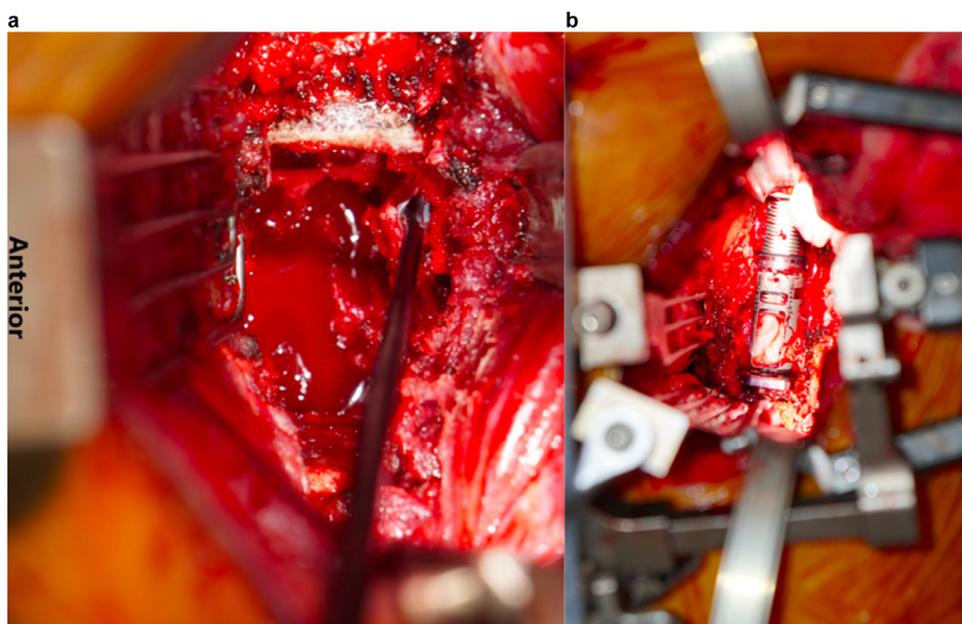

Figure 14 (a) Intraop photograph of canal decompression with canfield dissecting the PLO and bone fragment anteriorly the way from the dura. (b) Intraop photograph placement of appropriate size expandable cage or two-level corpectomy.

Figure 15 (a, b). Postoperative coronal and sagittal CT scan demonstrating adequate decompression of the canal and reconstruction with expandable cage with wide foot plates and placement structural autograft rib.

has been demonstrated that bacteria have lower adherence rates to titanium compared to cobalt chrome.[18] Single-stage surgery using expandable titanium cages and autograft or allograft has been shown to be effective, with low rates of infection recurrence, and with better improvement of sagittal alignment when using a titanium cage.[19-21] Expandable cages provide the advantage of being inserted through a small corridor, frequently encountered in the MIS approach, and aid in providing stability while spanning larger defects. The authors prefer the use of long rectangular footprint to decrease subsidence (Figs. 15 and 20a,b) and avoid collapse observed in circular cage designs as demonstared in Fig. 21. A key to proper placement of this footprint includes taking down the contralateral annulus similar to lateral interbody fusion technique.

Postoperative Management

Postoperatively, the patients are routinely admitted to the floor for neuromonitoring checks overnight as well as pain control. A deep drain is placed that stays in place until the output is <30 cc per 12-hour period. Patients are prescribed postoperative antibiotics that are targeted at the offending bacteria, and infectious disease is consulted to assist with comanaging the infection. Patients further receive a nutrition consult to help maximize their healing potential perioperatively. Physical therapy assists with postoperative mobilization and bracing with a lumbar corset is typically provided for the first 6 weeks following surgery. Standing scoliosis films are obtained prior to discharge.

Outcomes

Madhavan et al published their results on 10 patients over a 7-year period who underwent a lateral retroperitoneal approach for the treatment of vertebral osteomyelitis and discitis, and they reported estimated blood loss of 272 mL, with clearance of infection of all patients at an average follow-up of 680 days.[12] There were no approach-related injuries or complications. Patel et al performed MIS lateral retroperitoneal approaches on 6 patients
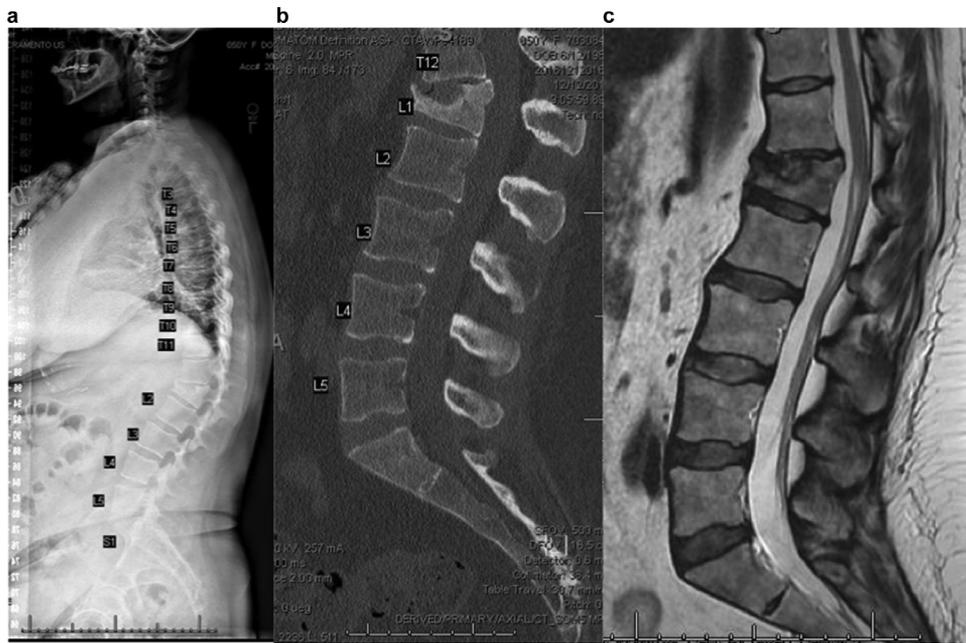
Figure 16 (a) Standing lateral radiograph (case example 3) with kyphotic deformity. (b, c) Sagittal CT scan and MRI demonstrating collapse and kyphotic deformity.
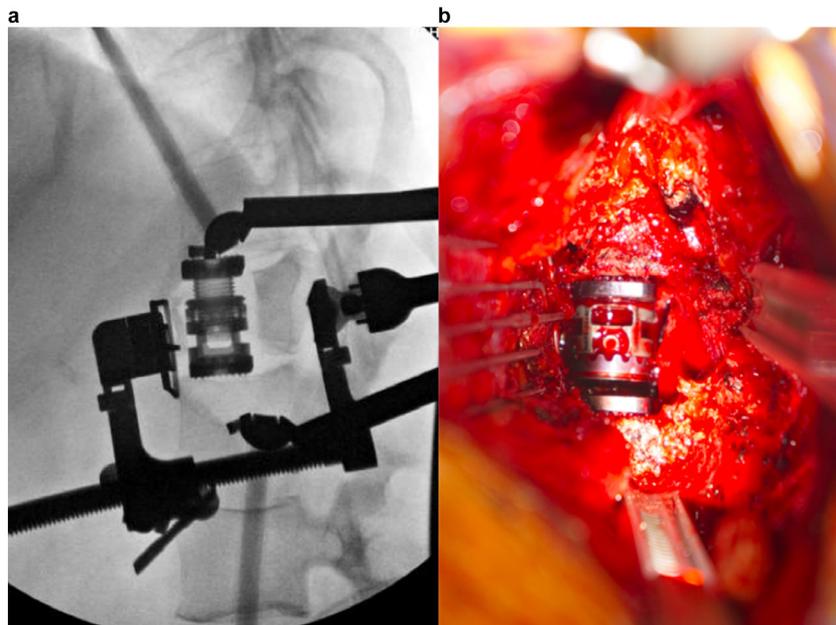

Figure 17 (a, b) Lateral fluoroscopy image and clinical photograph of corpectomy and cage placement.

over a 2-year period and had mean operative times of 218 minutes, estimated blood loss of 138 mL, and 1 patient developed hardware loosening and required a revision instrumented fusion.[13] At 1-year follow-up, all patients demonstrated solid fusion with stable hardware and continued pain improvements.

Case Example 3
Post-Traumatic Kyphotic Deformity

A 49-year-old female with history of L1 burst fracture treated nonoperatively for 4 months with a chief complaint of back pain and inability to stand upright. She was initially treated nonoperatively and prescribed a thoracolumbar sacral orthosis and given a trial of conservative treatment. Upon discontinuation of the brace, she had severe back pain that was not controlled on daily pain medications that improved with supine positioning. Her standing radiographs revealed approximately 50% anterior height loss, 30 degrees of focal kyphosis (Fig. 16a) and CT and MRI revealed significant anterior bone loss with (Fig. 16b,c). After discussing the risks, benefits, and alternatives to surgery, she was indicated for deformity correction surgery with anterior column reconstruction and posterior spinal fusion.
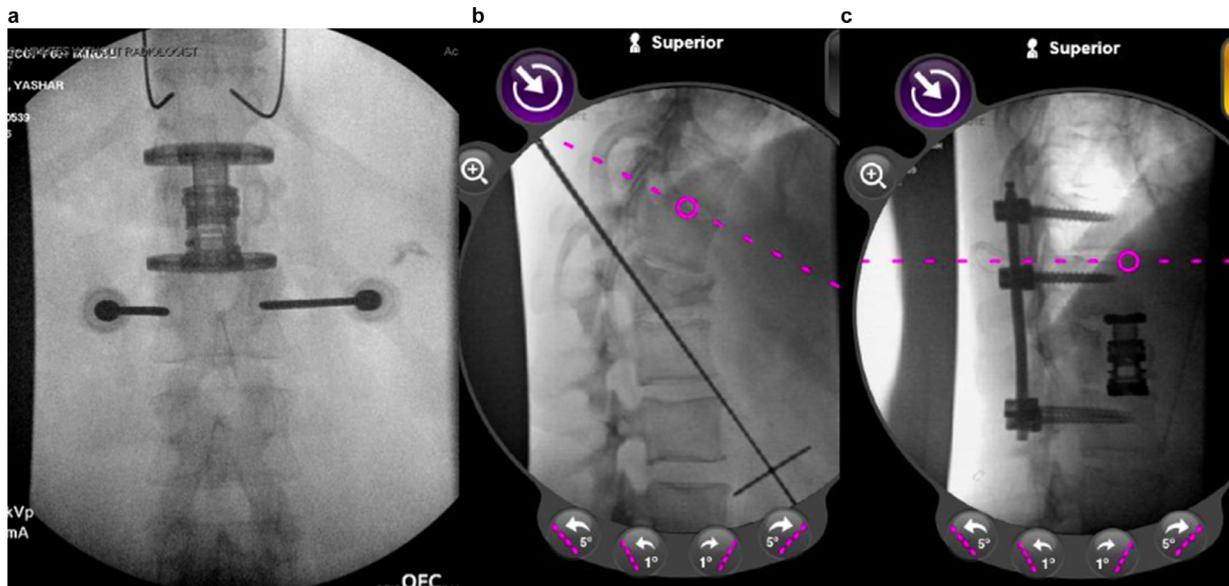
Figure 18 (a) Fluoroscopy view percutaneous screw fixation and visualization of expandable cage. (b, c) Lateral intraoperative fluoroscopy view demonstrating pre-op and post-op correction of kyphotic deformity.
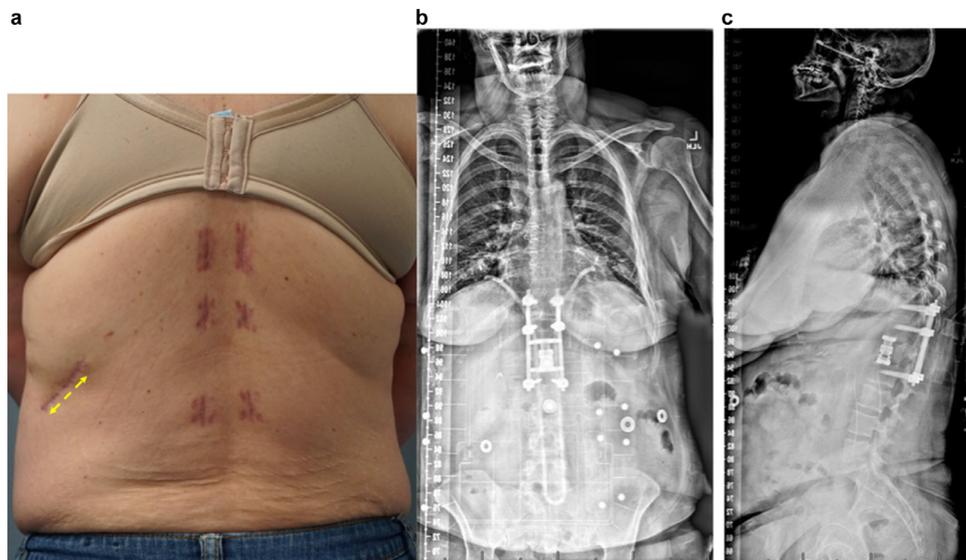

Figure 19 (a) Standing clinical photograph demonstrating placement of incision post operatively. (b, c) PA and lateral standing radiographs post-op demonstrating correction of kyphotic deformity.

Patients who fail conservative treatment and present with subacute fractures and focal kyphosis with localized back pain may benefit from anterior column realignment. Studies have shown that patients with sagittal malalignment have worse outcome scores related to pain, function, and self-image.[22] In the setting of fixed deformities a posterior-based procedure would possibly require use of osteotomy, and fusion above and below the deformity.[23-25] With complication rates reportedly as high as 78% in patients undergoing pedicle subtraction osteotomy, and to avoid multilevel posterior fusion, laterally based approaches to the thoracolumbar spine in the setting of deformity correction have shown promise with respect to realignment, complication profile, and durability.[4,16,26-28]

Technique

The patient was positioned in lateral decubitus position, and using her preoperative CT and MRI studies, a left-sided approach was chosen based on her vascular anatomy. An axillary roll was placed, and sequential compression devices were placed to bilateral lower extremities. Her hips and knees were flexed to alleviate tension across the psoas, and then her torso and lower extremities were secured to the bed with 3-inch silk tape. The operative level was identified and the skin was marked accordingly.

A standard lateral retroperitoneal approach is made to the appropriate vertebral level. After image intensifier confirmation
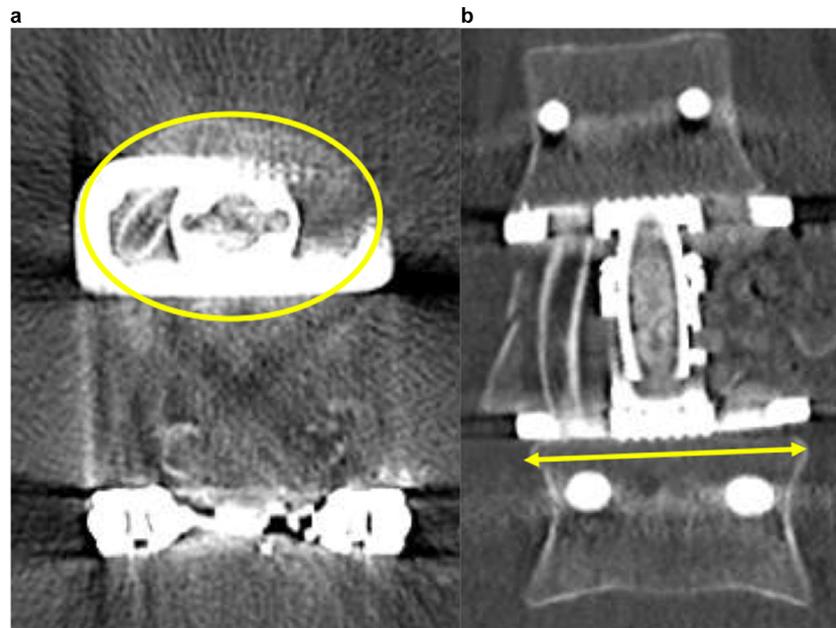
Figure 20 (a, b) Axial and coronal CT scan postoperatively demonstrating placement of expandable cage with wide foot plates crossing the epophyseal ring of vertebral body.
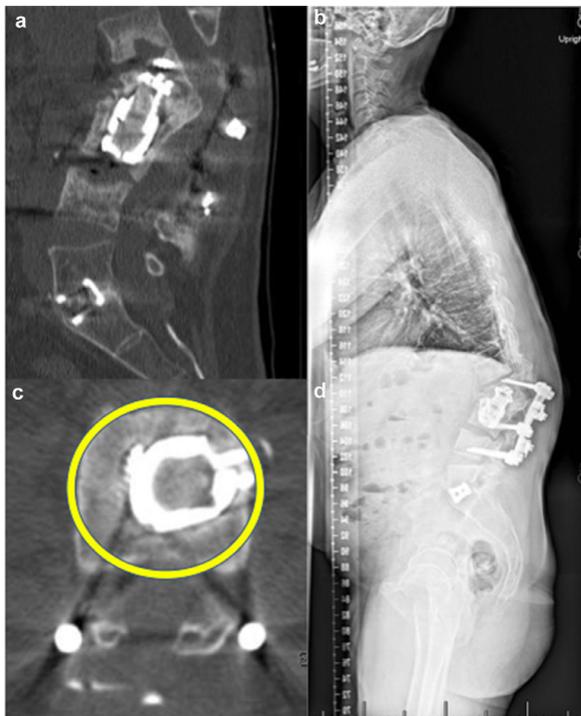

Figure 21 (a, b) Sagittal and axial CT scan demonstrating circular cage with collapse into the vertebral body. (c) Lateral standing radiographed demonstrating postoperative focal kyphosis with collapse of circular cage into superior and inferior vertebral body.

of the operative level, a guidewire is advanced into operative vertebral body through a soft-tissue dilator, and sequential dilation is then followed by table-mounted retractor deployment. Placement of a fan retractor can help protect anterior vasculature. Segmental vessels should be ligated and divided at the midpoint of the vertebral body. A complete release of the annulus and thorough discectomy is required to ensure proper realignment and interbody positioning of the disk space above and below the fractured level. Depending on the level, a portion of the crus of the diaphragm may be released to aid with exposure.

Osteotomes are used to create a bone channel in the ventral two-thirds of the vertebrae, and the bone is harvested for grafting later in the procedure. The posterior one-third of the vertebrae is preserved as a vascularized bone block to aid with postoperative fusion in the setting a neurologically normal patient (Fig. 17a,b). After a bony channel is established, an interbody device or graft can be placed for anterior column realignment. The segment of rib that was harvested during the approach is utilized as structural autograft to backfill the defect, in addition to the morselized cancellous pieces of vertebral body that were resected during the partial corpectomy.

The wound is then irrigated and a deep drain is laid into the retropleural space, and violations of the pleura can be sutured closed with absorbable suture. If there has been a violation of the pleura, a red rubber catheter can be placed into the space between the parietal and visceral pleura. Suture is passed in a purse string configuration around the red rubber catheter. Following a valsalva maneuver, the red rubber catheter is removed, and the purse string suture is tightened and secured. Standard closure as described in previous case examples is thus completed.

In this case, percutaneous pedicle screws and rods were subsequently placed to maintain fixation, protect the anterior column reconstruction, and to provide stability with attention to restoration of the kyphotic deformity (Fig. 18a,b,c).

Post-operative Management

Patients are admitted to the floor for neuromonitoring checks, prophylactic intravenous antibiotics, and pain control. A deep drain remains in place until the output is <30 cc

per 12-hour period. A chest radiograph is obtained if there were any violations of the pleura to ensure there is no pneumothorax. Post-op clinical photographs demonstrate the patients surgical incisions (Fig. 19a) and standing scoliosis films reveal adequate realignment (Fig. 19b,c).

Outcomes

Khan et al performed single- or two-level corpectomy on 25 patients from T5 to L4 over a 5-year period for tumor, infection, and trauma indications, and reported mean operating room times of 189 minutes, estimated blood loss was 423 mL, with no reported reoperations or blood transfusions and a 62% improvement in visual analog pain scores.[28] Baaj et al reported on complications from a series of 80 cases and found an overall complication rate of 12.5% and reoperation rate of 2.5%.[4] One reoperation was for hardware failure, and then second was to perform a debridement and irrigation of a hemothorax. Holland et al performed single- or two-level corpectomies on 17 patients with operative times averaging 361 minutes, a mean postoperative length of stay of 8.4 days, and an overall complication rate of 24%.[29]

Summary

The minimally invasive lateral approach to the thoracolumbar spine is a safe, effective, and reproducible approach that affords access to the spine and treatment of an array of spinal pathologies. The approach is not without its limitations and challenges, and requires extensive training and familiarity with the anatomy and diligent setup and technique. With proper understanding of the surgical anatomy, coupled with the use of intraoperative neuromonitoring and select MIS instruments, many of the challenges related to exposure have been mitigated, allowing for ease of access by the appropriately trained spine surgeon. We encourage surgeons interested in utilizing this approach in their practice to seek out expert surgeons to mentor them in a cadaver lab and the operating room.

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