38 Posterior and Posterolateral Approaches to the Lumbar Spine

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Overview

The posterior approach is undoubtedly the most utilized approach in all of spine surgery. It remains the workhorse for exposure of the entire spine, from occiput to sacrum, during minimally invasive and deformity operations alike. In the lumbar and thoracic spine, the posterior approach and its variations provide exposure of the anterior vertebral bodies as has been described in tumor,[1] trauma, and deformity surgeries.[2] Thus it is with utmost importance that a spine surgeon develop acumen with the posterior approach.

In the lumbar spine, with the exception of the L5–S1 segment, the likeness of the dorsal elements lends itself to similarities and potential confusion during surgery. Precise marking of laminae and a thorough understanding of dorsal surface anatomy is critical to avoid surgery on unintended levels. This requires intraoperative interpretation of imaging studies and visible anatomic landmarks that have been indelibly marked with a radiolucent marker; adequate planning and study of preoperative imaging is critical at this step.

Good subperiosteal exposure of the spinous processes and laminae is the important next step, but irregularities in the shapes of the dorsal elements can create difficulties of their own. Spondylotic bone, body habitus, and excess bleeding can all obscure visualization. Exposure for a direct midline or paramedian approach requires differing entry points and muscle planes. Also, whether intertransverse process fusion technique will be used dictates the amount of lateral muscle stripping required.

Finally, wound closure is perhaps as important, if not more so, than exposure. Because of the dorsal skin incision, often close to the perineum, watertight wound closure remains a critical yet sometimes overlooked last step of posterior spinal surgery. Although few complications occur as a result of the posterior exposure per se, it is assumed that some infections and wound dehiscence occur because of poor exposure and closure.

Anatomy

The dorsal skin anatomy is straightforward, and skin incisions can be planned according to surface landmarks (Fig. 38-1). Midline can easily be palpated, even in obese patients, using spinous processes (SPs). In the extremely obese, the thoracic SP or the sacrum/coccyx can be palpated. If using the paramedian approach, the recommendation is two fingerbreadths, or 2.5 to 3.0 cm, lateral to midline. The dorsoventral landmarks become more difficult, especially in obese patients. The iliac crests typically localize to L4–L5, although body habitus will often skew this landmark cephalad and will direct a surgeon toward L3–L4 (Fig. 38-2). If any concern exists, I use the inner bore of a 20-gauge spinal needle and localize using a lateral radiograph (Fig. 38-3).

Deep to the skin, the relevant anatomy includes subcutaneous fat, the Scarpa layer, and fascia. The Scarpa layer should be preserved with the intent to use it as an added layer during closure. Note that once the lumbodorsal fascia is reached, the perforating vessels will emerge. Midline should be easily palpable using SPs and the supraspinous ligament (Fig. 38-4). The paraspinal muscles—the multifidus, longissimus, and iliocostalis—occupy the space flanking the SPs and laminae and extend to the transverse processes (TPs; Fig. 38-5).

Short *intersegmental muscles,* the interspinalis and intertransversarii medialis, originate at a caudal vertebra and insert on the adjacent vertebra. The short *polysegmental muscles,* the multifidus and lumbar erector spinae, span two to five vertebral levels. The multifidus is the most medial and is also the largest of the paraspinal muscles. Lateral to the multifidus lies the lumbar erector spinae, made up of the longissimus and the iliocostalis lumborum. Each muscle has thoracic and lumbar fascicles that originate on the mamillary and transverse processes and insert on the medial aspect of the posterior superior iliac spine.

The Wiltse paraspinal approach exploits the interval between the multifidus and longissimus. This plane can be palpated after the lumbodorsal fascia is split, and segmental vascular and neural structures are often encountered here. The segmental dorsal ramus must be found and followed into the foramen of interest (Fig. 38-6), but note that it branches directly off the exiting nerve root, so it should be handled gently.

The relevant bony anatomy includes the SP, lamina, facet joint, and TP. Good subperiosteal dissection requires thorough understanding of the irregularities in lumbar anatomy. This includes understanding the depth and location of interspaces and the spatial relationships in between. From the perspective of the surgeon, the laminae will be found slightly cephalad in relation to the SP (Fig. 38-7). More cephalad and lateral on the lamina, the pars interarticularis and then the facet joint are encountered. Especially when using cautery, keep in mind that direct ventral

Figure 38-1 Dorsal view of back with drawing of spine and pelvis.

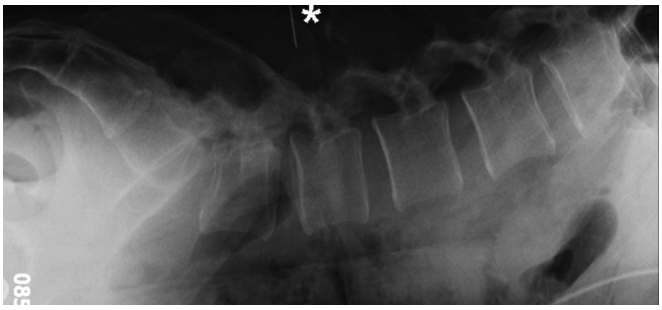

Figure 38-3 Radiograph of a spinal needle (*asterisk*).

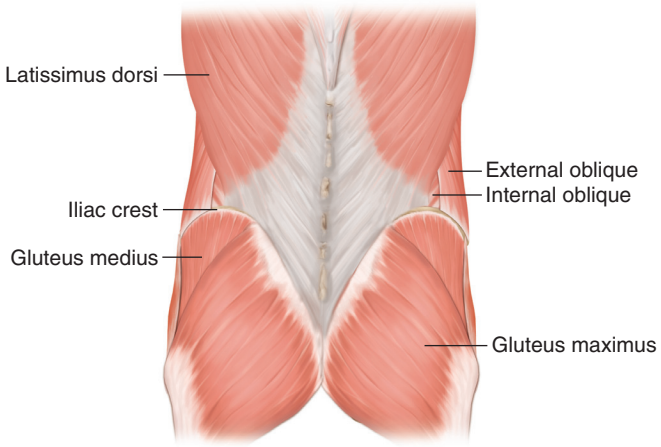

Figure 38-4 Midline structures of the lumbar spine.

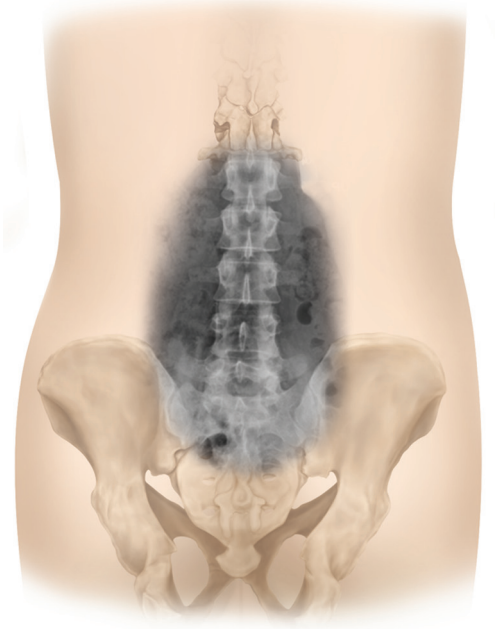

Figure 38-2 Anteroposterior radiograph with soft tissue drawn on the outside.

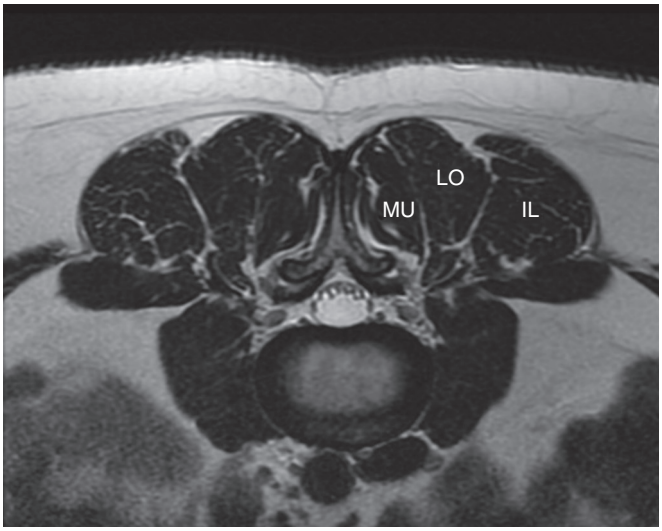

Figure 38-5 Magnetic resonance image (MRI) shows paraspinal muscles. *IL,* Iliocostalis; *LO,* longissimus; *MU,* multifidus.

dissection caudal to the lamina may lead to violation of the interspace, particularly at the lumbosacral junction at L5–S1. The facet joint capsules must be preserved, unless a fusion at that level is planned. A clear plane of attachment of paraspinal muscles on the facet capsules can be effectively dissected (Fig. 38-8). Coursing laterally, the accessory process—a typical pedicle screw entry point—is still seen, which then leads directly to the TP. Lateral dissection of the musculature out to the tips of the TPs then creates the posterior gutter for graft placement. The intertransverse membrane attaches from one TP to the next and should not be violated; it supports the fusion bed (Fig. 38-9).

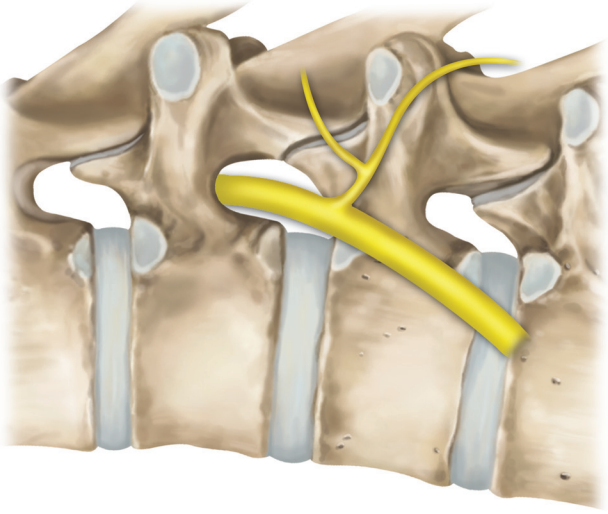

Figure 38-6 Lateral view into the foramen shows the dorsal ramus of a nerve root branching off just after the nerve root exits.

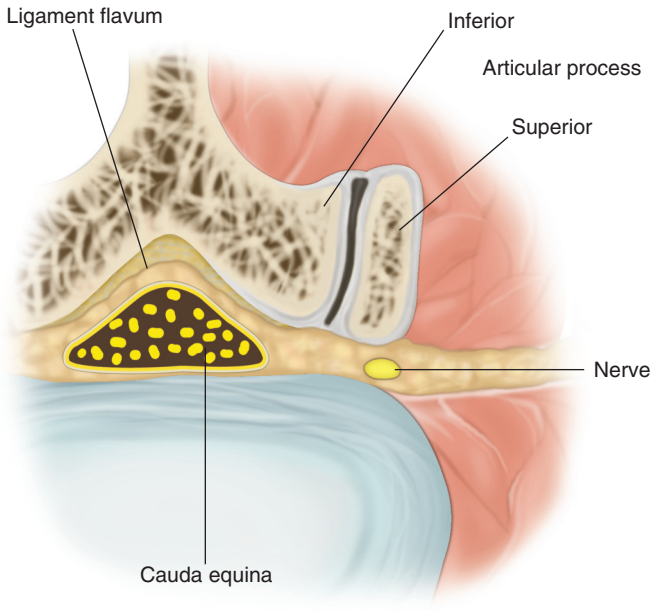

Figure 38-8 Facet capsule and overlying muscles *(asterisk)*.

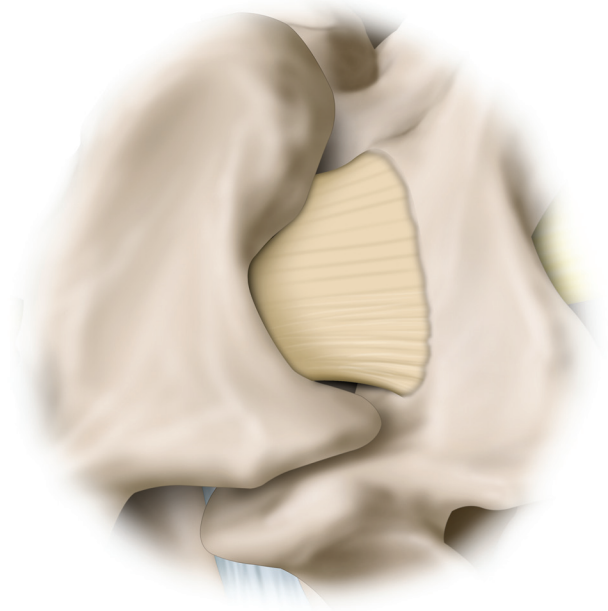

Figure 38-7 Bird's-eye view onto the spinous process and lamina.

Indications/Contraindications

INDICATIONS

- Posterior surgery (diskectomy/laminectomy, posterior fusion, posterior interbody fusion)
- Symptomatic radiculopathy from disk herniation (paracentral and far lateral) or spinal stenosis
- Instability as a result of spondylolisthesis, trauma, or tumor

CONTRAINDICATIONS

- Active infection of a dorsal compartment on or near operative site
- Previous or planned radiation therapy

Patient Positioning

- Patients are positioned prone using a variety of tables and padding options.
- The key components include maximizing equal weight distribution, minimizing abdominal compression, and ensuring face and eye protection.
- The surgeon must be keenly aware of the pitfalls of the prolonged prone position. Skin breakdown, facial and airway swelling, and muscle injury (myositis) are all possible complications, and all patients should be positioned with these issues in mind.
- For decompression procedures, reducing lordosis by placing patients in a knee-chest position and placing the hips into flexion will aid in opening interspaces (Fig. 38-10).
- If fusion is considered or planned, the hips and legs should be extended to achieve lordosis in the lumbar spine (Fig. 38-11).
- The abdomen and male genitalia should be checked to ensure they are free from compression.
- The chest is a major weight-bearing location. Ensure that no compression is placed on the anterior neck, particularly with large-breasted women. Proper chest positioning will also aid in positioning the patient's arms, which should be well padded. Upper extremity brachial plexus injuries have been reported and observed at one institution.[3]
- Head positioning is critical and should be a coordinated effort between surgical and anesthesia teams. Skin

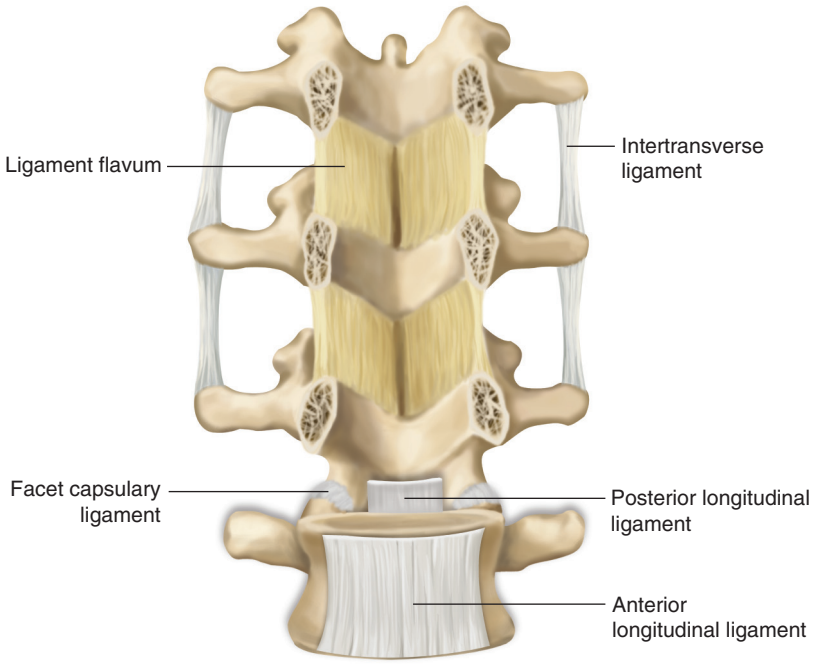

Figure 38-9 Intertransverse ligament of the lumbar spine.

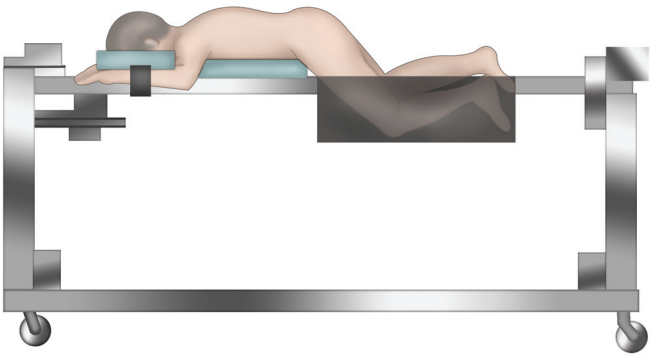

Figure 38-10 Jackson table with sling to minimize lumbar lordosis during decompression procedures.

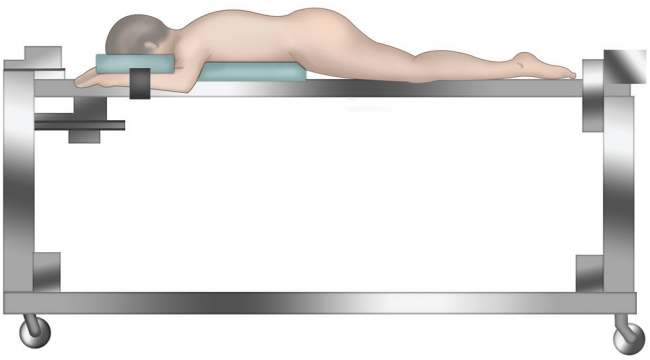

Figure 38-11 Jackson table with flat plate extends hips, which restores lumbar lordosis for fusion procedures.

breakdown on the forehead, chin, and nose is disfiguring and alarming to patients. Although most such injuries heal uneventfully, the tip of the nose may not.[4]

- Postoperative blindness is devastating and should be safeguarded against at all costs, particularly if long operative times are anticipated. Several reports list prone head position as a risk factor.[5]

Operative Technique

- The standard technique of exposure can be modified to surgeon and institutional preferences.
- For minimally invasive operations, preincision imaging can be helpful (see Fig. 38-3).
- A preincision "time-out" should be performed in which the correct procedure, site and side, patient, and imaging studies are examined and confirmed by the surgical team.[6]
- A subcutaneous injection of dilute epinephrine before incision is helpful. Once the skin incision has been made, careful dissection using cautery is recommended for hemostasis, particularly of the subdermal vascular layer.
- Dissection should be meticulous, and hemostasis should be a priority. Bleeding skin edges and perforating vessels can contribute to significant blood loss that will obscure the surgical field throughout the case.
- Create a deliberate incision through the layer of Scarpa fascia to aid in closure.
- The lumbodorsal fascia can be split on either side or in the middle of the SPs, where the supraspinous ligament is encountered.
- The paraspinal muscles can then be dissected off the SP, lamina, and pars interarticularis.

- For decompression alone, the pars interarticularis is the critical landmark to visualize to ensure that overzealous pars resection does not occur.
- If the procedure is a lumbar fusion, dissection should continue laterally and ventrally until TPs and the intertransverse membrane are exposed.
- Once exposure is completed, the next critical step for the surgeon is to confirm the levels to be operated on; with the exception of L5–S1, every other vertebral segment looks similar, if not identical.
- Appropriate marking of levels is critical.
- Several landmarks—SP, lamina, TP—and marking tools can be used.
- The next critical step is radiographic confirmation. The surgeon must verify that the landmark used has been securely marked and that the image confirms that location and level.
- Most pitfalls occur during translation of the image back into the anatomic location and levels marked.
- Once confirmed, the landmark should be indelibly marked.[6]
- Spine surgery performed at unintended levels has been a visible complication in today's medicolegal environment. It is considered avoidable and almost entirely the surgeon's responsibility.

WILTSE'S APPROACH

- Dr. Leon Wiltse described the posterolateral muscle-splitting approach in 1963.
- Its most common indication is far-lateral disk and nerve root decompression.
- The approach exploits the plane between the multifidus and longissimus muscles.
- It avoids detachment of midline structures and disruption of the supraspinous and interspinous ligaments, and it allows for easy access to the lateral and posterolateral compartments of the lumbar spine.
- The skin incision recommended is 2.5 to 3.0 cm lateral to midline.
- The lumbodorsal fascia is split longitudinally; typically, this plane is easier to palpate than to visualize.
- Blunt dissection easily finds the facet joint, which then leads to the TP.
- Retractors can be placed here, and the level can be marked using the TP or facet joint as a point of reference.
- To find the disk, the caudal TP, such as the L5 TP for far-lateral L4–L5 herniated nucleus pulposus, should be used as an anatomic landmark (Fig. 38-12). This will then mark the dorsoventral location of the intertransverse membrane.
- Coursing cephalad the facet joint, the pars interarticularis is encountered.
- At this point, the dorsal ramus should be found and dissected (see Fig. 38-6).
- The intertransverse membrane can be dissected free from surrounding bony attachments.
- Because of the proximity of the venous plexus, blunt dissection and bipolar cautery should be used.
- The facet joint and pars interarticularis will be removed from the lateral aspect to get access medially into the disk and canal.

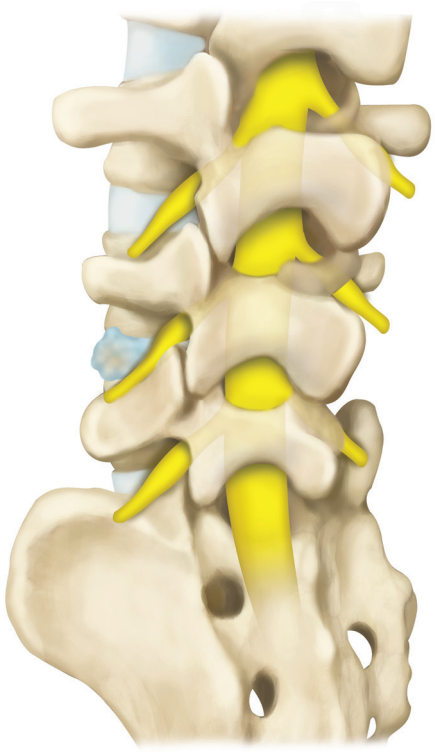

Figure 38-12 Oblique look at disk space shows location of far-lateral disk herniation.

- The far-lateral herniation is encountered cephalad to the pedicle and should be decompressed as far cephalad as the nerve root to ensure no free fragments or cephalad compression remains.
- Care must be taken not to injure the dorsal root ganglion.

ANTERIOR COLUMN SURGERY

In the lumbar spine, access to the vertebral bodies has been described for use in trauma, tumor, and deformity surgery (Fig. 38-13). Tomita[1] described an all-posterior vertebral body resection technique. The salient steps include removal of all dorsal elements, including pedicles, followed by careful dissection ventrally along lateral vertebral body walls until circumferential release has been performed. Similar dissection technique is used during trauma and deformity surgery.

Typically, dorsal elements are removed, leaving the pedicles (Fig. 38-14). Excellent dissection and isolation of both nerve roots and cephalad and caudal disks is imperative. The lateral pedicle walls are a useful guide to finding the lateral vertebral body wall, where blunt dissection can be used to separate soft-tissue attachments from bone. Maintaining hemostasis is critical, because much of the bony work that follows can lead to brisk blood loss. Removal of vertebral bodies requires release from disks and soft tissues. The thecal sac and nerve roots should be carefully retracted to remove the vertebral body, either whole or in fragments. Reconstruction is done based on indication and patient needs.

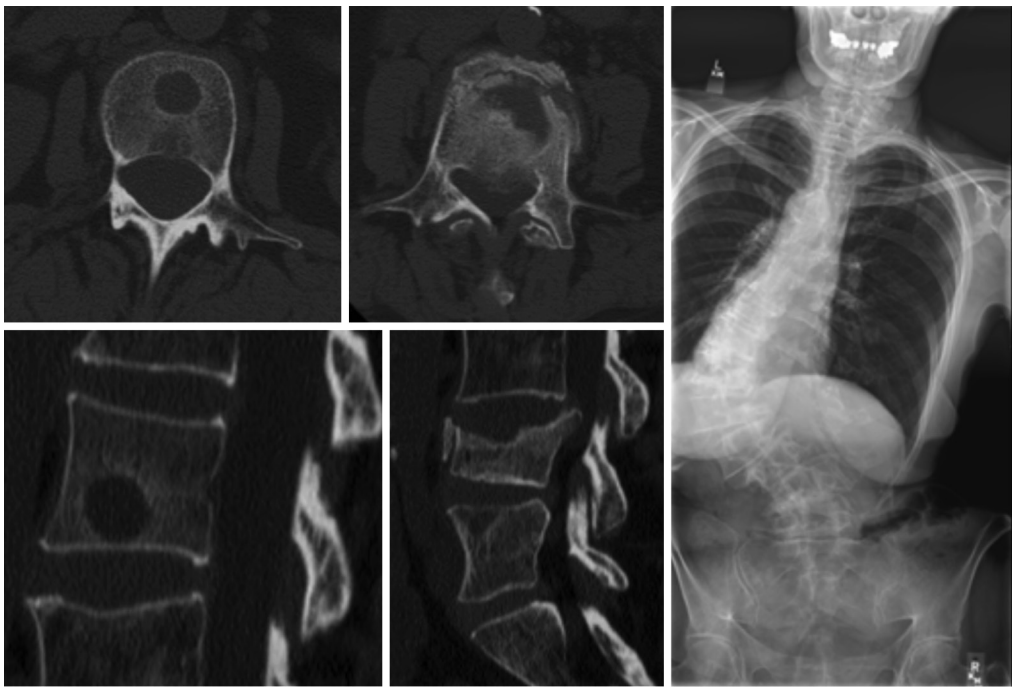

Figure 38-13 Images of tumor, trauma, and deformity.

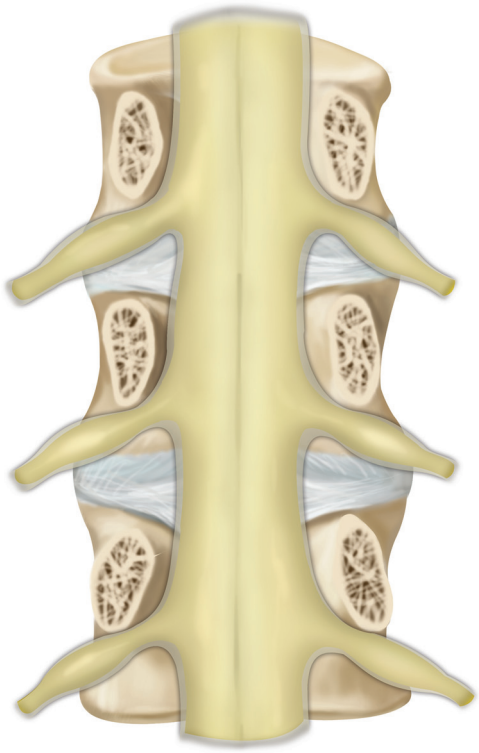

Figure 38-14 Pedicles with posterior elements removed.

SPECIAL CONSIDERATIONS AT L5–S1

- The lumbosacral junction has several special considerations that include a wide interspace, transitional vertebrae, and spina bifida occulta.
- The wide interspace will be encountered more often in younger patients with tall, well-hydrated disks.
- At risk here is the thecal sac, which can be injured during dissection and may lead to persistent cerebrospinal fluid (CSF) injury.
- Transitional vertebrae are seen in up to 36% of individuals, and 6% have six lumbar vertebrae. This can lead to a miscount to the right vertebral level for surgery.[7]
- It may be necessary to have a radiologist review magnetic resonance imaging and radiographic images preoperatively and confirm intraoperative marking images.
- Although uncommon, spina bifida occulta should be considered on every preoperative posteroanterior image to prevent thecal sac injury during routine dissection at or near the lumbosacral junction.

Closure

- Although developing acumen with posterior exposure of the spine is critical, wound closure is perhaps as important.
- The dorsal incision remains in a precarious position in the postoperative patient.
- A prolonged supine position demands the patient lie on the incision, which leads to inevitable perspiration and maceration of wound edges.
- The caudal edge of the lumbar incision is, by definition, near the perineum, where toileting and hygiene must be considered.
- In postlaminectomy cases, a subfascial drain can be used.
- No definite evidence suggests that postoperative drainage improves wound healing or minimizes hematoma formation or blood loss, although this makes sense intuitively.[8]
- The lumbar fascia is considered the primary mechanical and physical barrier to ingress and egress of fluid from the operative site.

- Watertight closure of lumbar fascia is paramount. I close the cephalad and caudal extents of the wound first to ensure those extreme ends close tightly.
- Once the lumbodorsal fascia has been closed, copious irrigation should be used once more to make certain skin flora is irrigated out of the surgical site.
- The Scarpa fascia is identified during exposure, typically as a robust and distinct layer that can be closed much the same as any other fascial layer. It provides one more barrier but adds little extra time to wound closure.
- Finally, skin closure and adequate dressing material complete the surgical dissection and the procedure.

Complications

Few complications are directly attributable or unique to the posterior approach, but they include excessive blood loss, infection, epidural hematoma, wrong-level surgery, and blindness. In addition, excessive blood loss can occur from posterior surgery at every step from exposure to closure. The major vascular contributions come from the subdermal vascular plexus, perforating segmental arteries, muscle, bone, and epidural venous plexus. Careful attention to vascular structures and meticulous hemostasis is necessary.

Wound infection from posterior surgery has an incidence of 1.0% to 12.0%. Operative factors include prolonged blood loss, long operative times, and revision surgery. Patient factors include obesity, smoking status, diabetes, and immune status.[9] Both types of factors can sometimes be controlled to a small degree, but many times they cannot. Treatment for wound infections often involves serial débridement followed by closure. Mok and colleagues[10] analyzed clinical outcomes using the SF-36 Physical Component Score (PCS) in patients who developed deep wound infection after instrumented lumbar fusion and were treated immediately with irrigation and débridement. If the infection was acute, the hardware was maintained. Outcome in infected patients was compared with those of a matched cohort, and no significant differences in PCS were found.

Epidural hematoma in the postoperative patient is a common radiologic finding. Cauda equina syndrome (CES) has an incidence of 1 to 2 per 1000 surgeries, yet because of its devastating sequelae, careful attention must be paid to patients' complaints. Sokolowski and colleagues[11] prospectively obtained preoperative and immediate postoperative MRI on 50 patients and found 58% showed epidural hematoma that caused thecal sac compression beyond its preoperative measurements. None had evidence of CES. Additionally, the hematoma extended to an average of 1.9 levels when 1.4 levels on average were operated on. Significant factors included age older than 60 years, multilevel surgery, and abnormal international normalized ratio values.

Wrong-level surgery has become visible since the Institute of Medicine published their landmark work "To Err Is Human: Building a Safer Health System." Since then, U.S. spine societies have adopted guidelines to avoid wrong-level surgery, the incidence of which may be as high as 8%; in a recent surgeon's survey, 50% of all respondents reported performing or nearly performing a wrong-site operation. The prevalence was estimated to be 1 in 3110 surgeries, and 17% led to legal action or monetary settlement to the patient.[6]

Postoperative visual loss (POVL) is a devastating injury that occurs at an incidence no higher than 1 per 1000. The differential diagnosis includes ischemic optic neuropathy (ION), central retinal artery occlusion, and cortical blindness. ION is most often associated with prone positioning. Risk factors include male gender, surgery longer than 5 hours, and blood loss greater than 1 L. Urgent ophthalmologic examination is necessary to differentiate ION from other forms of POVL. Blindness is often permanent.[5]

Conclusion

The posterior approach is the most utilitarian and necessary approach used in spinal surgery. Good technical execution of the approach is necessary for all spine surgeons, and a thorough understanding of both bony and soft-tissue anatomy is necessary to perform it well. Good prone positioning protects the patient and makes decompression more effective, and thorough care and attention should be paid to the marking process to ensure that surgery is performed at the correct site and side. With repetition and attention, the technique will become routine, and ultimate comfort with the approach can be achieved.

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