Thoracolumbar Posterior Approach

Authors: Dr. Robert Meves, Dr. William Gemio Jacobsen Teixeira
Editor In Chief: Dr Néstor Fiore
Senior Editor: Paul Matz
OBJECTIVES

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Anatomy and Techniques
Thoracolumbar Posterior Approach

- Define indications for wide posterior approaches to thoracolumbar spine.
- Focus on the details of the surgical technique.
- Describe potential complications and how to avoid them.
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1. INTRODUCTION

Overview

Thanks to technological advances, the wide posterior approaches to the thoracic and lumbar spine have made it possible to plan techniques that necessitated combined approaches in the past (Canale and Beaty, 2008).

These approaches are complex and high-risk procedures; therefore, they require careful training and planning. Depending on the difficulty of each case, the surgery may take longer than eight hours and involve significant bleeding (Hebert, de Barros Filho, Xavier and Pardini, 2009; Kim, Park and Lee, 2009).

Deformities

In the case of certain osteotomies for the treatment of deformities, it is convenient to have a view of the lateral wall of the vertebra. If an osteotomy with resection is performed, the view must be to the anterior surfaces of the bodies.

Example

Images of a patient with kyphosis at thoracolumbar level who had a pedicle subtraction osteotomy performed.

Correction obtained with the T11 osteotomy.

Pre- and post-operative lateral X-rays of the thoracolumbar spine
Tumors
For tumors, the wide posterior approach may be used for neurological decompression with intralesion resection and reconstruction or for en bloc vertebrectomies with reconstruction.

Example
Patient with a metastasis in L1 who underwent a release, intralesion resection and reconstruction.

Intra-lesional resections without the need for en bloc extraction are simpler from the technical viewpoint.

Example
Patient with a chondrosarcoma at thoracic level who underwent an en bloc resection.

Intralesion release at the L1 level and reconstruction.

Post-operative frontal and lateral X-rays of thoracolumbar spine

En bloc resection at thoracic level and reconstruction.

Post-operative frontal and lateral X-rays of thoracic spine
Indications

- The classical indication for corrective osteotomy is the correction of rigid deformities, both in the coronal and sagittal plane. The examples include sagittal imbalance of ankylosing or iatrogenic spondylitis, rigid scoliosis and post-traumatic kyphosis (Hebert, 1959).

- The indications for intralesion release with reconstruction are for the cases of tumor lesions requiring neurological decompression and vertebral reconstruction, without the need for an en bloc resection.

- En bloc vertebrectomy is indicated for treatment of certain localized malignant primary tumors or single metastasis of primary tumors, with favorable prognosis and no alternative to surgery for local control.
2. PREOPERATIVE WORKUP

As it is a major procedure, the preoperative workup may be planned with other specialists (medical and surgical specialties) if considered appropriate. It is also necessary to have blood reserved and the post-operative intensive care unit available (Canale and Beaty, 2008; Hebert, 1959; Law, 1962).

Patients with ankylosing spondylitis usually have difficult airway access, so a broncoscope may be required.

The preoperative planning for the treatment of spine deformities is important for choosing the best technique for the treatment. The simplest surgical technique that allows meeting the objectives proposed for each case must always be chosen (McMaster, 1965).

In the case of tumors, it is essential that the patient's staging exams be current, as the presence of metastatic disease may open the possibility to alternative procedures.

Example

Patient with a chondrosarcoma at thoracic level who underwent an en bloc resection.

Relation of the tumor to the left segmental artery and planning of the trajectories of the osteotomies are observed.

Axial, T1 sequence MRI of the thoracic spine
The WBB classification (Boriani, Weinstein and Biagini, 1997; Chan 2009) helps plan surgical treatment and makes it possible to determine the ideal osteotomy points for entering the spinal canal without involving the surgical margin.

A. Extraosseous soft tissue
B. Superficial intraosseous
C. Deep intraosseous
D. Extradural extraosseous
E. Intradural extraosseous

Rapid growth tumors with high contrast uptake on imaging studies may portend a high risk of bleeding. In the case of a highly vascularized lesion, pre-surgery embolization should be considered. (Weale, Marsh and Yeoman, 1995; Voos, Boachie-Adjei and Rawlins, 2001).

Using intraoperative neurophysiological monitoring is a consideration and may alert the surgeon of potential damages to the spinal cord.

Vascularization of the tumor to be resected.

Angiography of the lumbar spine to see the vascularization.

Diagram showing the WBB classification (Chan et al., 2009)
3. TECHNICAL DETAILS

Approach

For the wide posterior access to the dorsolumbar spine, an incision is made along the median line.

The size of the incision must be larger than that of a usual approach in order to allow a better view of the lateral parts.

With subperiosteal dissection, the erector spinae muscle of the spinous processes is dissected lateral to the transverse processes.

Following exposure and prior to performing osteotomy or resection, it is advisable to place pedicle screws cephalically and caudally (Scudese and Calabro, 1963).

- Pedicle screw fixation one or two levels above and one or two levels below osteotomy is reasonable.
- For a one-level vertebrectomy, the pedicle fixation two levels above and two levels below is recommended. For a two-level vertebrectomy, the fixation three levels above and three levels below is recommended (Boachie-Adjei, Ferguson, Pigeon and Peskin, 2006; Jaffray, Becker and Eisentein, 1992; Maclennan, 1922).

Resection of Ribs and Transverse Processes

Each thoracic vertebra is connected to the thoracic cage by two pairs of ribs and the relevant costovertebral ligaments.

In order to remove a vertebral body, the rib corresponding to the vertebral body at the lesion level and the lower rib should be resected.

Diagram of the relations of the ribs to the vertebral bodies
Example
CT with coronal reconstruction that shows the need to resect two pairs of ribs and costovertebral ligaments for each vertebra resected in order to allow the release of the vertebral body from the thoracic cage.

In order to resect a vertebral body, the relevant rib and the lower rib must be removed from both sides.

The ribs must be resected laterally for a minimum of 3-4 cm from the costotransverse joint to allow adequate access to the lateral and anterior parts of the vertebral body (Boachie-Adjei et al., 2006).

The more lateral the resection of the rib, the easier it will be to view the lateral and anterior region of the spine.

In the case of a vertebrectomy (with en bloc corpectomy), a greater space in the operating field will allow an easier extraction maneuver.

Screws placed cephalically and caudally. The lateral dissection must be large to allow at least one osteotomy of the ribs 4 cm from the costotransverse joints.

If the pathology and the case so allow, osteotomies of the transverse processes in conjunction with the rest of the posterior arch at a thoracic or lumbar level pave the way for anterior dissection. If they must be preserved with the posterior arch, the dissection is more difficult and must be made more laterally.
Resection of Posterior Elements (Posterior Arch)

The next stage of the procedure is the resection of the posterior elements. In an osteotomy to correct sagittal or coronal balance or if the region is not affected by a tumor, a conventional laminectomy may be performed, without the need for an en bloc resection.

In the presence of a tumor compromising the articular facet, the lamina or the spinous process, the resection must be en bloc.

For en bloc resection of the posterior arch, it is necessary to perform adjacent vertebrae laminectomies to allow exposure and release of the ligamentum flavum above and below the lesion. Thereafter, resection of the lower facet of the upper vertebra and the upper facet of the lower vertebra (this may be resected with the specimen) is performed.

The pedicles must be cut using the monofilament saw or delicate chisels.
Anterior Access To Vertebral Bodies

At thoracic level, the relevant intercostal nerves are ligated in order to avoid unnecessary traction of the cord. Through an extrapleural approach, the vertebral bodies may be accessed to perform a release and reconstruction. At lumbar level, if possible, it is important to preserve the nerve roots, and the dissection is performed by separating the psoas muscle from the lateral surfaces of the vertebral bodies.

- The provisional stabilization of a single side is enough.
- Placement of a curved rod permits continued access to the depth of the operating field.

From this stage onward, it is essential to stabilize the spine provisionally since the anterior release will result in instability with risk of damage status.

The tumor in the vertebral body after the ligation of the nerve roots and after gently tilting the cord to the left can be seen.

Intra-operative photograph of a wide posterior approach at the level of the thoracic spine

The pleura with the segmental vessels (yellow arrow), once the nerves have been ligated, and the partial fixation on the right side (white arrow) can be observed. The black arrow points the left lateral surface of the body.

Photograph in anatomical preparation of the unilateral temporary fixation, once the posterior arch has been resected
The pleura should be dissected from the vertebra carefully so as to avoid any injuries. At this point, it is important to identify and follow the segmental arteries (Boachie-Adjei et al., 2006).

It is easier to identify the segmental artery following the path of the intercostal artery.

Indication of the right segmental artery separated from the vertebral body.

Intra-operative photograph of the segmental artery

Diagram on how to reach the anterior surface of the bodies (Kawahara, Tomita, Murakami and Demura 2009)

The artery is carefully released from the vertebral body. Frequently, it is ligated; however, it may not be necessary to ligate it. If it is necessary, the anterior part is ligated to reduce the risk of accidental vascular injury due to traction. The ligation of the artery is facilitated by the use of vascular hemoclips, due to the depth and difficult access to perform the ligation manually.

The anterior dissection of the spine must be completed manually, with care to separate the adhesions of the vertebra to the pleura and vascular structures.
In this stage, placing malleable blades to the front of the vertebra protects the visceral and vascular structures against accidental damages. The vertebral body to be resected may then be separated by discectomy of adjacent levels or osteotomy of the endplates of the upper and lower vertebrae.

The bone may be cut with a chisel or saw, depending on the surgeon's preference and training.

At present, the authors have preferred cutting the adjacent vertebra through the bone, since the thoracic discs are usually short in height and increase the risk of accidental violation of the margin.

**Removal of Vertebral Body and Reconstruction**

In case of removal, the vertebral body must be carefully turned outside the thoracic cage. In this stage, difficulty usually arises due to the mobilization of the vertebra caused by the incomplete release of soft tissues, often because of lack of section of a part of the anterior or posterior longitudinal ligament.
At the end of the vertebra resection, there is a significant osteoligamentous defect that requires circumferential reconstruction. The vertebral body must be replaced with a cage filled with graft for a fusion to be obtained. In this surgery, it is preferable to use mesh cages as they cost less and permit placement of a larger amount of graft compared to the expandable cage. The cage may be easily fixed by the compression of the posterior fixation system.

Vertebra rotation outside the thoracic cage.
In this case, the body is removed to the left.

Intra-operative photograph showing removal of the vertebral body

Specimen with a vertebral body and the relevant discs with part of the bodies of the adjacent vertebrae.

Photograph of the specimen of the vertebral bodies.

Anterior reconstruction with mesh cage and autologous graft.
The anterior cage and the right rod already placed are perfectly seen.

Intra-operative photograph showing the reconstruction of the area
4. COMPLICATIONS

Spine osteotomies and vertebrectomy are procedures associated with high complication rates.

- The most feared complication is bleeding. Bleeding may be due to the duration of the surgery and/or damage to the great vessels (Hebert et al., 2009; McMaster, 1965; Weale et al., 1995).

- In the correction of deformities, there is a risk of vascular damage, especially in elderly patients and in osteotomies that lengthen the anterior column. Slow and gradual correction, avoiding angular corrections beyond 60 degrees, increases the safety of this procedure (Hebert et al., 2009; Goel, 1938, Voos et al., 2001).

- There is a neurological risk of nerve root and/or spinal cord damage due to direct trauma and ischemia. Hemodynamic monitoring of the patient is essential, and using intraoperative neurophysiological monitoring may help to reduce the risk of serious complications although this has not been proven.

- Other complications of the procedure are visceral lesions such as pleuropulmonary damages and late mechanical complications.
5. SUMMARY

Summary:

THORACOLUMBAR POSTERIOR APPROACH

Advances in surgical techniques, implants and anatomical knowledge have permitted more aggressive approaches to complex problems, such as serious deformities or tumors, through the exclusive wide posterior access.

These techniques offer the advantage of reduced morbidity compared to circumferential approaches with reduction of the time required for surgery; however, extensive training and judicious pre-operative planning are necessary in order to reduce the risk of complications from surgery.
REFERENCES


