The Role of a Miniopen Thoracoscopic-assisted Approach in the Management of Burst Fractures Involving the Thoracolumbar Junction

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KEYWORDS

• Thoracoscopic surgery • Burst fractures • Vertebrectomy • Expandable cages
• Minimally invasive surgery • Thoracotomy

KEY POINTS

- Thoracoscopic miniopen access to the anterior spine should be considered as an alternative minimally invasive access approach to traditional open procedures.
- Thoracoscopy can be used along the entire thoracic spine and can be extended via transdiaphragmatic incision to the upper third of L2 in the retroperitoneal space, allowing access to the most common sites of burst fractures.
- Good single-lung ventilation with a double-lumen endotracheal tube is crucial for thoracoscopy.
- Thoracoscopic miniopen surgery can be used for vertebrectomy and anterior reconstruction of unstable fractures.

INTRODUCTION

The thoracolumbar junction (TLJ) from T11 to L2 represents a transition zone for several anatomic structures that have implications and predilections for spinal cord trauma, bony fractures, and ligamentous injuries. The spinal cord anatomy changes at the conus and cauda equina. The diaphragm inserts at T12/L1 and divides the thoracic cavity from the retroperitoneal space. The spinal column transitions from the stiff thoracic spine, with rib heads overlapping the disk spaces and ribs that attach to the sternum creating a 4-column structure, to a mobile spine, where floating ribs attach only to the vertebral body, resulting in a 3-column structure. These unique characteristics contribute to the complexity of clinical symptoms, neurologic deficits, and radiological features of burst fractures.

The management of traumatic burst fracture is a controversial topic in spine surgery because of limited high-quality outcomes data. Therapy options range from no treatment, to nonoperative treatment with bracing, to surgical instrumentation of various sorts. Stable burst fractures without neurologic deficit are often treated conservatively. For unstable burst fractures that involve the TLJ, spine surgeons often consider surgery an important option.

An unstable burst fracture involves both the anterior and the middle columns and is associated with a primarily axial load with or without flexion, rotation, or lateral flexion forces. In addition, McAfee and colleagues[1] classified burst fractures

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based on the status of the posterior elements. Unstable burst fractures should have evidence of disruption of the posterior elements, including pedicles, lamina, and ligaments.

Posterior approaches for correction of burst fracture–related kyphosis and fusion remain the most common spine surgery for unstable burst fractures; however, posterior-alone approaches for unstable burst fractures involving the TLJ can result in loss of correction, degenerative kyphosis, nonunion, and hardware failure. This outcome is likely secondary to the loss of weight-bearing capacity of the fractured vertebral body, including the end plates and the adjacent ligamentous structures. Strategies to counteract these problems include multilevel posterior fusion, transpedicular bone grafting, vertebral augmentation, screw insertion at the fracture level, and corpectomy with vertebral body replacement (VBR).[2–5]

Corpectomy and VBR can be done via a posterior lateral approach or anterior approaches alone or in combination with posterior fusion.[6] The thoracoabdominal approach consists of a thoracotomy with a transthoracic incision of the diaphragm to enter the retroperitoneal space. This traditional, open approach provides excellent access to the anterior spine but is associated with significant access-related morbidity and postoperative complications. The development of the miniopen thoracoscopic approach for anterior column surgery after a short-segment posterior fusion has decreased the access morbidity and allowed faster healing times,[7] although the learning curve related to miniopen thoracoscopic surgery has restricted its widespread appeal in treating burst fractures. This article describes the use of this procedure for addressing burst fractures at the TLJ.

SURGICAL TECHNIQUE

Anesthesia and Surgical Setup

The thoracoscopic miniopen procedure is performed under general anesthesia with double-lumen tube intubation for single-lung ventilation. Once the endotracheal tube is positioned, its placement is confirmed by bronchoscopy. An arterial line is placed before patient positioning for continuous blood pressure monitoring.

The patient is placed in a lateral decubitus position. The approach side depends on the position of the major vessels shown on the preoperative computed tomography scan. There needs to be enough distance from the aorta to allow for the placement of the anterior lateral plate to avoid direct contact between the plate and the aorta. At the TLJ, the burst fracture is most commonly accessed from the left side, which also avoids manipulation or retraction of the liver during the transdiaphragmatic exposure.

Four supports are placed: at the sternum, between the scapulae, and at the sacrum and coccyx. An axillary roll, a Krause arm rest, and a special U-shaped cushion for the legs are also positioned to prevent obstruction during the instrumentation (Fig. 1A, B). Four access portals (for the endoscope, suction-irrigation, retractors, and working access) are localized. The burst fracture is displayed in the lateral projection under precise adjustment of the image intensifier, and the injured spinal section is marked onto the lateral thoracic wall. The projection of the vertebrae, whose end plates and anterior and posterior margins should be displayed in the central beam, is used as the sole reference for portal placement.

The working portal is positioned directly above the lesion, and then the location for the endoscope portal is marked approximately 2 intercostal spaces from the working portal along the axis of the spine in a cranial direction at the TLJ. The suction and irrigation and retractor portals are then located ventral from these portals.

Operation

After skin disinfection and sterile draping, single-lung ventilation is begun. The most cranial portal is opened first to reduce the risk of injury to the liver, spleen, and diaphragm. After opening, the insertion site is inspected with the fingers before the trocar is introduced and then the rigid 30° endoscope is inserted to inspect the thoracic cavity for adhesions or parenchymal lesions. The lung is visually confirmed to be deflated. The access ports for the instruments are placed under direct visualization, the instruments are introduced and the diaphragm is safely retracted, and the operating portal is opened (Fig. 1C).

The attachment sites of the diaphragm to the spine are at the level of the first lumbar vertebra and the lowest point of the thoracic cavity is at the level of the baseplate of the second lumbar vertebra (Fig. 1D). After incision of the diaphragm attachment to the spine, a trocar is placed intrathoracically in the phrenicocostal sinus to afford access to the retroperitoneal section of the TLJ down to the baseplate of the second lumbar vertebra. A 4-cm to 5-cm incision parallel to the attachment of the diaphragm is used to prevent a postoperative diaphragmatic hernia; access as far as the L1-L2 intervertebral disk can be obtained with a shorter, 2-cm to 3-cm incision.