Management of Pediatric and Adolescent Thoracolumbar Burst Fractures

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Abstract

Thoracolumbar burst fractures are relatively uncommon in the pediatric and adolescent populations. Older children who engage in high-risk activities are more likely to sustain these injuries. Burst fractures are caused by axial compressive forces that drive the intervertebral disc through the vertebral endplate thereby fracturing the body and disrupting both the anterior and middle columns of the thoracolumbar spine. These fractures deserve careful consideration, and at times, surgical intervention, given their potential to cause significant neurological injury and disability. This chapter defines stable and unstable injuries of the thoracolumbar spine and outlines the indications for surgical management of burst fractures. We present a rationale for level selection while performing a posterior spinal instrumentation, and we share the techniques employed in order to achieve fracture reduction and decompression of the involved neurological elements.

1 Brief Clinical History

A 16-year-old female presented in the emergency department after a motor vehicle collision. On examination she complained right-sided thigh pain and was noted to have knee extensor weakness, and bilateral lower leg paresthesias. Rectal tone and sensation were preserved. Imaging demonstrated an L2 burst fracture. Operative intervention was chosen due to mechanical instability of the fracture as well as neurologic symptoms. Immediately post-operatively, her paresthesias resolved, yet she still demonstrated 4/5 strength in

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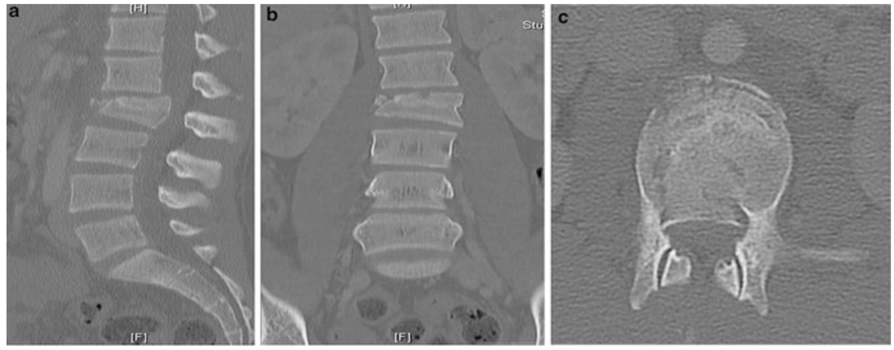

Fig. 1 CT scan of lumbar spine demonstrating significant relative sagittal kyphosis (**a**), coronal deformity (**b**), and bony retropulsion (**c**) of an L2 burst fracture

the right L3 nerve root. At 1-year post-op, she had full recovery of her motor function. Radiographs demonstrated maintenance of her sagittal and coronal alignment.

2 Preoperative Clinical Photos and Radiographs

See Fig. 1.

3 Preoperative Problem List

Unstable lumbar burst fracture with neurological injury.

4 Treatment Strategy

Burst fractures are uncommon in the pediatric population but can lead to significant morbidity. These injuries can be associated with abdominal as well as head injuries in 42% and 30% of cases, respectively. Thus, evaluation of these patients must be dictated by Advanced Trauma Life Support (ATLS) protocols. A motor and sensory examination by dermatome should be performed. Additionally, the examiner should palpate and inspect the entire spine for the presence of step-offs, tenderness, ecchymosis, or evidence of open fractures. Such findings have been shown to be up to 87% sensitive and 75% specific for detecting thoracolumbar spine fracture. When spinal trauma is suspected, plain radiographs of the entire spine are indicated to evaluate for concomitant and noncontiguous injuries. The Thoracolumbar Injury Classification and Severity (TLICS) score provides a framework for the evaluation of burst fractures as well as surgical decision-making. Its validity has been demonstrated recently in pediatric patients. Burst fractures must be differentiated from Chance fractures, which are caused by distraction rather than compression. Suspicion and evaluation for posterior ligamentous complex (PLC) injury is paramount in avoiding misdiagnosis of these injuries.

Our preference for surgical management of most unstable lumbar fractures below the conus medullaris is posterior instrumented fusion, with indirect reduction by ligamentotaxis or direct reduction by anterior tamping of the posterior column fragments. Fractures resulting in spinal cord compression, or those which cannot be reduced from a posterior approach, may benefit from anterior decompression and fusion with structural support. Finally, postoperative activity modification and bracing may be indicated until fusion is complete.

5 Basic Principles

1. Axial compression is the pathologic force that causes burst fractures as the elements of the intervertebral disc are driven through the vertebral endplate fracturing the body and disrupting the anterior and middle columns of the spine.
2. Radiographs should be evaluated for indicators of potential instability as well as posterior element injuries such as lamina and pedicle fractures and facet dislocations. Indicators of instability include local kyphosis (>30°), coronal deformity, bony retropulsion (>50%), and vertebral height loss (>50%).
3. Advanced imaging with a CT scan can identify retropulsion of the fractured vertebral body (Fig. 1). An MRI scan can delineate the status of neurological elements and the integrity of the PLC.
4. Stable fractures have an intact PLC and do not have associated neurological injury or significant kyphosis or retropulsion. These injuries are typically treated with a thoracolumbosacral orthosis (TLSO) and activity modification for 8–12 weeks.
5. Patients with biomechanically unstable fractures are indicated for posterior spinal instrumentation and possible fusion. Our preference is to perform a short-segment fixation of the more lordotic middle and lower lumbar levels. A long-segment fixation (2 levels above and below) is deemed to be biomechanically superior and thus used for

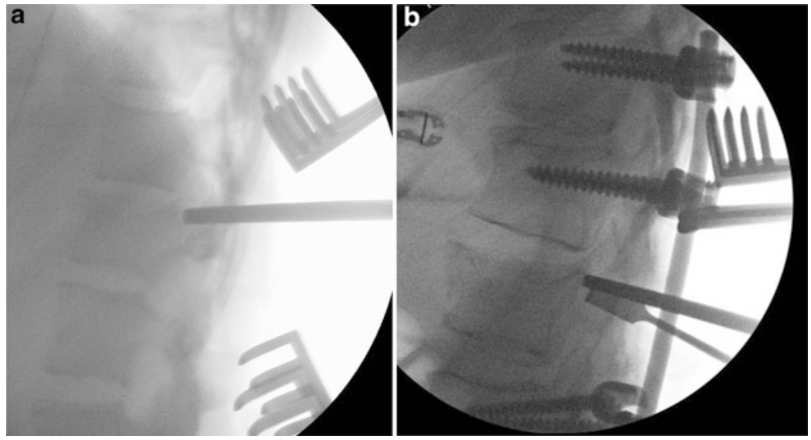

Fig. 2 Intraoperative fluoroscopic images demonstrating the use of a bone tamp to reduce dorsally retropulsed fracture fragments (**a**). A nerve root retractor is used later in the case to aid in the visualization and reduction of more lateral fracture fragments (**b**)

injuries near or at the thoracolumbar junction. A fusion is performed for significant instability and/or posterior element fractures or dislocations.

6. Non-fusion treatment with removal of the instrumentation after fracture healing is preferred in some centers. An anterior decompression is typically performed for severe canal compromise, significant vertebral height loss, and kyphosis and/or thoracic injuries.
7. Postoperative activity modification and a TLSO brace are used for 12 weeks.
8. A gradual return to activity is supplemented with physical therapy.
9. Clinical follow-up is recommended for at least 1 year (Figs. 3 and 4). Pseudoarthrosis is rare in surgically treated patients, yet kyphotic deformity can progress in patients treated nonoperatively.

6 Images During Treatment

See Fig. 2.

7 Technical Pearls

1. The patient is positioned prone with access to the fluoroscope.
2. Our preference is to utilize intraoperative neurophysiological monitoring to reduce the chance of iatrogenic neurological injury.
3. Our practice is to complete the spinal instrumentation prior to the decompression.
4. The skin incision and dissection is carried down to spine with the goal of exposing 1–2 levels above and 1–2 levels below the zone of injury (Fig. 3).
5. Posterior element fractures in the segments adjacent to the fracture may obviate screw placement at that level.
6. Pedicle screws are placed.
7. Appropriately curved rods are then inserted, followed by end caps. Rod connectors add rigidity to the construct.
8. Rod contouring into lordosis and distraction often provide indirect canal decompression, which is checked radiographically. Occasionally, myelographic dye can be used to look for any residual compression. If present, formal decompression is performed.
9. A laminectomy is performed. It is important to note that neural elements released via a traumatic durotomy can be herniated into a laminar defect. This is increasingly likely in the presence of posterior element fractures seen on preoperative scanning and should be anticipated.
10. Repair of any encountered traumatic durotomies is performed with 6-0 monofilament suture in a figure-of-eight interrupted fashion and augmented with a commercial fibrin sealant.
11. The decompression is then performed. In the lumbar spine, the dural tube can be mobilized to expose the retropulsed fragment lying ventrally. Free fragments can be removed with a pituitary rongeur. The fracture fragments are gently malleted ventrally with a straight or curved (for midline fragments) bone tamp using fluoroscopy to confirm the position of the tamp after impaction (Fig. 2). Indirect decompression of the nerve roots is performed at the level of the lateral recess and via foraminotomy as indicated.
12. A water-tight closure is carried out. A drain is placed and vancomycin power is used in the subcutaneous layer.

8 Outcome Clinical Photos and Radiographs

See Figs. 3 and 4.

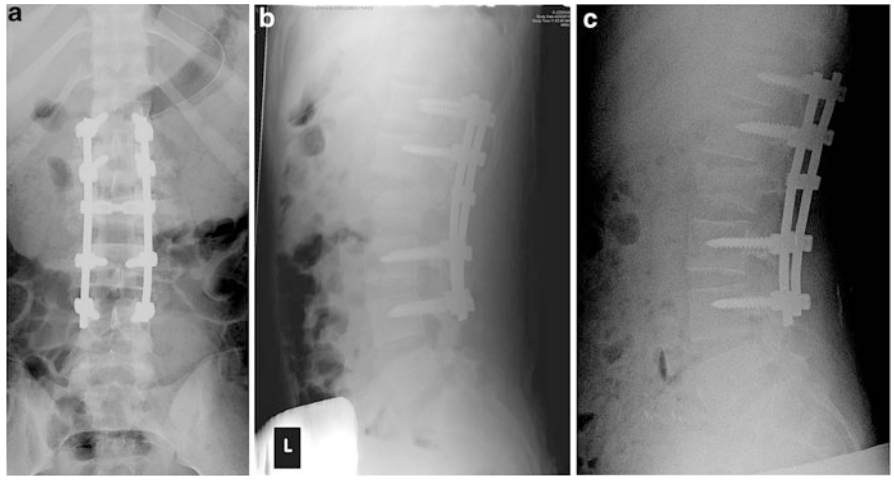

Fig. 3 Postoperative AP radiographs demonstrating correction of kyphosis and restoration of lumbar lordosis (**a**) and improved coronal alignment (**b**) with a long-segment fixation. Lateral radiograph 1-year post-op (**c**) with maintained alignment

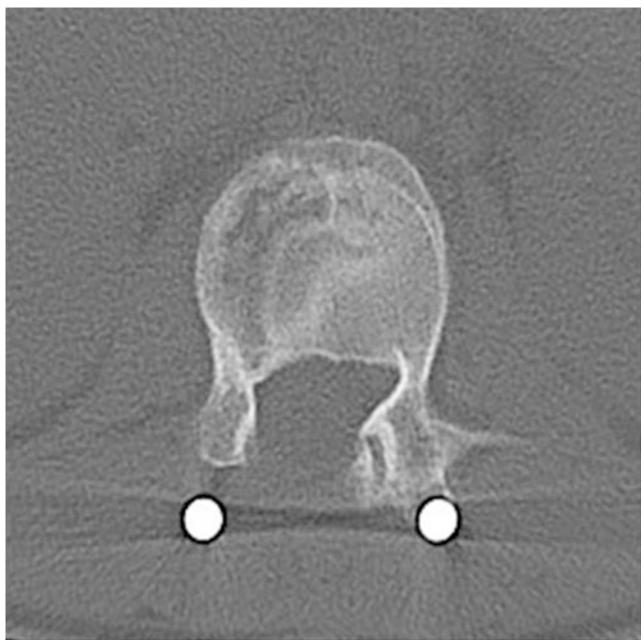

Fig. 4 Axial cut of burst fracture at 1-year post-op demonstrating remodeling of the spinal canal

9 Avoiding and Managing Problems

1. The pedicle entry sites along the thoracolumbar spine vary in the axial and sagittal planes. Understanding these anatomical differences will ensure safe screw insertion along the pedicle axis.
2. Rod breakage and/or persistent pain may indicate pseudoarthrosis. Open exploration and hardware exchange may be indicated. Additional bone grafting supplemented with BMP and bone graft substitutes can help achieve fusion.

10 Cross-References

▶ Thoracic and Lumbar Compression Fractures

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