THORACOLUMBAR BURST FRACTURES:
Through the Front D’Orr
(Think Sutton’s Law), the Side Door
the Back Door, or No Door.

Orthopaedic Grand Rounds
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Dr. Doug Orr
Dr. Michael Boucher
Overview

- Epidemiology
- Anatomy
- Classification
- Pathophysiology
- Radiology
- Sutton’s Law (AKA Doug’s law)
- Non-operative, Anterior, Posterior, & Posterolateral (The literature . . . as it where)
- and what you should do?
Epidemiology

- Thoracolumbar fractures account for approximately 40% of all spinal fractures.
- Of these, Burst fractures represent ~ 17%.
- ~60% occur at the transitional zone (kyphosis to lordosis) between T11 and L1.
- 15-20% have some form of neurological deficit.
Anatomical Issues

- Thoracolumbar junction fractures common.
- Increasing size of vertebral bodies moving distal from T to L spine.
- Thoracic canal is narrower than lumbar spine (at the junction it is ~ 17mm).
- Abrupt change from rigid thoracic spine to a mobile lumbar spine increases regions vulnerability.
- Thoracic spine limited flexion due to facet joint & spinous process orientation.
- Lumbar spine limits rotation via sagitally oriented facets and axially oriented spinous processes.
• Ligamentous structures impart additional considerations.

• Additional stability gained in region from ALL and PLL.

• Strength mismatch with strong ALL providing greater than 450 Newtons tensile strength and the weaker PLL 66 Newtons.

• Significant bending moments can develop from external forces applied at the upper thoracic region and the pelvis (falls, MVA).
Classification

- Can be classified via fracture morphology, force of injury, stability, or a combination.
- The burst fracture was initially described by Holdsworth in 1963, he considered these fractures to be stable because the posterior column was preserved.
- In 1983 Denis went on to develop the three column classification system. This differed from Holdsworth due to his recognition that if two of three columns are disrupted, the segment involved is actually considered unstable.
Classification

• Divides the spine into three different anatomic columns.
• Anterior column consists of the anterior 2/3 of the body and the two adjacent disc spaces plus the ALL.
• Middle column is the posterior 1/3 of the vertebral body, disc, the PLL, and the two pedicles.
• Posterior column comprises the two facet joints, the lamina, spinous processes, and supporting ligaments.
Classification

- He described the radiographic findings including fracture of one or both endplates, disruption of the posterior vertebral cortex with retropulsion of bone, widening of interpedicle distance, fracture of lamina, loss of body height and angular deformity.

- Noting the hallmark of all burst fractures is failure if the middle column in compression, Denis subdivided burst fractures into five categories.

- Type A – Both endplates, seen in low lumbar, pure axial force.
- Type B – Superior endplate, most frequent, T/L junction. Axial load and flexion.
- Type C – Inferior endplate, rare. Axial load and flexion.
- Type D – Burst rotation, mid-lumbar. Axial & rotation
- Type E – Burst lateral flexion. Differs in that posterior wall fractures allowing retropulsion.
Classification

- To account for the presence of the stable burst fracture, McAfee suggested that middle column failure in compression was stable unless a posterior column injury had also occurred.
- The McAfee system is based on CT findings.
- Both systems provide insight into the fracture stability, however neither completely guide appropriate case selection.
Pathophysiology

- Typical mechanism of injury is fall from height (greater than 17 ft) or MVA).
- Burst fractures generally involve only compressive failure of the vertebral body both anteriorly & posteriorly, w/ failure of both anterior and middle columns.
- Posterior column may fail either under direct compression or tension.
Pathophysiology

- Axial loading applied to intravertebral disc results in increased nuclear pressure and hoop stresses in the annulus.
- Results in a high shear stress on the vertebral end plate at inner border of the annulus, away from the center of the disc.
- Retropulsion of the superior posterior endplate occurs.
- The inferior endplate/disc may also be damaged.
- Instability and failure occur in anterior and middle columns.
- Posterior column may fail either under compression or tension.
Radiographic Assessment

- AP & Lat films of the T & L spine must be obtained for initial evaluation.
- Systemic evaluation needed to identify fractures.

Thoracolumbar Spine Fractures: X-Ray Diagnosis

Plain radiographs can provide valuable insight into the characteristics of thoracolumbar spinal fractures in the initial assessment of a patient.

Mohit Bhandari, MD, Kesava Reddy, MD and Desmond C. Kwok, MD

Canadian Journal of Diagnosis, October 1998
Radiographic Assessment

• If fracture found need complete spine series, noncontiguous fracture in 10-30%.
• CT enhances mech of neuro injury and fracture morphology and is recommended.
• Plain films ~54% predictive value in differentiating compression fractures and bursts fractures.
• Little need for MRI
Treatment Options

- Posterior reduction with distraction instrumentation and arthrodesis without decompression.
- Posterolateral decompression and arthrodesis with posterior instrumentation.
- Posterior arthrodesis with instrumentation followed by anterior decompression and arthrodesis.
- Anterior decompression and arthrodesis followed by posterior instrumentation and arthrodesis.
- Anterior decompression and arthrodesis with anterior instrumentation.
- Non-surgical.
Decompression

- Role of decompression is controversial.
- Compression of the neural elements by retropulsed bone fragments can be relieved indirectly by the insertion of posterior instrumentation or directly by exploration of the spinal canal through a posterolateral or anterior approach.
- There is no universal agreement as to indications for each of these.
Anterior Approach

• The anterior approach allows direct decompression of the thecal sac but is an unfamiliar approach to many surgeons.

• Placement of an iliac strut graft provides no immediate stability if the posterior ligamentous or osseous structures are incompetent.

• Numerous anterior internal fixation devices have been developed, including the Z-plate, Kaneda device, Texas Scottish Rite Hospital, Zielke, modified Kostuick-Harrington instrumentation, and various plate-and-screw devices.
• The disadvantages include increased morbidity of the surgical approach and potential vascular injuries caused by large anterior implants.

• Adequate correction of kyphosis may be impossible with anterior instrumentation alone if the posterior supporting structures are incompetent.

• Large amount of bone graft material is needed to bridge the defect after an anterior decompression; therefore a large amount of iliac crest must be harvested or allograft used from the bone bank.
• Biomechanical studies indicate enhanced bone graft healing with the use of anterior internal fixation devices.

• Advantages include more adequate debridement of the spinal canal, decompression of the neural elements, avoidance of damage to the posterior muscle structures, which are important for dynamic stabilization of the spine, and avoidance of soft tissue irritation, which frequently occurs with posteriorly implanted spinal instrumentation.

• Chance of additional damage to the spinal cord, nerve roots, or thecal sac is avoided during an anterior approach, unlike with the posterior approach, in which iatrogenic manipulation or compression of the dural sac during a reduction maneuver may occur.
The Literature

- This report details the use of the anterior approach for burst fractures of the thoracic and lumbar spine.
- Indication for dural decompression is acute neurological injury arising from significant canal intrusion.
- Anterior surgery has been performed in 80 cases for burst injuries of the thoracic and lumbar spine.
- Fifty-seven of these were paraparetic.
- While there were two cases of nonunion and 11 screw breakages, there were no early or late vascular or neurological complications.
- Average neurological recovery was 1.6 grades on the Frankel scale. All incomplete paraplegics recovered at least one grade.
- All complete paraplegics (four) failed to show any recovery.
The Literature


• Between 1973 and 1981, seventy patients were treated by anterior spinal-canal decompression.

• All patients had an incomplete neurological deficit caused by retropulsed vertebral-body fragments and intervertebral disc material in the spinal canal.

• Forty-eight patients were followed for an average of 3.4 years (range, two to 8.6 years). Either computed tomography or lateral tomography, or both, was performed after surgery on these forty-eight patients, and confirmed the successful removal of the cause of compression in all of them.

• No patient lost further cord or cauda equina function after the anterior decompression. Thirty-seven of the forty-two patients who had a motor deficit improved by at least one class in motor strength.

• The degree of neurological recovery of spinal cord injury after anterior spinal decompression of thoracolumbar fractures appears more favorable than after other, previously reported techniques that do not decompress the spinal canal.
The Literature

- Prospective, randomized study using 40 patients alternately treated by posterior distraction (AO fixateur interne) or anterior decompression and instrumentation (Kostuik-Harrington device).
- Mean follow-up of 20 months.
- Preoperatively, significant canal compromise in 39 patients. This measured 44.5% in those patients undergoing posterior surgery and 58% in those patients undergoing anterior surgery. Postoperatively, this was reduced to 16.5% and 4%, respectively (P less than 0.0001).
- No statistically significant difference in kyphotic deformity.
- Two implant failures of the anterior Kostuik-Harrington construct and two implant failures of the AO fixateur interne.
- Blood loss significantly higher in anterior surgery, but there were no complications from thoracotomy and anterior decompression of the dural sac.
- This study supports the hypothesis that posterior distraction instrumentation can effectively decompress the canal and correct kyphosis in patients sustaining burst-type injuries. Anterior surgery, however, results in more complete and reliable canal decompression.
The Literature


• One hundred eighty five consecutive patients underwent anterior decompression, stabilization, and/or fusion procedures of the thoracolumbar spine.

• At 1 year or more followup, the incidence of complications was analyzed.

• There were no iatrogenic spinal neurologic deficits and no deep wound infections.

• The most common complication was in 13 patients who developed more than 20 degrees kyphosis.

• The use of Kaneda anterior instrumentation provided marked improvement in the prevention of this problem.

• A custom made carbon fiber reinforced cage packed with autogenous cancellous bone graft used in the treatment of ten patients with large corpectomy defects resulted in a good outcome.
Indications for Anterior Approach

INDICATIONS FOR ANTERIOR DECOMPRESSION AND INSTRUMENTATION IN THORACOLUMBAR INJURIES

Absolute
Burst fractures with incomplete neurologic deficits with severe canal compromise and evidence of posterior longitudinal ligament or annular disruption

Relative
Neurologically intact patients with T10 to L3 unstable burst fractures
Patients with incomplete neurologic defects and associated canal compromise presenting early or late at the T10 to L3 levels

Contraindications
L4 and L5 fractures
Burst fracture with greater than 50° of kyphosis or other evidence of severe three-column injury (needs supplemental posterior instrumentation)

Data from McAfee PC, Levine AM, Anderson PA: Surgical management of thoracolumbar fractures. Instr Course Lect 44:47, 1995; with permission.
Posterior Approach

• The indirect approach to decompression of the spinal canal generally involves insertion of posterior instrumentation (Harrington, Edwards, Cotrell-Dubousset, or Texas Scottish Rite Hospital implants).

• These techniques use the distraction instrumentation and the intact posterior longitudinal ligament to reduce the retropulsed bone from the spinal canal (Ligamentotaxis).
The Literature

- Prospective analysis of 80 consecutive patients who underwent stabilization with the fixateur interne.
- Follow-up examination at an average of 35 months (minimum, 24 months). The mean wedge angle of the fractured vertebra was corrected from 17.4 degrees to 7.9 degrees.
- In the kyphosis angle there was a loss of 5 degrees after implant removal within the next year because of the disc space collapsed above the fractured vertebra.
- All 29 cases of translational displacement of 4-36 mm were anatomically reduced.
- No neurologic or vascular complication occurred.
- Posterolateral fusion or transpedicular interbody fusion in the disrupted disc space is recommended.
The Literature


- Compares outcome of patients with thoracolumbar burst fractures who were treated with short segment pedicle screw fixation without fusion.

- Retrospective review of 28 consecutive patients with min 2 yr F/U.

- All patients underwent a clinical and radiological assessment.

- The only significant factor affecting outcome was the influence of a compensation claim (P < 0.05).

- Implant failure rate (14% of patients) and the clinical outcome was similar to that from series where fusion had been performed in addition to pedicle screw fixation.

- Results of this study support the view that posterolateral bone grafting is not necessary when managing patients with thoracolumbar burst fractures by short segment pedicle screw fixation.
The Literature


- Retrospective review of 20 patients with thoracolumbar burst fractures without neurologic deficit examined clinical and radiological outcome.

- Treated by indirect reduction, bisegmental posterior transpedicular instrumentation and monosegmental fusion. Average f/u of 6.4 years.

- Re-kyphosis of the entire segment including the cephaled disc was significant, but did not influence the generally benign clinical outcome.

- Posterior instrumentation of thoracolumbar burst fractures can initially reduce the segmental kyphosis completely.

- Loss of correction within the fractured vertebral body is small. However, disc space collapse leads to eventual complete loss of segmental reduction.

- Posterolateral fusion alone does not prevent disc space collapse. Nevertheless, clinical long-term results are favorable.
## Indications for Anterior Approach

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<th>Indications for Posterior Instrumentation in Thoracolumbar Injuries</th>
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<td><strong>Absolute</strong></td>
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<tr>
<td>Thoracic injury with complete neurologic deficit</td>
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<td>Low lumbar burst fracture with dural lacerations</td>
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<td>Segmental deformity without neurologic deficit at the thoracolumbar junction (early or late)</td>
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<td><strong>Relative</strong></td>
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<td>Neurologically intact patients with unstable fractures</td>
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<td>Incomplete neurologic deficits due to canal compromise within 48 hours of injury</td>
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<td>Low lumbar fractures</td>
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<td>Unstable flexion-distraction injuries</td>
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<td>Pathologic fractures with limited life expectancy (with posterolateral decompression)</td>
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<td><strong>Contraindications</strong></td>
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<tr>
<td>Incomplete neurologic deficits due to canal compromise more than 10 days after injury</td>
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<td>Fractures with minimal axial compression or sagittal plane deformity but with significant canal retropulsion</td>
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<td>Fractures in which the posterior fragment is turned so that the cancellous portion is facing posteriorly into the canal</td>
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Posterolateral Approach

• The posterolateral technique for decompression of the spinal canal is effective at the thoracolumbar junction and in the lumbar spine.

• This procedure involves hemilaminectomy and removal of a pedicle with a high-speed burr to allow posterolateral decompression of the dura along its anterior aspect.

• In the thoracic spine, where less room is available for the cord, this technique involves increased risk to the neural elements.
Non-Operative Approach

- Stable burst fractures and low lumbar burst fractures can often be treated conservatively.
- Neurologically intact, posterior arch remains intact (pedicle widening implies post arch disruption w/ instability), less than 25 to 35 deg of kyphosis and less than 50% anterior body height collapse.
- Mild burst fracture and absence of neurologic injury, non operative treatment is indicated. Consider use of corsette w/ rigid stays, Jewett brace, or hyperextension cast.
The Literature


- The outcomes of traumatic two- and three-column lumbar burst fracture patients treated operatively and nonoperatively were investigated with respect to treatment complications, resumption of employment, and quality of life.

- 22 met the criteria for study (12 operative, 10 nonoperative). Exclusion was based on single-column compression or chance fractures, neurologic compromise, and nontraumatic fractures.

- When comparing the operatively and nonoperatively treated lumbar burst fracture patients in this study group, no significant difference in treatment outcome was established.

- Nonoperative treatment remains a viable alternative to operative intervention in selected lumbar burst fracture patterns.
The Literature

- Prospective clinical trial comparing the results of nonoperative treatment versus short-segment posterior fixation using pedicle screws with 2 yrs F/U.
- 80 patients, neurologically intact patient, single-level closed burst fracture involving T11-L2, no fracture dislocations or pedicle fractures, age 18 to 65.
- Nonoperative group (n = 47) were allowed AAT with a hyperextension brace. Operative group (n = 33) underwent three-level fixation.
- Surgical group had less pain up to 3 months and a better Greenough Low Back Outcome Score up to 6 months, but the outcome was similar afterward. No neurologic deficit in any patient. Nonoperative group, kyphosis angle worsened by 4 degrees, retropulsion decreased from 34% to 15%. Operative group the kyphosis angle was improved by 17 degrees, this was gradually lost. Hospital charges were four times higher in the operative group.
- Short-segment posterior fixation provides partial kyphosis correction and earlier pain relief, but the functional outcome at 2 years is similar.
The Literature


- Retrospective review, 42 patients with burst fractures of L3, L4, and L5. Largest low lumbar (L3-L5) burst fracture study in the literature to date.

- Objective to determine whether conservatively treated patients had satisfactory outcomes compared with surgically treated cohort.

- 42 patients identified from 1980 through 1996. Mean F/U = 45.2 months.

- 20 patients were treated without surgery (18 were neuro intact, and 2 had isolated nerve root injury), 22 with surgery (14 had neuro injury, 8 intact).

- None showed neurologic deterioration. The ability to return to work and achieve a good-to-excellent long-term result was not significantly different.

- Results of nonoperative treatment were comparable with those of operative treatment. The rate of repeat surgery (41%) and absence of a clearly definable long-term functional or radiographic benefit in patients without neurologic compromise may make surgery less appealing.
Conclusion

- Best Approach has not been elucidated and remains controversial.
- Fracture characteristics (mechanism of injury, fracture type, amount of comminution, associated ligamentous injury, and amount of instability), level of injury, presence and degree of neurological deficit, associated injury, and surgeon’s experience all affect the timing of the surgery, operative approach, and surgical instrumentation utilized.
- Confused yet???????