Surgical Treatment of Fractures and Dislocations of the Thoracic and Lumbar Spine

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Spinal Stability

**Mechanical stability**: maintain alignment under physiologic loads without significant onset of pain or deformity

**Neurologic stability**: prevent neural signs or symptoms under anticipated loads
Mechanical Stability

3-column theory (*Denis* ‘83)
- **middle** = posterior ½ VB, posterior disc, post longitudinal lig

2-column theory (*Holdsworth*, ’53)
- anterior = VB, disc, ALL, PLL
- posterior = neural arch, **Post lig complex**
Denis:

**MIDDLE COLUMN** is key to stability
  – No anatomic basis
  – *Stable* burst fracture defies definition

Holdsworth:

**PLC** is key to stability !!!
  – James, et al ‘94
  – Posterior lig complex more important to
    in vitro resistance versus kyphosis
How Can We Detect Instability?

**Dynamic**: deformity worsens under physiologic loads

- acute kyphosis with standing
- progressive kyphosis over time

**Static**: Inferred from x-rays

- Plain films- widened spinous processes, biplanar deformity
- CT - facet complex disruption
- MRI- disrupted PLC
Deformity (Kyphosis)

Initial radiographs in supine alignment can appear acceptable without load. Upright loading can increase deformity. If unstable, deformity will progress or neurological signs will occur.
Instability
(“textbook” definition)

Relies on ‘accepted’ standards
>50 % loss of height implies PLC injury
>30 ° Cobb kyphosis implies PLC injury

Direct MRI visualization of a disrupted PLC

However, little clinical data to support these values.
Neurologic Stability

Defined by the neurological findings at time of presentation ... and

Reflects the \textit{(remaining)} intrinsic ability of the spinal column to protect the neural elements from (further) damage under anticipated loads

Related to mechanical stability

Crucial for intact and incomplete SCI
Goals of Surgical Treatment

- To “stabilize” the **unstable** spine
- To restore/improve sagittal balance
- To decompress a progressive neural deficit
- To protect intact or incompletely injured neural elements
How Do We Achieve These Goals?

- Decompression
- Fixation for acute correction and stability
- Fusion with bone graft for long-term maintenance of reduction/stability
Canal Decompression

Complete SCI

- Complete SCI (after spinal shock resolves): regardless of treatment method, shows little functional improvement

Intact neurological status

- Intact neuro status: regardless of x-ray appearance, neuro status can’t get better !!!
Canal Decompression

Indicated for incomplete neurological deficits with canal compromise.

Does surgical decompression improve neurological recovery?

*Current literature lacks stats to support*
Decision to Decompress

Location of SCI

– Little **functional** benefit seen with 1 or 2 level improvement in upper thoracic (>T9) cord injuries
– Conus (T10-L1) lesions are critical: bowel/bladder
– Low lumbar--roots more accommodating to canal compromise, and more apt to recover

Completeness of SCI
 Methods of Decompression

Anterior Decompression = “Gold Standard”

- Most common in thoracic and thoracolumbar regions
- Direct visualization of cord with removal of fractured body
- Readily combined with reconstruction and fusion
- Treatment of choice for burst fractures with incomplete SCI
  - In presence of posterior ligamentous injuries may require A/P surgery
Methods of Decompression

• Laminectomy alone is **Contraindicated !!!**
  – Further destabilizes an **unstable** spine, may lead to post-traumatic kyphosis
  – Provides access to allow visualization and repair of dural tears.
  – Be aware of the clinical triad of neurological injury and concomitant lamina fracture with burst pattern *(Cammisa, 1989)*---**trapped roots!!**
Methods of Decompression

Posterolateral decompression
  – Transpedicular or costo-transversectomy
    – Useful when anterior approach not a viable option
    – Useful in lumbar spine w/dural mobilization

• Indirect Reduction (ligamentotaxis)
  – Canal cleared by spinal realignment
  – Relies primarily on posterior annulus reducing retro-pulsed fragment
  – Optimal time: within 72 hrs.
Timing of Decompression?

**Early**
1. Most animal SCI studies support early decompression
2. Intuitively, remove pressure early for improved recovery

**Delayed**
1. Clinically, early intervention has less support, it’s less convenient.
2. Fear of complications related to early surgery
Indication for Early/Emergent Decompression

Progressive neurological deficit associated with canal compromise from retro-pulsed fragments or spinal malalignment (fracture-dislocations).
Timing of Surgical Stabilization

Benefits of early surgery:
– facilitates aggressive pulmonary toilet
– decreases risk of DVT/PE with mobilization
– prevents likelihood of decubitus ulcers
  – facilitates earlier rehab

Surgery should be delayed until:
– Hemodynamically/medically stabilized
– An experienced surgeon/ team is available
Specific Thoraco-lumbar Injuries

Compression fractures
Burst fractures
Flexion-distraction/Chance injury
Fracture-dislocations
Gunshot wounds to the spine
Compression Fractures

Anterior column injury
Does not extend into posterior vertebral wall on CT
With increasing severity, the likelihood of posterior lig complex injury increases.
If PLC is disrupted -- **UNSTABLE**
(not a compression fracture)
Compression Fractures

Compression fractures rarely require surgery. Surgery is indicated if PLC disrupted. The relative indications for surgery include:

- Single level lumbar VB height loss >50%.
- Single level thoracic VB height loss >30%.
- Combined multi-level height loss >50%.
- Relative segmental or combined kyphosis >30°.
Compression Fractures

Non-operative treatment
  – TLSO or Jewitt extension bracing
  – Frequent radiographic follow-up
    – Deformities can progress

**Advantages**: avoid surgical complications and muscle injury 2\(^0\) to surgery

**Disadvantages**: post-traumatic kyphosis
Compression Fractures
Outcomes and Complications

Most common sequelae is BACK PAIN
– does not correlate with severity of deformity (Young, 1993, Hazel, 1988)
– Lumbar worse than thoracic (Day, 1977)
Specific Thoracolumbar Injuries

Compression fractures
Burst fractures
Flexion-distraction/Chance injury
Fracture-dislocations
Gunshot wounds to the spine
Burst Fractures

**Definition:** fracture extends into posterior vertebral wall

May be stable or unstable
Unstable Burst Fractures

Related to PLC integrity

>30 ° relative kyphosis
Loss of vertebral body height > 50%
Biplanar deformity on AP x-ray
MRI finding of disrupted PLC
Stable Burst Fractures

Criteria (burst with intact PLC)
- <20-30 ° kyphosis (controversial)
- <50% lumbar canal compromise
- <30% thoracic canal compromise

TLSO/Jewitt brace for comfort
Stable Burst Fractures

Radiographic follow-up to follow potential deformity progression
Repeat CT to monitor canal resorption
Same treatment principles as compression fracture
Surgical Approaches

**Posterior Approach**
- Fractures at T6 or above
- Posterior ligament complex injury
- Multi-level injury
- Associated chest trauma

**Anterior Approach**
- Ideal for T6 and lower
- Decompression via corpectomy
- Reconstruction with strut graft and anterior instrumentation
- May combine with post stabilization
Nerve and Cord Decompression

Anterior corpectomy to visualize neural elements.

- Safest and most predictable form of decompression

Alternative within 48-72 hours: *indirect decompression*

- Lordosis and distraction
- Relies on annulus to reduce retro-pulsed fragment through ligamentotaxis.
Burst Fractures
Outcomes and Complications

Anterior Approach
– Ileus (GI) after anterior approach
– Retrograde ejaculation
– Risk of large vessel damage

Improved chances of bladder recovery with anterior decompression *(SRS,’92)*

Without decompression: fragment resorption decreases canal compromise by 30%

*Non-operative results are similar to results of operative treatment.*
Specific Thoracolumbar Injuries

Compression fractures
Burst fractures
Flexion-distraction/Chance injury
Fracture-dislocations
Gunshot wounds to the spine
Chance (Flexion-Distraction) Injury

“Seatbelt” injury
Trans-abdominal ecchymosis
Common in children (seatbelt higher up)
0-30% neurologic injury
Most common associated non-spinal injury: perforated viscus (pressure)
Chance Injury

Injury involves 3-columns
Usually little comminution
Center of rotation: ALL
PLC disrupted or posterior neural arch fractured transversely
“Chance” Fracture Variants

- Purely bone
  - Best healing

- Part bony/part ligamentous
  - Some healing

- Purely ligamentous/trans-discal
  - No healing
Flexion-Distraction Injuries

Boney Chance: stable in extension
(TLSO) brace
– the fracture will heal
Ligamentous injuries do not heal, require stabilization and fusion
– need to restore the disrupted posterior tension band
Surgical Approach

Posterior approach
Relies on intact ALL
If burst component present, optimal treatment with pedicle screws (maintain anterior column length, don’t over compress as that may increase retro-pulsion)
Chance Fractures
Outcomes and Complications

10-20% residual pain
65% functional recovery
35% diminished function
Specific Thoracolumbar Injuries

- Compression fractures
- Burst fractures
- Flexion-distraction/Chance injury
- Fracture-dislocations
- Gunshot wounds to the spine
Fracture-Dislocations

High-energy injuries
Highest rate of SCI of all spinal fractures
Thoracic--worst prognosis
Rare non-operative management
Unstable with multi-planar deformity---little residual stability
Decompression

Spinal realignment often decompresses the cord.
- prone positioning on OR table
  - “O.R.I.F.”
- “locked” facets requires open reduction by resection of articular processes.
Fracture-Dislocations

Posterior constructs provide stability after re-alignment
– little chance for neuro recovery

Rarely require anterior decompression/reconstruction
Fracture-dislocations
Outcome and Complications

Severity of SCI -- main predictor of outcome
Specific Thoracolumbar Injuries

- Compression fractures
- Burst fractures
- Flexion-distraction/Chance injury
- Fracture-dislocations
- Gunshot wounds to the spine
Gunshot Wounds

Non-operative treatment the standard
Steroids not useful (Heary, 1997)
10-14 days IV antibiotics for colonic perforations (colon before spine) ONLY
No role for debridement
Treatment

Decompression rarely of benefit except for INTRA-CANAL BULLET AT THE T12 TO L5 LEVELS (better motor recovery than non-operative)

Fractures usually stable, despite “3-column” injury
GSW to the Spine
Outcome and Complications

Most dependent on SCI and associated injuries

High incidence of CSF leaks with unnecessary decompression

Lead toxicity rare, even with bullet in canal

Bullet migration rare: late neurological sequelae
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