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

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Spinal Stability

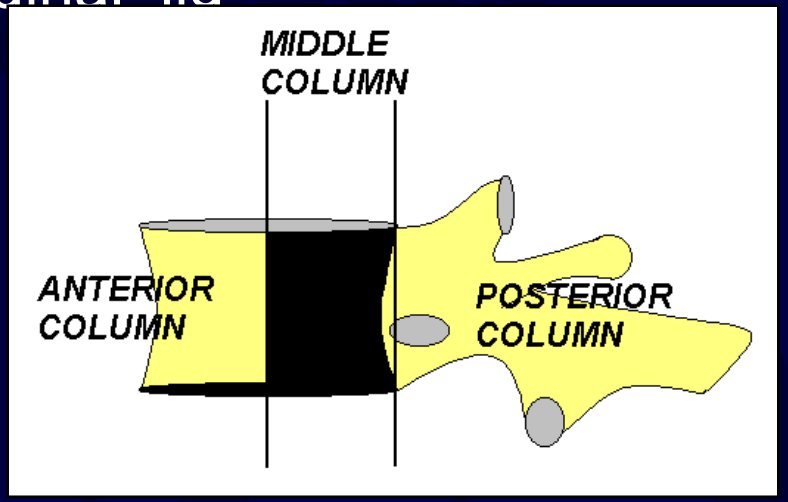
Mechanical stability: maintain alignment under physiologic loads without significant onset of pain or deformity

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 radiograph
supine
Alignment can
acceptable with
Upright loading ca
deformit
If unstable, deformity w
neurological sign

Instability
("textbook" definition)

Relies on 'accepted' standards

>50 % loss of height implies PLC injury

>30 º 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 (*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

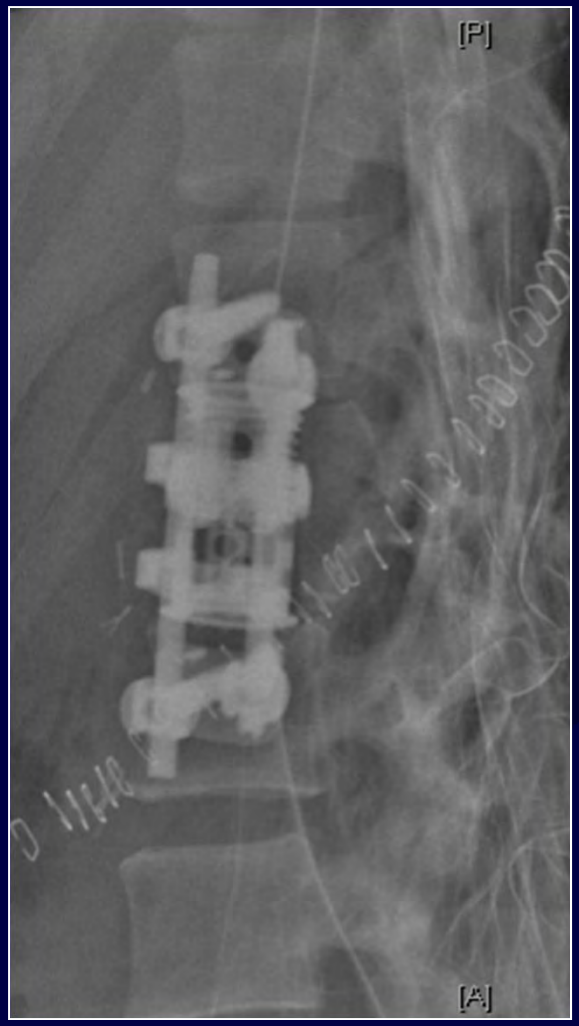
– Conus (T10-L1) lesions are critical: bowel/bladder

– 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	*Delayed*
1. Most animal SCI studies support early decompression	1. Clinically, early intervention has less support, its less convenient.
2. Intuitively, remove pressure early for improved recovery	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 mal-alignment (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

Relative indications for surgery

– 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 º

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 º relative kyphosis

Loss of vertebral body height > 50%

Biplanar deformity on AP x-ray

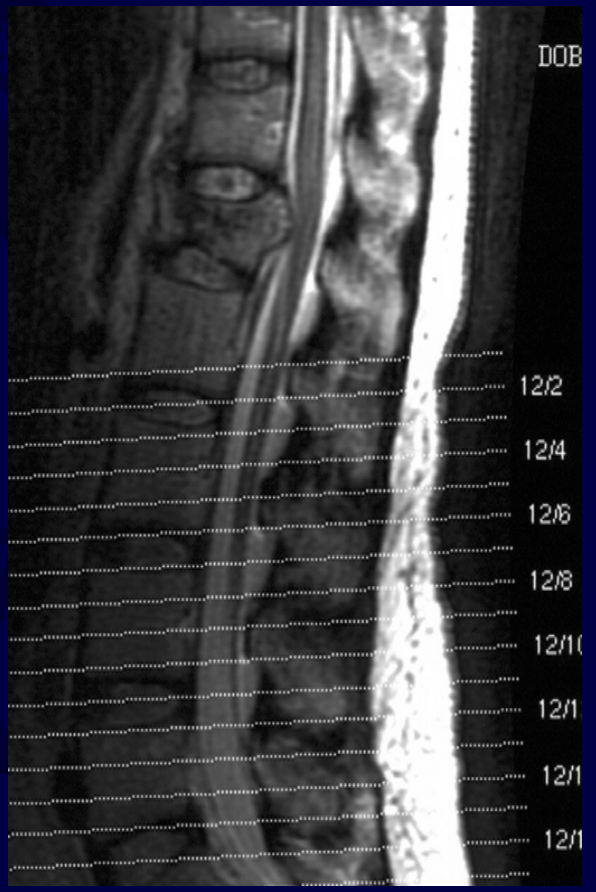
MRI finding of disrupted PLC

Stable Burst Fractures

Criteria (burst with intact PLC)

- <20-30 º kyphosis(controversial)
- <50% lumbar canal compromise
- <30% thoracic canal compromise

TLSO/Jewitt brace for comfort



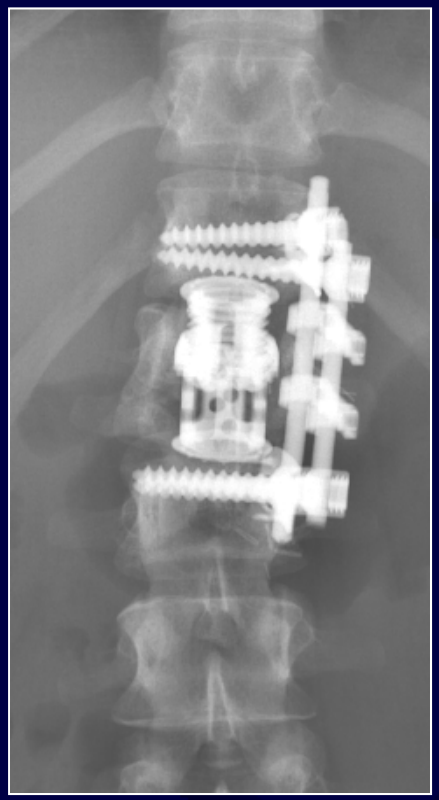
Stable Burst Fractures

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

Thank you

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Return to Spine Index

Return to index