Classification of Fractures and Dislocations of the Thoracic and Lumbar Spine

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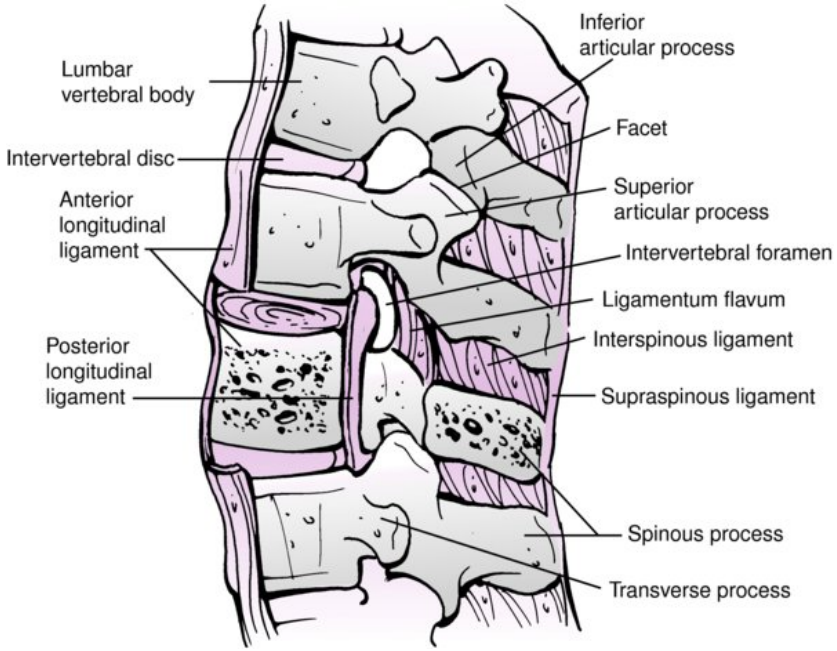
Objectives

- Understand the anatomy and its impact on pathology
- Learn the patterns of neurologic injury
- Understand the widely used classification systems
- Learn how to determine operative versus non operative management

Introduction

- Males > females
  - 30% males in 30s
- High energy injury
- MVA >> Fall
- Spinal column injury, 10-25% neurologic deficit
- Thoracolumbar spine most common site of spinal injuries

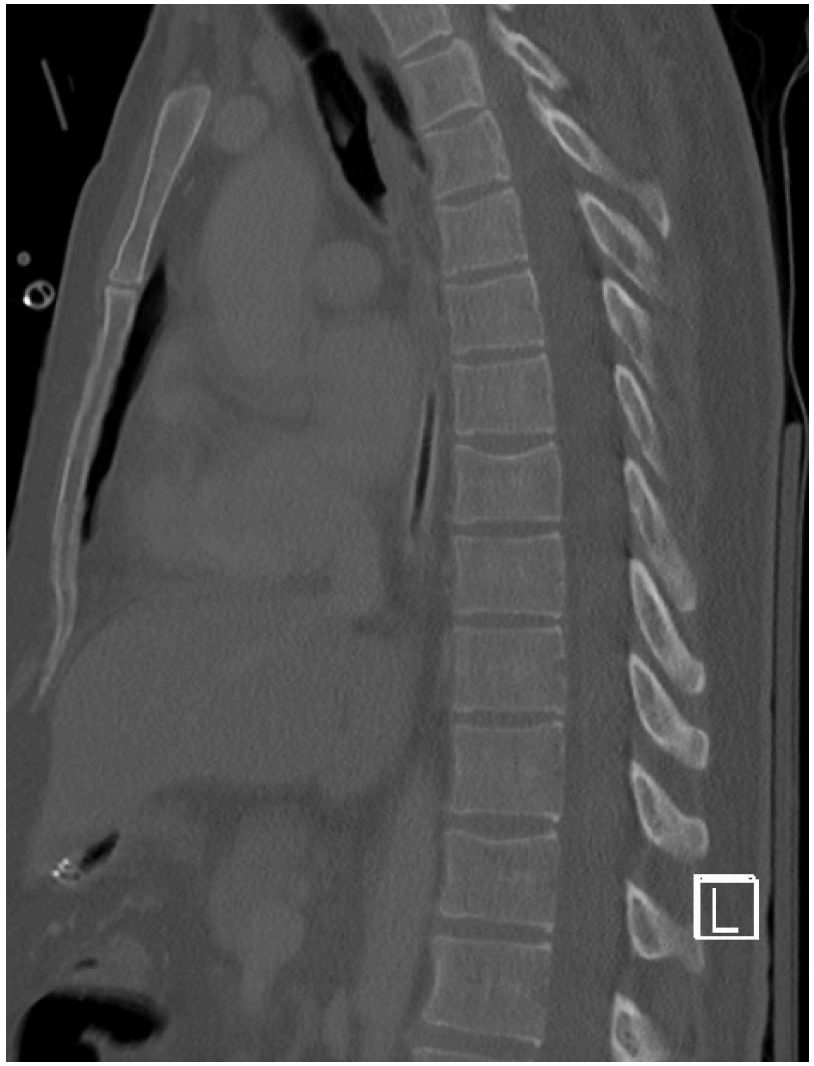


Introduction

- Frequency (Gertzbein 1994)
  - T11-L1(52%) > L1-5(32%) > T1-10(16%)
- Up to 50% have associated injuries
  - Intra-abdominal (liver, spleen)
  - Pulmonary injury- up to 20%
  - Up to 15% noncontiguous fractures

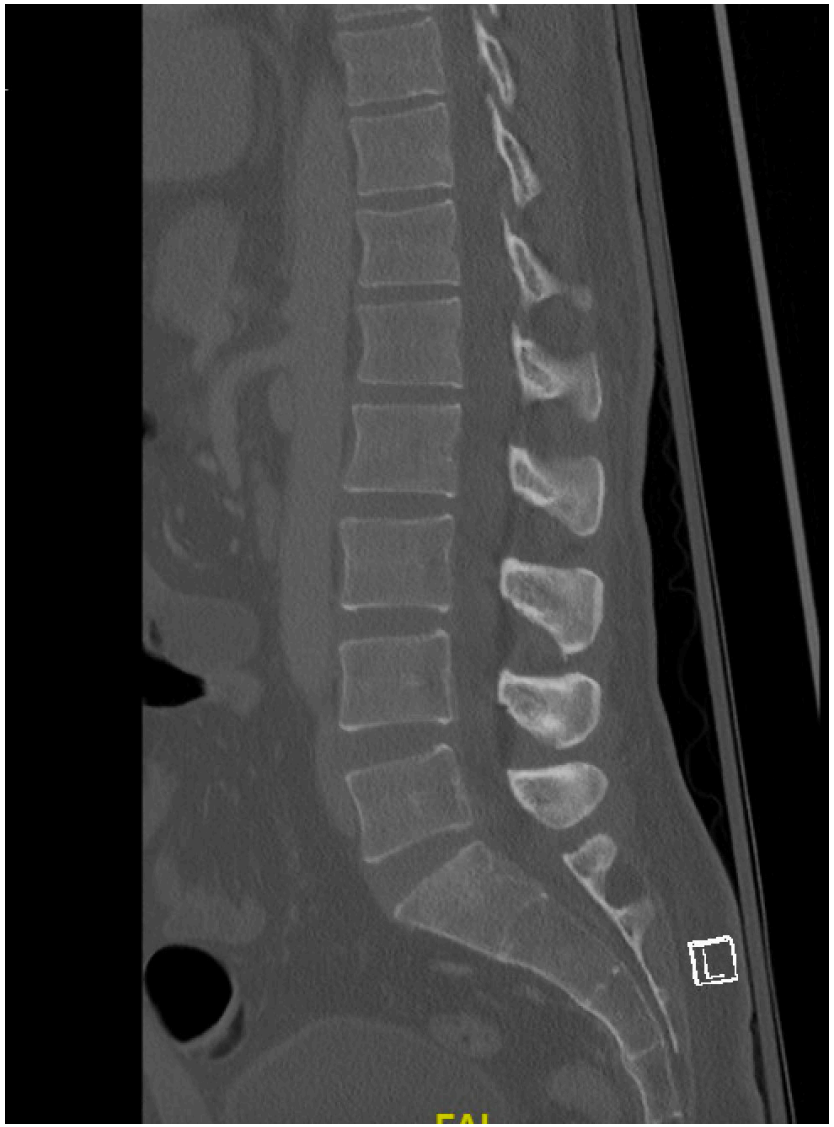
Clinical Anatomy

- Thoracic spine
  - Kyphotic
  - Facets in coronal plane
  - Stabilized by ribs
    - 2X Flexion stiffness
    - 3X lateral bending stiffness
    - Prevent rotation
  - ↓ canal:cord ratio (T2 to T10)
    - More susceptible to SCI



Clinical Anatomy

- Lumbar spine
  - Lordotic
  - Oblique/sagittal facet orientation
    - Prevent rotation
  - Wider canal
  - Cauda equina



Clinical Anatomy

- Thoracolumbar
  - Area of transition
    - Decreased stiffness (below rib cage)
    - Facet orientation (coronal → sagittal)
      - More vertical
      - Coronal to 45º inward
    - T11-12 “weak link”
      - Predisposed to rotational injuries
      - Absence of rib support with transitional facets

Neuroanatomy

- Spinal Cord: C1-L1
- Conus medullaris: L1-2
- Cauda equina: L2-S5

Patterns of Neurologic Injury

- Spinal cord injury
  - Complete versus incomplete
  - Conus medullaris syndrome
- Root injury
  - Isolated root dysfunction
  - Cauda equina syndrome

ASIA Classification

- A = Complete
  - No motor or sensory function is preserved in the sacral segments S4-S5
- B = Incomplete
  - Sensory but no motor function is preserved below the neurological level and includes the sacral segments S4-S5
- C = Incomplete
  - Motor function is preserved below the neurological level, and more than half of the key muscles below the neurological level have a muscle grade less than 3
- D = Incomplete
  - Motor function is preserved below the neurological level, and at least half of the key muscles below the neurological level have a muscle grade of 3 or more
- E = normal
  - Motor and sensory function are normal

Conus Medullaris Syndrome

- Thoracolumbar cord injury
- Presents with low back pain, lower extremity weakness, saddle anesthesia, bowel/bladder dysfunction
- Injury to sacral myelomeres
- Can involve both upper and lower motor neurons (+/- root escape)
  - Isolated: pure bowel, bladder & sexual dysfunction
  - Combined root/cord injury: lumbar traversing roots

Conus Medullaris Syndrome

- Exam
  - Absent bulbocavernosus reflex
  - Bowel/bladder/sexual dysfunction more frequent than lower extremity weakness
- Treatment: urgent decompression
- Prognosis
  - ? Improved with early decompression
  - Better for root recovery (L1-4) than cord recovery (L5-S)

Cauda Equina Syndrome

- Injury below L1/2 level
- Bowel and bladder dysfunction
  - Urinary retention ➔ overflow incontinence
  - Fecal incontinence
- Bilateral motor/sensory deficits
- Diminished perianal sensation and rectal tone

Cauda Equina Syndrome

- Natural history: progressive weakness of lower extremities, loss of bladder/bowel function
- Prognosis: presence of saddle anesthesia/bladder symptoms associated with worse outcomes
- Treatment: Urgent decompression for best prognosis
  - Treatment after 48 hours associated with worse outcomes

Thoracolumbar Trauma Classification

Mechanisms of Injury

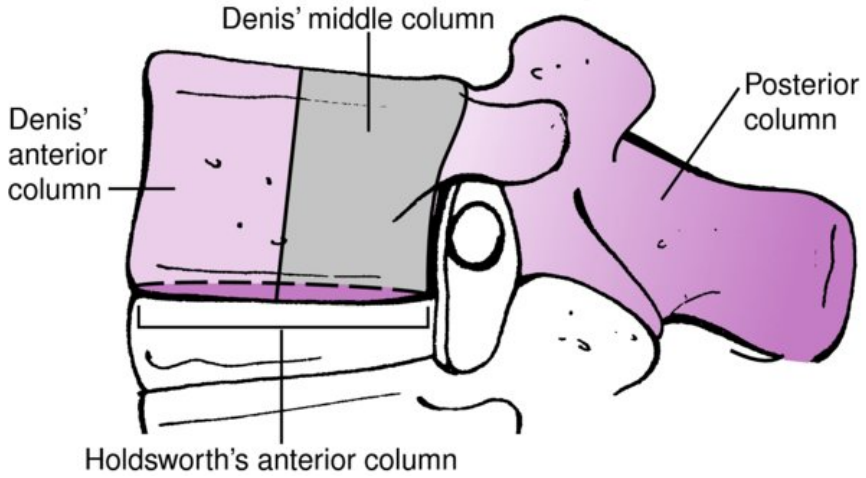
- Axial compression
- Flexion
- Lateral compression
- Flexion-Rotation
- Flexion-Distraction
- Shear
- Extension

Thoracolumbar Trauma Classification

- Decision to operate often challenging
- >10 classification schemes described
- A useful classification system should:
  - Be easy to remember, use, and communicate
  - Predict patient outcome
  - Drive treatment
  - Have high inter- and intra-oberver reliability

Denis Classification

- 1983: retrospective review of 412 thoracolumbar fractures
- 3 columns
  - Anterior: anterior body, disc, ALL
  - Middle: posterior body, disc, PLL
  - Posterior: interspinous ligament, supraspinous ligament, posterior elements
- Middle column “crucial”

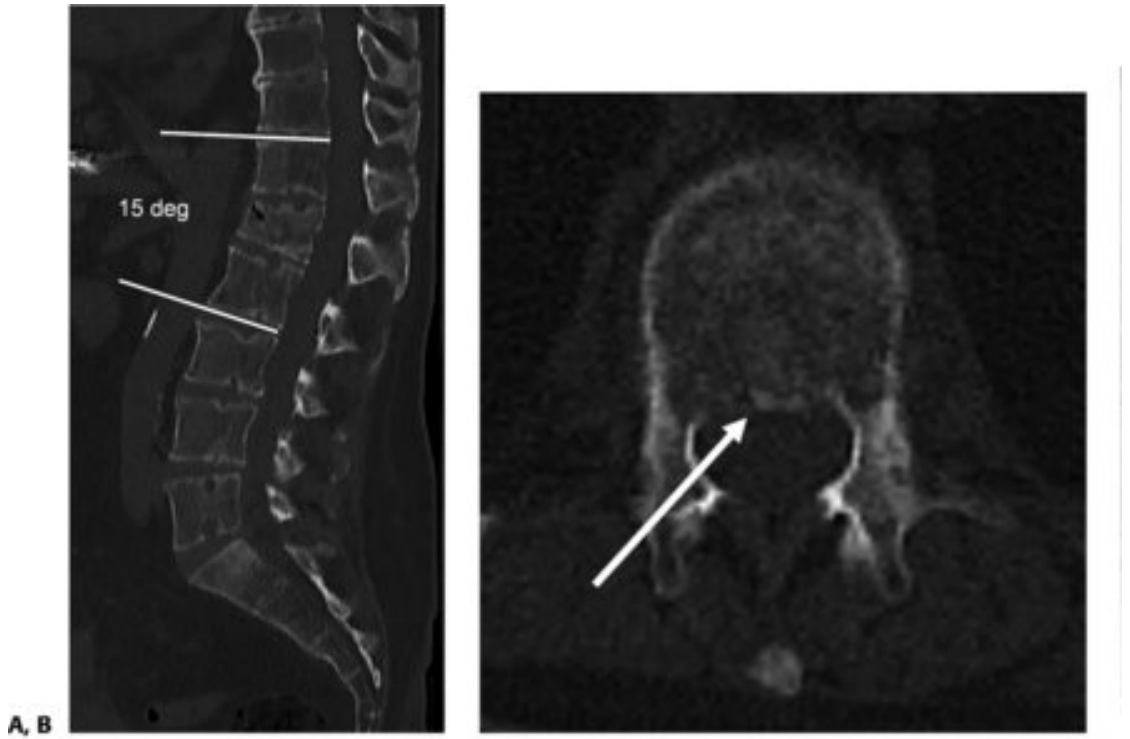


Compression Fracture

- Failure of anterior column only
- Anterior (or lateral)
- Flexion (or lateral bending/compression)
- Typically stable
- Brace when near thoracolumbar junction

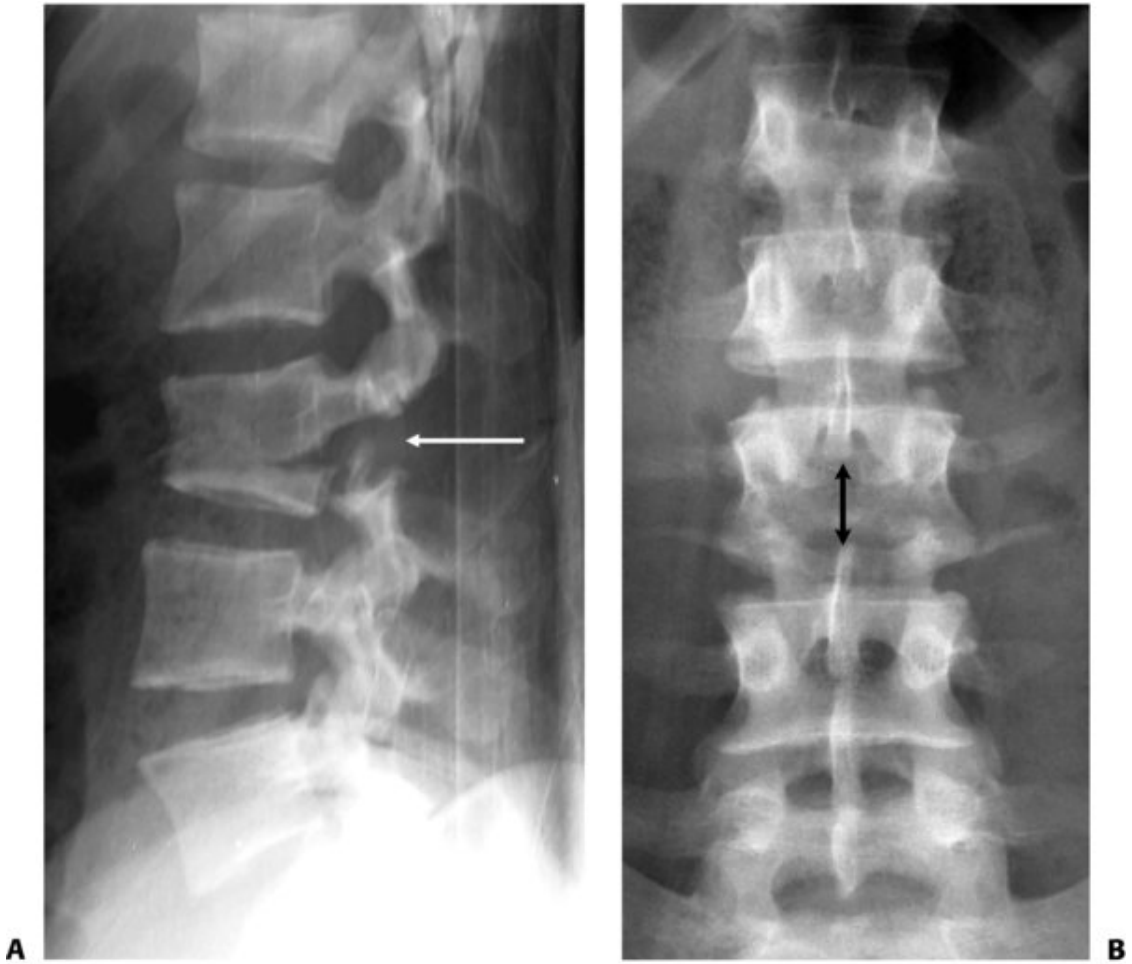
Burst Fracture

- Involves middle column
- Axial load +/- rotation, etc
- Associated lamina fracture ➔ 70% dural tear
- Stable (low lumbar) vs. unstable (thoracic, thoracolumbar, upper lumbar)



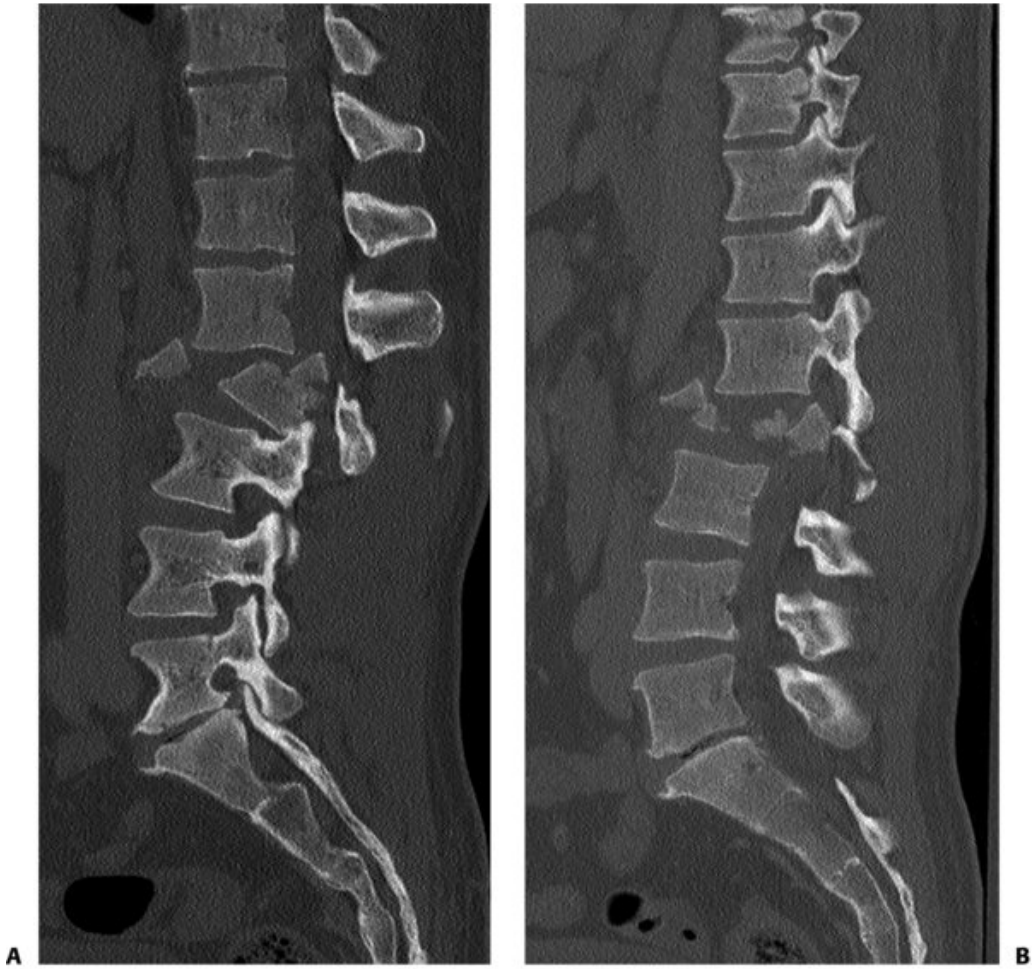
Flexion-Distraction

- Seat belt injuries
- Chance fracture (bony, ligamentous, both)
- Distraction of posterior and middle columns
- 0-10% neuro involvement
- Often requires surgery

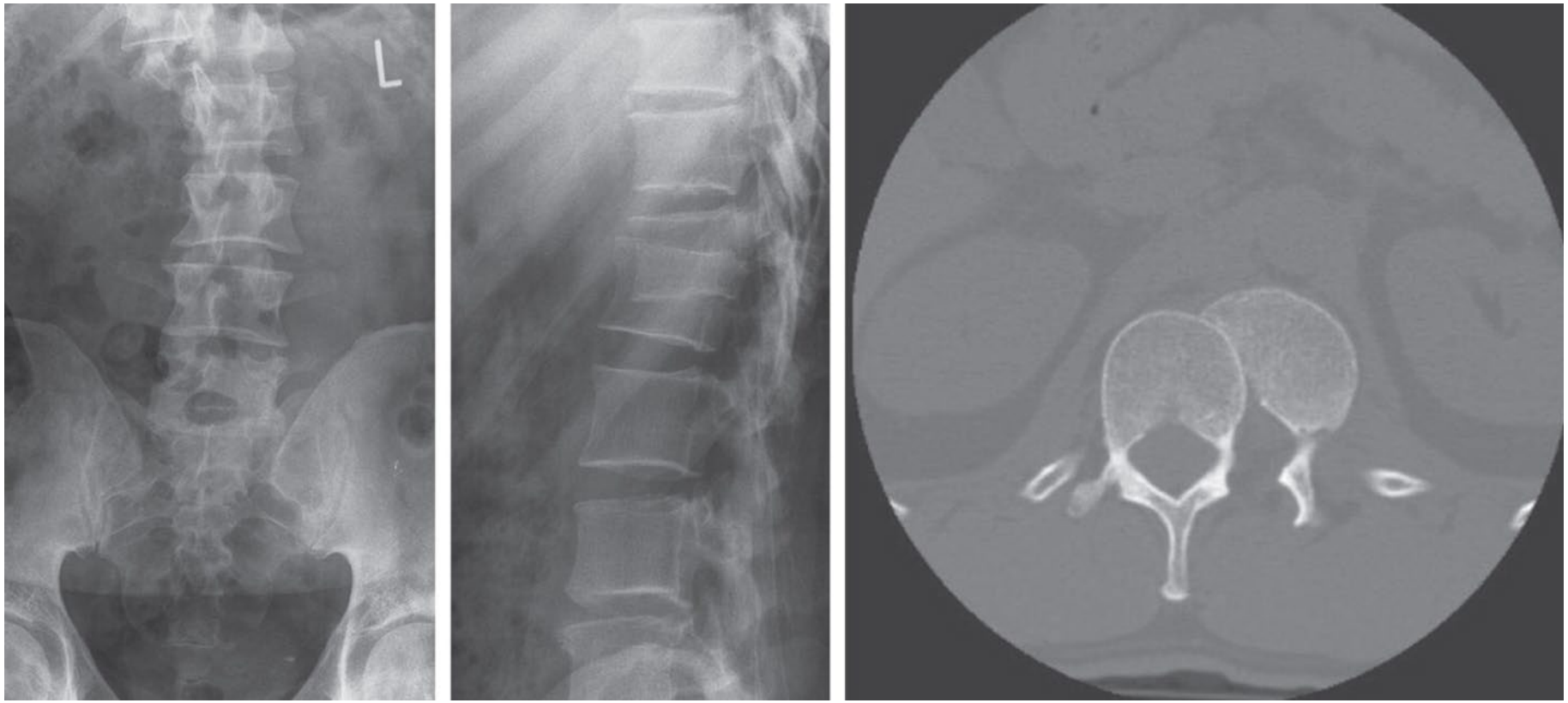


Fracture Dislocation

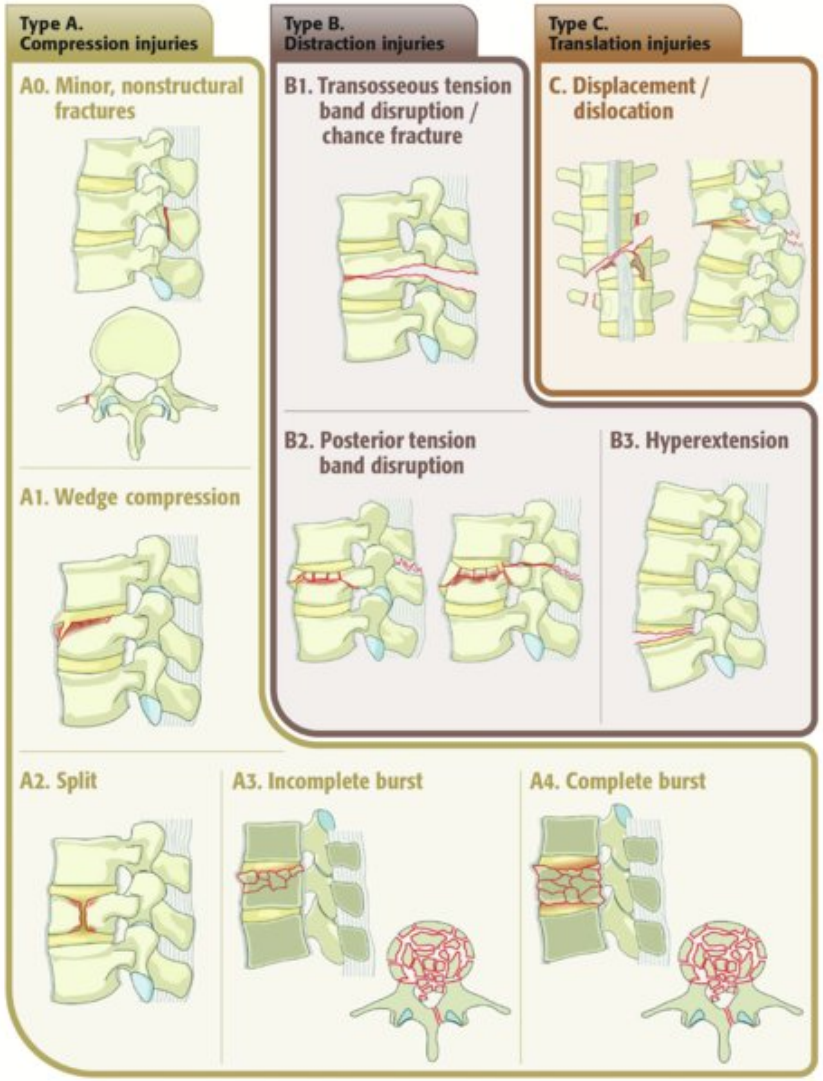
- Injury to all three columns
- Combination of high energy forces (shear)
- High likelihood of neuro deficit
- Always requires surgery



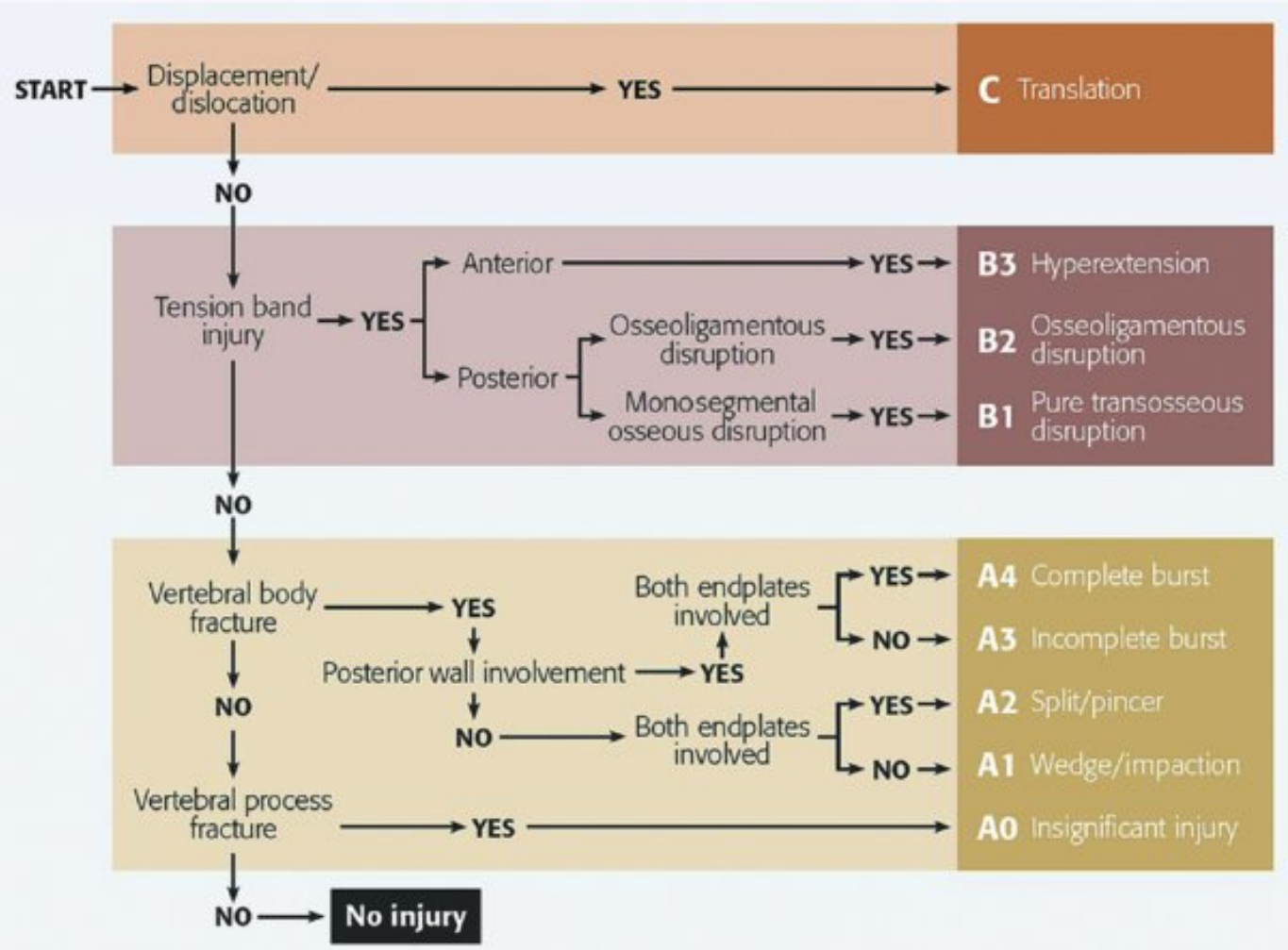
Denis Classification: Fracture Dislocation



AO Classification



AO Classification



Thoracolumbar Injury Classification and Severity Score (TLICS)

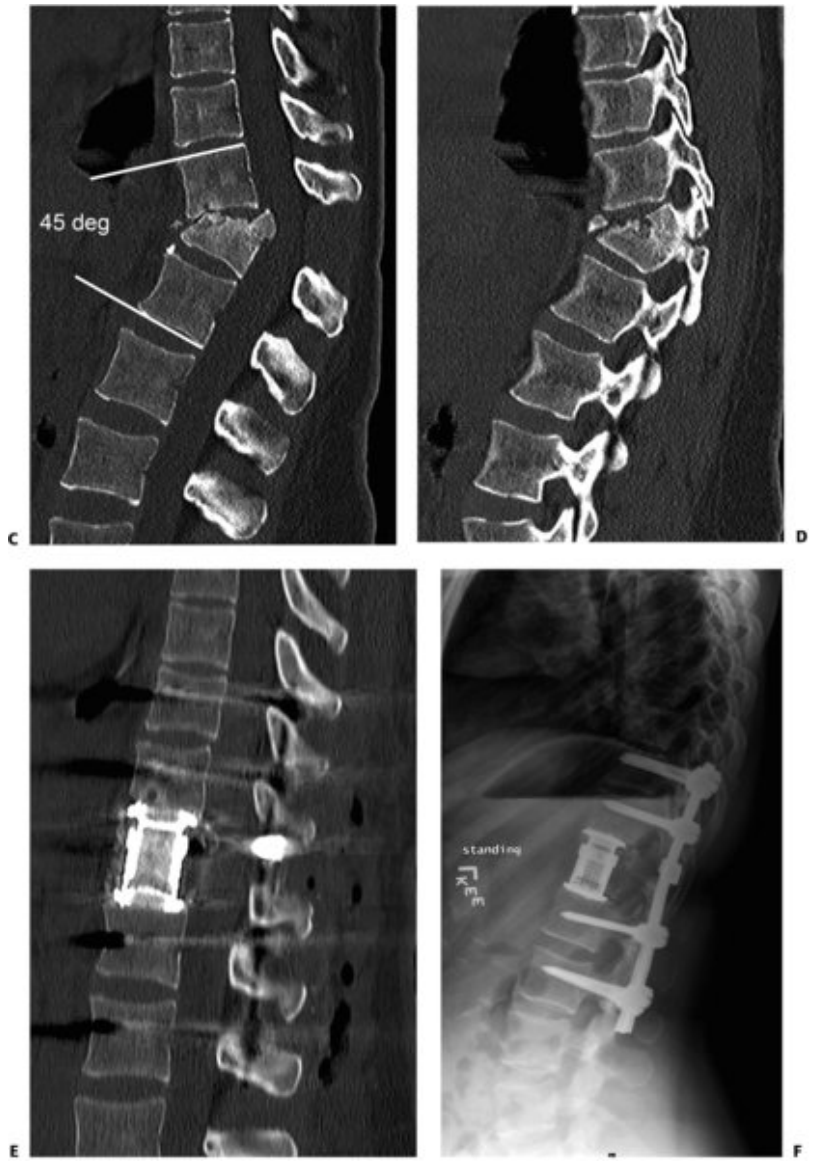
- Developed to drive surgical versus nonoperative management of thoracolumbar fractures (Vaccaro et al 2005)
- Score based on 3 factors
  - Injury morphology/mechanism
  - Posterior ligamentous integrity
  - Neurologic injury

TLICS: Injury Morphology

- Compression = 1 point
  - Burst = +1 point
- Translation/rotational = 3 points
- Distraction = 4 points

TLICS: PLC Integrity

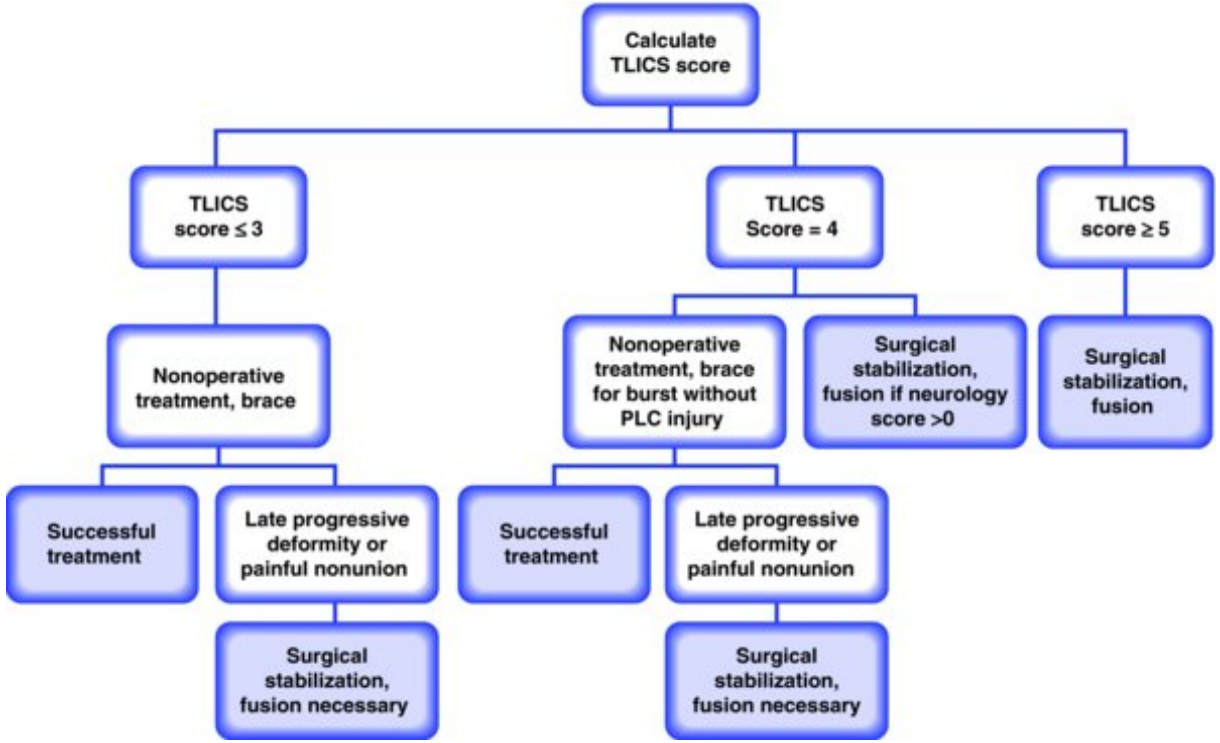
- PLC disrupted in tension, rotation, or translation
  - Intact = 0 points
  - Suspected/indeterminate = 2 points
  - Injured = 3 points



TLICS: Neurologic Status

- Involvement
  - Intact = 0 points
  - Nerve root = 2 points
  - Cord, conus medullaris
    - Complete = 2 points
    - Incomplete = 3 points
  - Cauda Equina = 3 points

TLICS Score



- *Relatively simple, shown to predict treatment, high IRR*

Stable vs. Unstable Injuries

- White and Panjabi (*Spine 1978*)

  "the loss of the ability of the spine under physiologic conditions to maintain relationships between vertebrae in such a way that there is neither damage nor subsequent irritation to the spinal cord or nerve root and, in addition, there is no development of incapacitating deformity or pain from structural changes"

Stable vs. Unstable Injuries

- Stable (Burst fracture)
  - < 25-30º kyphosis
  - < 50% loss of height
  - < 30–50% canal compromise
  - Neuro intact
- Unstable
  - Neurologic deficit
  - > 25-30º kyphosis
  - > 50% loss of height
  - >50-60% canal compromise

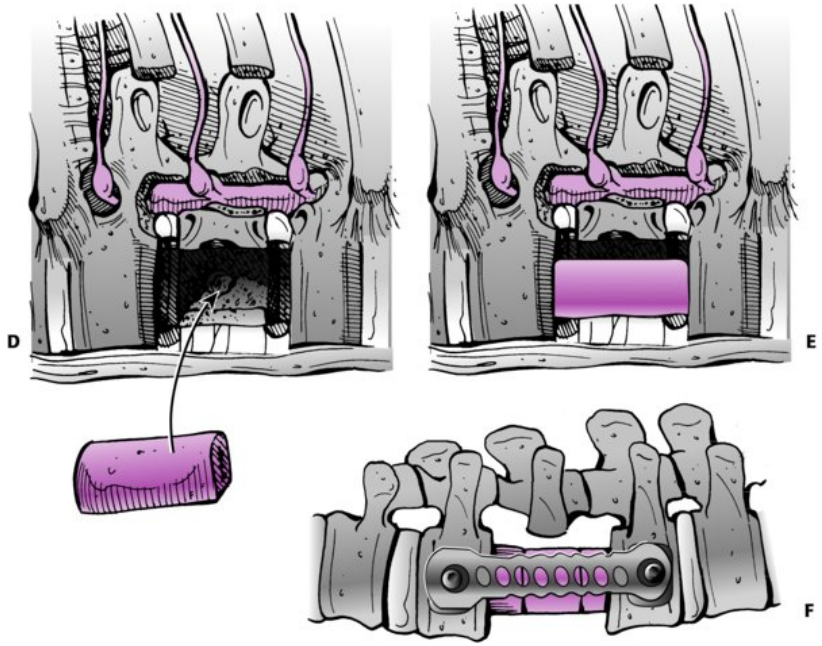
*No study to date has shown direct correlation between percentage of canal compromise and severity of neurologic injury following burst fracture

Surgical Decision Making

- Goals
  - Maximize function
  - Facilitate nursing care
  - Prevent deformity/instability
  - Potentially improve neurologic function
- Indications
  - ? Instability
  - Neurologic compression
  - Posterior osteoligamentous disruption

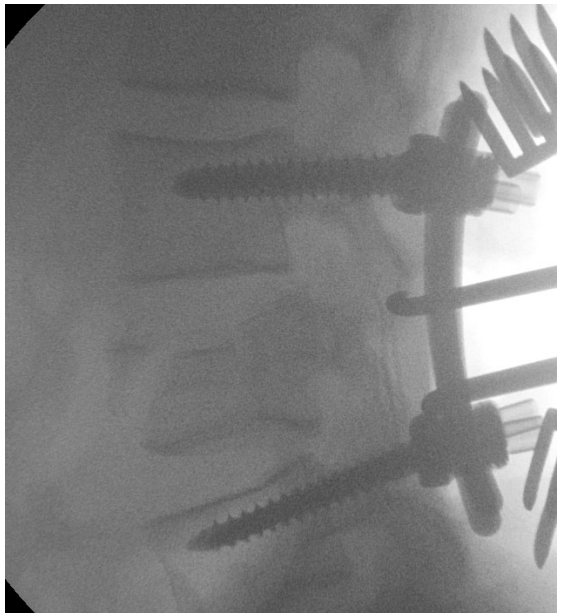
Surgical Approaches

- Anterior
  - Transthoracic (T4- 9)
  - Thoracoabdominal (T10- L1)
  - Retroperitoneal (T12- L5)
- Posterior
  - Indirect reduction possible: ligamentotaxis
- Posterolateral
  - Transpedicular, costotraversectomy, etc
- Lateral
  - XLIF, DLIF



Surgery

- Indicated in Unstable injuries
- Anterior surgery for anterior compression at TL junction
- Posterior surgery in lower Lumbar spine

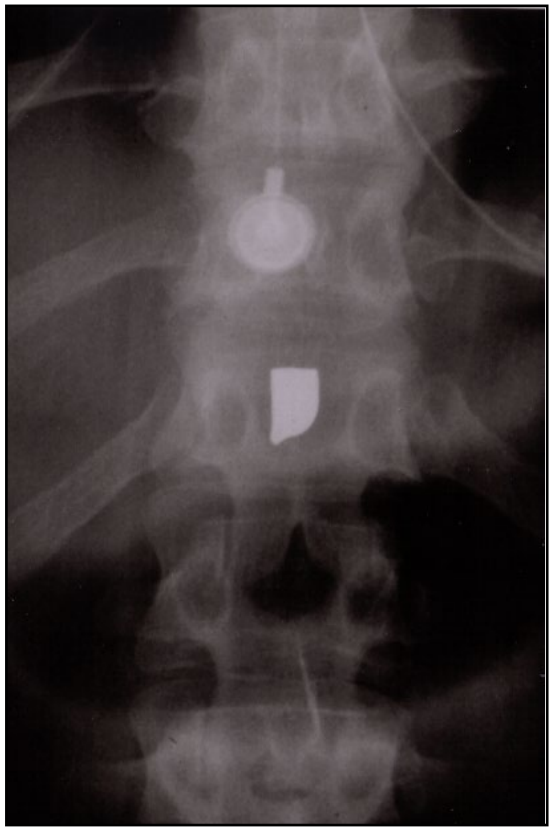


Gunshot Wounds

- Non-operative treatment standard
- Steroids not useful *(Heary, 1997)*
- 10-14 days IV antibiotics for colonic perforations *ONLY*
- Evidence for debridement and extraction of bullet fragments is controversial, however patients with incomplete injuries may improve (Scott 2019)

Treatment

- Decompression rarely of benefit except for intra-canal bullet from T12-L5
  - Better motor recovery than nonoperative
- 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

Summary

- There are several patterns of neurologic injury for thoracolumbar trauma
- There are multiple classification schemes
- Most thoracolumbar injuries, in the absence of neurologic deficit, are stable and can be treated successfully nonoperatively
- Surgical intervention may be beneficial in improving patient mobilization and early functional return for unstable spine fractures
- Indications for surgical intervention, timing of intervention, and approach remain controversial

Conclusions

- The goals of managing thoracolumbar injuries are to maximize neurologic recovery and to stabilize the spine for early rehab and return to a productive lifestyle

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