Lumbar Spine Trauma

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Agenda

- Anatomy and Biomechanics of Lumbar Spine
- Three-Column Concept
- Classification of Fractures
- Our Patient
- Imaging Modalities
- Role of Radiologist in Spinal Trauma
Anatomy and Biomechanics of the Lumbar Spine

- Each vertebra articulates with adjacent vertebrae at three points
  - intervertebral disk
  - paired facet joints posteriorly
- Muscles attach to the lumbar vertebrae -> strength and stability
- more mobility than thoracic spine due to sagittal orientation of facet joints and absence of ribs
Lumbar Ligaments

From Netter’s Atlas of Human Anatomy
The Thoracolumbar Junction

• Transition from thoracic spine to the upper lumbar spine

• Specially vulnerable to injury
  – Alignment changes from kyphotic curvature to a lordotic alignment
  – Lumbar spine segments are more mobile:
    • No ribs to provide additional stability
    • Changing orientation of facet joints-> Facets assume an oblique orientation in upper lumbar spine and eventually a sagittal orientation at the lumbosacral junction

• Fractures result in a high incidence of neurologic deficit
Denis’ THREE-COLUMN CONCEPT (1983)

- Determines fracture severity and predicts stability
- Fractures involving only the anterior columns are considered stable, while fractures that additionally involve the middle or all three columns are considered unstable.

http://www.hawaii.edu/medicine/pediatrics/pemxray/v6c13.html
Major Lumbar Spine Fractures

- Denis 4 Basic Types
  - Compression Fracture
  - Burst Fracture
  - Seat Belt Injury
  - Fracture-Dislocation

- McAfee’s (based on CT appearance)
  - Wedge Compression Fracture
  - Stable Burst Fracture
  - Unstable Burst Fracture
  - Seat Belt-type Injury
  - Flexion Distraction Injury
  - Translation Injuries
McAfee Classification of Major Fractures

- Compression Fracture
- Burst Fracture
- Chance Fracture
- Flexion Distraction
- Translational Injury

www.hawaii.edu/medicine/pediatrics/pemxray/v6c13.html
Compression Fractures

- Most common - 58% of major spine fractures
- Represent isolated failure in compression of the anterior column with the middle column remaining intact
- True compression fracture shouldn’t produce any neurologic defect
- STABLE

From www.hawaii.edu/medicine/pediatrics/pemxray/v6c13.html
Burst Fractures

- 17% of major spinal fractures
- Like compression fractures, they occur during hyperflexion and axial loading of a vertebra (e.g. MVA, fall from height)
- BURST= spreads out in all directions
- Compressed disk adjacent to the affected vertebra herniates into the vertebral body
- Failure of ANTERIOR and MIDDLE columns defines these as UNSTABLE
Burst Fractures (cont.)

Associated fractures of posterior elements common
Bony fragments may be retropulsed into canal (25% of cases) → Potential for severe neurologic sequelae

http://www.accessexcellence.org/RC/VL/xrays/1spine/eatspanu.html
Radiology of Burst Fractures

PLAIN FILMS

• AP Vertebral Body height ↓
• If severe:
  – Posterior column fractures
  – Widening of interpedicular distance

Seat Belt Injuries

- 6% of Major Spinal Fractures
- Spectrum of Ligamentous and Bony Injuries: Includes the classic CHANCE fracture
- Mechanism of Injury
  - Restrained by lap belt w/o shoulder harness
  - Propelled forward but restrained at abdominal wall
  - Fulcrum for rotation moves anterior to spine and results in distraction force → MIDDLE AND POSTERIOR COLUMNS FAIL

***UNSTABLE***
Seat-belt Injuries

From www.rad.washington.edu/maintf/cases/unk41/answers.html
Chance Fractures

Fracture can extend through the pedicles into posterior elements
www.medmedia.com/o11/198.htm

AP shows involvement of pedicles and lamina

Fracture extension from posterior elements into vertebral body with buckle in anterior cortex

The Radiology Clinics of NA
THE FOLLOWING WOULD HAVE TO BE TORN TO ALLOW THIS NEW POSITION

- supraspinous ligament
- interspinous ligaments
- ligamenta flava
- capsular ligaments
- posterior longitudinal ligament
- possibly the posterior annulus fibrosus

www.rad.washington.edu/maintf/cases/unk41/answers.html
Review of Ligaments

www.thebackpage.net/spinal_anatomy.htm
Fracture Dislocations

• 19% of Major Fractures
• Anterior and Cranial Displacement of Superior Vertebral Body
• Failure of all 3 COLUMNS!
• Higher incidence of neurologic deficit

Fracture Dislocation of T11-T12
Our patient

- Hx: 20 y.o. man with 30 feet fall off roof onto concrete
- Trauma Series
- Started on steroids per spine injury protocol
- No rectal tone, + urinary retention
- Significant pain and tenderness over sacrum and T12 vertebrae
- Motor strength 5/5
- Sensation intact
Pelvic Film (part of Trauma Series) shows some obvious fractures

But look closely at right hemisacrum…
Disruption of R Sacral Foramina

No “lucent” neural foramina
Lateral L-spine

Compression Fracture? Think twice Order CT

L3 Teardrop fracture
Every compression fracture should be examined closely for evidence of a retropulsed fragment!!!!!!
CT Axial 1
CT Axial 2
CT Axial 3
CT Axial 4
Coronal CT Reconstruction Showing Burst Fracture

From BIDMC.PACS
CT Sagittal Reconstruction

Teardrop fracture through the anterior superior endplate of L3

Burst Fracture in L2
MRI - Spine

• Should be used in addition to but not as a replacement of CT
• Better defines extent of injury to soft tissue elements: Muscles, ligaments, intervertebral disc, neural elements
• Cord Compression vs Cord injury
• Cord edema vs. hemorrhage
• Spinal malalignment
MRI T2 Sagittal View

Our Patient

Normal

Slice 1/5

Posterior longitudinal lig.
L2-L3 intervertebral disk
Aorta
Anterior longitudinal lig.
L3 vertebral body
Basivertebral v.
Left common iliac v.
L5-S1 intervertebral disk
Uterus

Spinal cord (conus medullaris)
Supraspinous ligament
Cauda equina
L2 Lumbar spinous process
Spinal canal
Anterior epidural fat
S1 vertebral body
Rectum

DAVID, Online Atlas of Human Anatomy
for Clinical Imaging Diagnosis
Developed by J.-C. Oberson MD. Copyright 1998.
www.cid.ch/DAVID/LUM2/lum2s01.html
RADIOLOGIST IMPRESSION: Severe comminuted L2 fracture with retropulsion and compression of the cauda equina and thecal sac with associated epidural hemorrhage causing mild mass effect upon the ventral thecal sac. From BIDMC.PACS

Early stage hemorrhage=low-signal

Cord edema would show up as area of high-signal on T2 images- None present in our patient
Axial View of L2 Burst Fracture in Our Patient

MRI vs CT

From BIDMC.PACS
CT Coronal Reconstruction

Can appreciate fracture of posterior elements of L1 which is not evident in axial views
Other Spinal Fractures in this Patient

Transverse Process Fracture at L1

nondisplaced fracture through the right transverse process.
Fracture of the Posterior Elements of L2

Gross burst fracture, with retropulsion of a large fragment into the central canal, resulting in 75% invasion. This fracture continues posteriorly through the spinous process, in a sagittal orientation.

From BIDMC.PACS
Retroperitoneal Bleeding on CT

Obscuration of the retroperitoneal fat anterior to the major vessels suggests a retroperitoneal hematoma from the L2 burst fracture.

Observe how the small bowel is displaced anteriorly. There is a large retroperitoneal hematoma measuring approximately 6 x 6 cm at the level of the sacrum, secondary to a complex sacral fracture.

From BIDMC.PACS
S/P Vertebrectomy and Reconstruction with Internal Fixation
Conclusion

• Lumbar fractures need to be characterized as either stable or unstable
• REMEMBER 3-column concept
• Radiologist is instrumental in the evaluation of patients with suspected spine fractures and can guide which imaging studies are performed and in what order.
References

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