Spine Trauma- Part B
Cervical Spine Injuries

• Atlanto-Occipital Dislocation
  – Hyperextension and distraction mechanism
    • Down’s syndrome, RA more susceptible
  – Asymmetric lateral masses on odontoid view
  – Widened predens space
  – Treatment-
    • Often fatal
    • Highly unstable
    • If not fatal avoid traction, definitive fusion occiput to C1
Atlanto-axial Dislocation

- Hyperextension injury
- Children > adults
- Head slips forward on C1
- Usually fatal
Atlas Fractures

- Neural Arch Fracture of C1
- Most common fracture of C1
- Hyperextension injury
- Not associated with neurologic deficit
- May be confused with congenital anomaly
Atlas Fractures

• Jefferson fracture
  – Burst fracture of atlas (C1)
  – Usually bilateral breaks in ant/ post arches
  – Vertical compression/ axial load injury
  – Widened lateral masses of C1 on open-mouth odontoid view
  – Widened predens space
  – Moderately unstable
  – Neuro deficits uncommon

• Associated with:
  – Fractures of C7 (25%)
  – Fractures of C2 pedicle (15%)
  – Extrapspinal fractures (58%)
Transverse Ligament Ruptures

• May occur alone or with fracture atlas or atlanto-axial subluxation
• Transverse lig is the main restraint to ant motion of C1
• Mechanism- due to flexion
• Widening of normal distance between ant ring of atlas and dens less than 3mm
• Unstable
Axis Fractures

- Incidence: 6% of cervical spine fractures
- Associated with atlas fractures in 8%
- Hyperextension
- Often forward subluxation of C1 on C2

Odontoid fracture

- Type I
  - Avulsion of tip of odontoid (5-8%)
  - Difficult to detect; required CT
- Type II
  - Fracture through base of dens (54-67%)
  - Complication: nonunion
- Type III
  - Subdental injury (30-33%)
  - Prognosis: good
Hangman’s Fracture

- Most common fracture of C2
- Bilateral fracture of pedicles of axis (C2)
- Anterior slip of C2 on C3
- Mechanism: Sudden deceleration with hyperextension
- May or may not have anterior subluxation
- Unstable
- Neuro deficits variable
- Teardrop fracture of inferior aspect of C2 or C3 is clue
Tear Drop Fracture

• Avulsion of antero-inferior corner of cervical vertebral body by anterior ligament
• Most severe and unstable injury of the C-spine
• Mechanism: may be secondary to hyperflexion or hyperextension sudden, forceful flexion
  – Often the result of diving into shallow water
• Typically at C2
• Unstable with ligamentous instability
• Remainder of body displaced backward into spinal canal
• Facet joint and interspinous distances usually widened
• Disk space may be narrowed
• Neuro deficit in up to 70%
Teardrop
Teardrop
Compression Fracture

• Flexion injury
• Anterior wedging of 3mm or more suggests fracture
• Usually involves superior endplate of vertebral body
Unilateral facet dislocation

- Mechanism: flexion, combined flexion/rotation
- Anterior dislocation of one vertebral body by 25-30% on lateral view
- Stable if anterior displacement on lateral less than $\frac{1}{2}$ width of VB
- Only 30% associated with neurologic defect
Unilateral facet dislocation

- AP view-disruption of spinous process line
- Oblique- disruption of the tilting of the lamina
  - Superior articulating facet impinges in neural foramina
Unilateral Facet Dislocation

AP view- spinous processes of the vertebrae above the dislocation displaced towards the side of the dislocated facet
Unilateral Facet Dislocation

Bowtie Sign
Bilateral Facet Dislocation

- Mechanism: flexion, combined flexion/rotation
- Anterior dislocation of one vertebral body by 50% on lateral view
- Unstable
- Neurologic deficits common
  - Seen in up to 85%
Bilateral Facet Dislocation
Clay Shoveler’s Fracture

- Avulsion fracture of posterior spinous process of C7 or T1
- Mechanism: sudden load on a flexed spine or secondary to rotational injury
  - Shoveling snow, clay
- Very stable
Clay Shoveler’s Fracture
Cervical Spine Fracture Stability

Failure of middle column bony structures indicated by-
- Wide pedicles
- More than 25% loss of post body ht
- Fracture lines through post body cortex

Failure of middle column ligamentous structures indicated by-
- Interspinous or intervertebral angulation 11 deg more than adjacent segment
- Horizontal translation more than 3.5 mm
- Intervertebral disc space separation more than 1.7 mm
Cervical Ligamentous Injury

- Mechanism is flexion/distraction
- Clues to diagnosis
- Disk space narrower anteriorly than posteriorly
- Widening of the interspinous distance
- Widening of the facet joint
  - Usually the posterior aspect
Thoracic Spine

- Rigid
- Spinal canal narrower than cervical or lumbar spine
  - Large spinal cord diameter relative to canal diameter increases the risk of cord injury
- Injury, usually significant (complete), less common than in other regions
- Association between fractures of the thoracic spine and severe pulmonary injuries, mediastinal hemorrhage
Thoracic Spine Fractures

- Normal (grade 0)
- Mild fracture (grade 1, 20–25%)
- Moderate fracture (grade 2, 26–40%)
- Severe fracture (grade 3, > 40%)
Thoracic Spine Injuries

Compression fracture

- Injury to anterior column due to anterior or lateral flexion
  - Middle, posterior column remains intact
- X-ray - decreased height anterior vertebral body, post body ht normal
- Amount of ant compression usually less than 40% of post body height
- Clinically - stable, cord injury rare
Thoracic Compression Fracture

• Unstable if:
  – Loss of vertebral ht > 50%
  – Angulation more than 20 deg
  – Multiple adjacent compression fractures
Thoracic Spine Injuries

Burst

• Disruption of the middle column
• Mechanism- axial loading
• Varying degrees of retropulsion into the neural canal
• X-ray- spreading of post elements
• If post elements involved- 50% have neuro injury
• Neurologic injury more common in:
  – Loss of vertebral ht > 50%
  – Angulation > 20 deg
  – Canal compromise more than 40%
Lumbar Spine

1. Vertebral body
2. Spinal cord
3. Conus medullaris
4. Intervertebral disc
5. Filum terminale
6. Subarachnoid space
Lumbar Spine Fractures

- Thoracolumbar spine and lumbar spine are the most common sites for fractures due to the high mobility of the lumbar spine compared to the more rigid thoracic spine.
- Injury to the cord or cauda equina occurs in approximately 10-38% of adult thoracolumbar fractures and in as many as 50-60% of fracture dislocations.
- Most occur in people younger than 30 years.
- Nearly 60% of patients have serious disabling deficits.
- Etiology- 40% caused by motor vehicle accidents, 20% by falls, and 40% by gunshot wounds, sporting accidents, industrial accidents, and farming accidents.
Lumbar Spine Injury

- Lower lumbar spine is the most mobile
- Isolated fractures of the lower lumbar spine rarely result in complete neurologic injuries
- Injuries usually complete cauda equina lesions or isolated nerve root injuries
Sacro-coccygeal Injuries

• Sacral spine, nerve root injuries unusual
• Frequently associated with fractures of the pelvis
• Transverse fx through the body are most significant
  – May cause injury to part or all of the cauda equina
  – If there is involvement of the central sacral canal, however, bowel or bladder dysfunction may also occur
• Longitudinal fx may cause radiculopathy
  – Rectal examination to assess anal sphincter tone and the bulbocavernosus reflex
  – Often associated with fractures of the pelvis
Sacral Fractures

Central Sacral FX

Transverse

Vertical

U Shaped

H Shaped

L Shaped
Sacro-coccygeal Injuries

- Careful neurologic evaluation is essential
- Rectal examination will assess anal sphincter tone and the bulbocavernosus reflex
- Patients with complete damage to the sacral portion of the cord
  - Loss of control of bowel and bladder function
  - Paralysis of the lower extremities with preservation of some movement of the hips and knees and preserved knee jerks and sensation in the lumbar dermatomes.
Sacro-coccygeal Injuries

- Coccygeal injuries are usually associated with direct falls onto the buttocks
- Diagnosis of fracture is made on rectal exam
  - Pain with of the coccyx
  - X-rays are not needed
  - Rarely a bony injury
- Treatment symptomatic
  - Analgesics, rubber doughnut pillow
Penetrating Spine Trauma

• Majority caused by gunshot wounds.
  – Most gunshot wounds result in stable vertebral injuries
  – Cord lesions are often complete.

• Stabbing injuries are much less common
  – Prognosis better than similar paralysis with GSW
  – Majority of stab wounds involve incomplete Brown-Séquard lesions of the thoracic cord
  – Best prognosis of incomplete spinal injuries
Penetrating Injuries

• Most vertebral injuries to the spine following penetrating trauma are stable and require only symptomatic treatment

• Progressive neurologic deficits warrant surgical decompression

• Bullet removal controversial in patients with stable cervical and thoracic spinal cord lesions
  – Bullet removal from the thoracolumbar spine improved motor recovery in both complete and incomplete injuries
Anterior Cord Syndrome

- Flexion compression of anterior cord or ischemia to anterior spinal artery
- Motor paralysis, loss of pain and temperature distal to the lesion
- Posterior columns spared
  - Light touch, motion, vibration, gross proprioception preserved
- Prognosis poor
Central Cord Syndrome

- Hyperextension injury in older patients, spondylosis, cervical stenosis
- Buckling of ligamentum flavum into cord during extension
- Partial cord syndrome
- Weakness greatest in hands
- Greater in arms than legs
- Variable sensory sensory and bladder involvement
- Treatment usually nonoperative with relatively good prognosis
Brown Sequard Syndrome

- Injury to one side of the cord
- Usually penetrating wound, hematoma, lateral disk
- Ipsilateral paralysis, loss of proprioception and vibratory sense
- Contralateral loss of pain and temperature
- Prognosis good
Cauda Equina Syndrome

- Cauda equina
  - Composed of lumbar, sacral, coccygeal nerve roots
  - Peripheral nerve injury rather than a spinal cord injury cord

- Symptoms
  - Variable motor and sensory loss in the lower extremities
  - Sciatica
  - Bowel and bladder dysfunction
  - Saddle anesthesia
    - Loss of pain sensation over the perineum

- Prognosis for recovery better than spinal cord lesions
Pediatric Spine Injury

• Pediatric spine has increased mobility
  – Laxity of the interspinous ligaments and joint capsules
  – Horizontal orientation of facet joints, incompletely ossified wedge-shaped vertebrae
  – Underdeveloped neck, paraspinous muscles

• Spinal injury occur less commonly in the pediatric population
  – Usually secondary to mechanisms involving considerable force
  – High degree of neurologic compromise at presentation
SCIWORA

- Spinal cord stretching leads to neuronal injury or even complete severing of the cord
- Accounts for up to 70% of peds SC cord injuries
- Most common in kids < 8 years
- Paralysis may be present on arrival
  - Up to 30% have a delayed onset of neurologic abnormalities
  - May not occur until up to 4-5 days after injury
  - Many have neurologic symptoms at the time of the injury, such as paresthesias or weakness, that have subsequently resolved
SCIWORA

- Most have a complete recovery
  - Especially if the onset is delayed
- MRI defines cord anatomy, helps prognosticate
Treatment

• Airway
• Chin lift, in-line immobilization, cricoid pressure, RSI
• Patient with an injury at C5 or above should be intubated
Hemodynamic Spinal Shock

- Seen with cervical or thoracic cord injury
- Relative hypotension due to the sudden loss of sympathetic tone below the level of the lesion
- Warm, dry skin and normal capillary refill, paradoxical bradycardia
- Must exclude blood loss
  - Concurrent in 30% blunt trauma, 90% penetrating lesions
- Treat with direct acting pressors
  - Norepinephrine > dopamine
Spinal Shock

- Partial or complete injury
  - Typically at the T₆ level or above
- Temporary block of ascending/descending communication past injured cord segment
- Clinical signs
  - Areflexia, loss of sensation, flaccid paralysis below level of lesion
  - Loss of rectal tone
  - Bradycardia, hypotension
  - Priapism implies a complete spinal cord injury
Spinal Shock

• Traumatic spine lesions not complete until spinal shock has resolved
  – Lasts variable amount of time- typically ~ 24 hours
  – Bulbocavernosus first reflex to return
    • Elicited when squeezing or tugging on the glans penis with reflex contraction of the anal sphincter
  – Cremasteric reflex suggests some spinal cord integrity
    • Tested by running a pin/blunt instrument up medial thigh with scrotum rising in response
  – Anal wink reflex suggests some sacral sparing
    • Tested by touching skin around anus with a pin with reflex “wink” (contracture of anal sphincter)
Treatment

• Methylprednisolone
  – Load with 30 mg/kg as a bolus, followed by a continuous drip of 5.4 mg/kg/hour for the subsequent 23 hours
  – Shown to lead to a statistically significant improvement in blunt trauma in neurologic outcome
  – Not studied in penetrating trauma
  – Resulted in improvement of both motor and sensory function in complete and incomplete lesions
Conclusion

• Cervical spine CT in
  – Elderly with degenerative disease
  – Neuro deficits
  – Concurrent severe head injury
    • GCS ≤ 8, ICH

• MRI in
  – Suspected cord injury, especially children