Spine and Spinal Cord Injuries

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Anatomy of the Spine

http://education.yahoo.com/reference/gray/fig/387.html
Anatomy of the spine

- 7 cervical vertebrae
- 12 thoracic vertebrae
- 5 lumbar vertebrae
- 5 fused sacral vertebrae
- 3-4 small bones comprising the coccyx

http://www.courses.vcu.edu/DANC291-003/unit_3.htm
Anatomy of the Spine

- Cervical lordosis
- Thoracic kyphosis
- Lumbar lordosis

Structure of the Vertebra
Anatomy of the Spine

http://www.courses.vcu.edu/DANC291-003/unit_3.htm
Spinal cord and Vertebrae

http://www.gotorna.com/pages/346343/index.htm
Spine Anatomy

- Disc is joint between both vertebral bodies
- Facet joints form intervertebral foramen through which pass the nerve roots

http://www.courses.vcu.edu/DANC291-003/unit_3.htm
Spine Anatomy

- Anterior and posterior longitudinal spinal ligaments
- Ligaments check the motion of the vertebrae and prevent the discs from slipping out of place

http://www.courses.vcu.edu/DANC291-003/unit_3.htm
Spine Motions

- Flexion
- Extension
- Side bend
- Rotation
Mechanisms of Injury

- Compression
- Flexion Injury
- Extension Injury
- Rotation

Compression Injury

- Vertebral body fracture
- Disc herniation
- Epidural hematoma
- Displacement of posterior wall of the vertebral body

Flexion Injuries

- Tearing of interspinous ligaments
- Disruption of capsular ligaments around facet joints
- Fracture of posterior elements
- Disruption of posterior ligaments
- Often unstable fractures

http://www.maitrise-orthop.com/corpusma...spine_injury.shtml
Extension Injury

- Tearing of anterior longitudinal ligament
- Separation of vertebral bodies
- Rupture of Disc
- Avulsion of upper vertebral body from disc

Rotational Injury

- Associated with unilateral facet dislocation

Cervical Spine

- 7 Cervical Vertebrae
- C1 (Atlas) is a ring which articulates with the occiput
  - C1 has no body
  - C1 has no spinous process
- C2 (Axis) so named because it is the pivot on which the Atlas turns to rotate the head
  - The Atlas has a vertical extension, the Dens, which articulates with C1
- Notice the canal for the vertebral arteries bilaterally
Jefferson Fracture

Compression of base of skull against C1
Results in cracking the ring of C1
Best seen on open mouth x-ray
Notice spreading of lateral masses of C1 away
From the Dens projecting up from C2 due to
Disruption of C1 ring
Atlantoaxial and Dens Fractures

The result of hyperflexion or hyperextension injuries
8% of Dens Fractures associated with C1 fractures
C2 Fractures

• Dens Fracture
  – Hyperflexion Injury

• Hangman Fracture
  – Hyperextension Injury
  – Bilateral Fracture of Pedicles of C2

http://www.emedicine.com/sports/topic22.htm
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Fractures above C4

- Associated with Paralysis of muscles of respiration
- Diaphragm innervated by C3-5
Fractures in the Middle of the Cervical Spine

- Associated with dysfunction of upper extremities > lower extremities (Central Cord Syndrome)
Thoracolumbar Trauma

- Mechanism of injury
  - Compression
  - Distraction
  - Rotation
Assessing Stability: Denis Classification

I Fracture involves the anterior 1/2 of Vertebral body—Stable—termed Anterior Column

II Fracture involves the Posterior 1/2 of Vertebral Body—Unstable—termed Middle Column

III Fracture involves the pedicles and lamina of the vertebrae—Unstable—termed Posterior Column
Chance Fracture: Failure of all three columns due to flexion-distraction

http://www.ortho-u.net/o11/198.htm
Compression vs Burst Fracture

• Compression Fracture
  – Stable
  – Failure of anterior column without injury to middle column

• Burst Fracture
  – UNSTABLE
  – Failure of both anterior and middle column
  – Often a boney fragment projecting into spinal canal
Indications for Spine Surgery

- Neurologic Deterioration
- Unstable fracture
- Epidural Hematoma
- Narrowing of spinal canal
Goals of Spinal Surgery

• Decompression of Spinal Canal
• Stabilization of Spine
Spinal Cord Anatomy
Spinal Cord Anatomy
Spinal Cord Anatomy
Neurologic Exam: Dermatomes

- C5 - Deltoid
- C6 – Thumb
- C7 – Middle Finger
- C8 - Little Finger
- T4 – Nipple
- T8 – Xypoid
- T10 - Umbilicus
- T12 – Symphysis Pubis
- L4 – Medial aspect of leg
- L5 - Space between first and second toes
- S1 – Lateral border of the foot
- S3 – Ischial Tuberosity
- S4-5 – Perianal region
Neurologic Exam: Myotomes

- C5 – Deltoid
- C6 – Wrist Extensors
- C7 – Elbow Extensor
- C8 – Finger flexors
- T1 – Little finger abduction
- L2 - Hip flexion
- L3 - Knee Extension
- L4 - Ankle dorsiflexion
- L5 - Toe extension
- S1 – Plantar flexion
Spinal Cord Anatomy: A Brief Review

1 & 2 Posterior Columns: convey Ipsilateral information about two Point discrimination, proprioception and vibratory sense.

5 Lateral Spinothalamic Tract: carries Pain and Temperature Information From contralateral extremity.

4 Lateral Corticospinal Tract: Carries Motor Information from Contralateral Brain to Ipsilateral Extremity.

http://academic.uofs.edu/student/mcnallye2/frames1.html
Afferent Sensory Tracts in the Spinal Cord

http://www.homestead.com/emguidemaps/files/spinalcord.html#Inferior%20cord%20syndrome%20(Conus%20medullaris%20syndrome)
Clinical Syndromes resulting from Incomplete Spinal Cord Injury

- Central Cord Syndrome
- Brown-Sequard Syndrome
- Anterior Cord Syndrome
- Conus Medullaris Syndrome
- Cauda Equina Syndrome
Central Cord Syndrome

- Motor > Sensory Loss
- Upper > Lower Extremity Loss
- Distal > Proximal Muscle Weakness
- Pneumonic: MUD
- Classically occurs with hyperextension injuries of the cervical spine

http://www.homestead.com/emguidemaps/files/spinalcord.html#Central%20cord%20syndrome
Brown-Sequard Lesion

- Loss of Ipsilateral Proprioception, Light Touch and Motor Function
- Loss of Contralateral Pain and Temperature Sensation
- Due to hemisection of the cord due to penetrating injury
- Incomplete lesions most common
Anterior Cord Syndrome

- Loss of Motor function, Pain and Temperature Sensation
- Preservation of Light touch, Vibratory Sensation and Proprioception
Conus Medullaris Syndrome

• Injury to sacral cord, lumbar nerve roots causing
  – Areflexic bladder
  – Loss of control of bowels
  – Knee jerk reflexes preserved, ankle jerk absent
  – Signs similar to cauda equina syndrome except more likely to be bilateral

http://education.yahoo.com/reference/gray/fig/661.html
Cauda Equina Syndrome

- Injury to nerve roots and not spinal cord itself
- Muscle weakness and decreased sensation in unaffected dermatomes
- Decreased bowel and bladder control
Treatment of Acute Spinal Cord Injury

• Methylprednisolone 30mg/kg as soon as possible (within the first 8 hours after injury) for proven NON-PENETRATING spinal cord injury

• 5.4 mg/kg/hr for the next 23 hours
Important Adjunct Measures

- Frequent turning
- Special bed to prevent pressure sores
- Splint extremities to prevent flexion contractures—splints MUST be well padded to protect skin
- Range of motion of joints
- Occupational and Physical Therapy

- Intermittent urinary catheterization if appropriate
- Skin Care
- Avoid succinylcholine b/o induced hyperkalemia
- Autonomic hypersensitivity
- Pulmonary Embolus Prophylaxis
Principles of Initial Management

- Prevent further damage
- Assume a spine injury until proven otherwise
Primary Survey

- Airway
- Breathing
- Circulation
- Disability: Moves upper and lower extremities??
- Exposure
Secondary Survey

Careful Orthopedic and Neurologic Evaluation takes place in the Secondary Survey
History

- Pre-injury neurologic status
- Mechanism of injury
- Review Pre-hospital report
- Change in neurologic status?
- DOCUMENT FINDINGS
Cervical Spine Injury

• Cervical Spine poorly protected
• Suspect if:
  – Supraclavicular injury
  – Maxillofacial trauma
  – Head injury
  – High speed injury
Clinical Clearance of Cervical Spine only if:

- Patient awake and fully cooperative
- The neck is pain free without swelling, hematoma, pain to palpation or boney abnormalities
- No distracting injuries
- The patient has full pain free active range of motion
- **DO NOT PASSIVELY MOVE THE PATIENT’S HEAD!!!**
Initial Treatment of Possible Cervical Spine Injury

• Immobilization

• Imaging studies
  – AP, lateral and open mouth spine films
  – Consider CT
  – MRI to view ligaments and spinal cord

• Search for occult injury in patient with a neurologic deficit

• DOCUMENT FINDINGS

• Early neurosurgical/orthopedic consultation
Neurological Examination

- Motor examination of upper and lower extremities
- Sensory Examination of upper and lower extremities
  - Examine perianal sensation to pinprick (S3, S4)
  - Distinguishes between a complete and incomplete spinal cord injury
- Reflexes
- DOCUMENT FINDINGS
Clinical Signs of Cervical Spinal Cord Injury

• Areflexia
• Diaphragmatic Breathing
• Forearm flexion
• Response to pain above the clavicle
• Hypotension and bradycardia (sympathetic nervous system paralysis)
• Priapism (paralysis of parasympathetics)
Complete vs Incomplete Spinal Cord Injury

- Perianal pinprick
  - absent: Complete
  - Present: Incomplete

- Spinal Cord:
  - Anal Sphincter
  - Urethra

Bulbocavernosus Reflex: Present -- Complete
Spinal Shock

- Temporary COMPLETE cessation of spinal cord function
- Occurs IMMEDIATELY after injury
- Complete loss of all reflexes— including the bulbocavernosus
- Flaccidity of all muscles
“Neurogenic” Shock

• Caused by high spinal cord injury
• Slow pulse
• Low blood Pressure
• Treatment
  – R/O Hemorrhage and other causes of hypotension
  – Fluids, Trendelenburg
  – Alpha adrenergic drugs
• Other problems
  – Inadequate ventilation
  – Change in clinical signs due to absent sensation
Frankel Classification of Spinal Cord Injury

• A. Complete: no motor or sensory function
• B. Sensory Only: Some sensation preserved, no motor function
• C. Motor Useless: Some sensory and motor function but motor function not useful
• D. Motor Useful: Sensory function preserved. Motor function weak but useful
• E. Intact: Normal Sensory and Motor function
American Spinal Injury Association (ASIA) Classification

- A. Complete: No sensory or motor function preserved in the sacral segments S4 & S5
- B. Incomplete: Sensory but not motor function preserved below neurological level including S4 and S5
- C. Incomplete: Sensory and motor function preserved below neurological level but more than half of the muscles have a grade of 3/5 or less
American Spinal Injury Association (ASIA) Classification

• D. Motor function preserved below neurological level and at least half of muscles have better than grade 3/5 function
• E. Normal motor and sensory function
• BUT ASIA Grade E does not describe pain, spasticity and dysesthesia that may result from spinal cord injury
ASIA Assessment of Motor Strength

- 5  Normal Strength
- 4+ Submaximal movement against resistance
- 4  Moderate movement against resistance
- 4-  Slight movement
- 3  Movement against gravity but not resistance
- 2  Movement when gravity eliminated
- 1  Flicker of Movement
- 0  No Movement

http://www.emedicine.com/pmr/topic182.htm
Radiologic Evaluation of Spine

• Cervical Spine
  – AP, Lateral and Open Mouth (to see the Odontoid) Views
  – Swimmer’s View to see junction of C7 on T1
  – CT Scan outstanding exam to view bone anatomy and diagnose fractures
  – Flexion/Extension views: NOT BY NON-SPECIALIST

• REMEMBER: THE PATIENT CAN HAVE AN UNSTABLE CERVICAL SPINE WITHOUT A FRACTURE!!!!!
Ligamentous Injury

Hyperflexion injury
Disruption of posterior
Longitudinal ligament

Hyperextension Injury

http://www.uth.tmc.edu/radiology/test/er_primer/spine/spfrm.html
Cervical Spine Film Evaluation

- See all 7 vertebrae including top of D1
- Check for soft tissue swelling
- Check for vertebral alignment

acceptable

unacceptable
Evaluation of Lateral Cervical Spine Film

http://www.aafp.org/afp/990115ap/331.html
MRI is the definitive imaging technique

http://www.medi-fax.com/atlas/normalspine/case1.html

http://www.trauma.org/imagebank/imagebank.html

http://www.trauma.org/imagebank/imagebank.html
Summary

• Assume a spine injury until proven otherwise in blunt trauma
• X-ray the entire axial skeleton if: (1) appropriate mechanism of injury, (2) patient unable to cooperate with exam, a spine fracture is identified
• Careful DOCUMENTED neurologic, orthopedic, and radiologic evaluation of spine in secondary survey
• Timely orthopedic and neurosurgical consultation