Spinal Injury: After On-the-Field Management

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Objectives

- Brief review spinal anatomy
- Brief Radiological review (X-ray, Computed Tomography, Magnetic Resonance Imaging)
- Mechanism of athletic spinal injuries
- Differential for spine injuries
- Initial on-the-field evaluation
- Brief review of potential surgical interventions

Spinal Anatomy

- Cervical
- Thoracic
- Lumbar
- Sacral

Cervical Spine

- 7 Vertebrae
  - Atlas
  - Axis
- Lordotic curve
- Contents
  - Brainstem (C2-C3)
  - Spinal cord
- Nerves
  - C1-C8
- Vasculature
  - Vertebral arteries

Spinal Anatomy

NORMAL C-SPINE


Bony Anatomy

Vasculature

- Gray matter >> White matter
- Anterior Spinal Artery: 75%
  - Aorta and vertebral arteries
  - Foramen magnum to filum terminal
- Posterior spinal arteries:
  - Segmental
  - Posterior aspect of aorta
  - Artery of Adamkiewicz aka arteria radicularis magna
  - T10, T7-L4

Crossectional Anatomy

- Differences in white/gray matter
- Enlargements
  - Cervical
  - Lumbar

Vascular supply
Mechanism
- Sport
  - Football: linemen, defensive ends, linebackers, wrestling, ice hockey, lacrosse
  - Fourth most common cause for spinal injury
    - MVA, violence, falls

Physical Exam – On the Field
General
- Airway – equipment
- Breathing
- Circulation
- Level of Consciousness
- Global motor exam
- Equipment
Specific
- Pupils
- Level of alertness
- Speech
- Orientation
- Situation
- Point tenderness
- Motion of extremities
- Sensation
- level
- Bowel/bladder control
- Abdominal breathing
- Priapism

PE- upon ED arrival
- ABCs
- Glasgow Coma Score
- Cranial nerves
- Myotomes
  - Power 1-5/5
- Dermatomes
  - Dorsal column evaluation
- DTR
- UMN vs LMN
- Rectal tone

UMN vs LMN Signs

<table>
<thead>
<tr>
<th>Exam</th>
<th>Upper Motor Neuron</th>
<th>Lower Motor Neuron</th>
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<tbody>
<tr>
<td>DTR</td>
<td>Clonus</td>
<td>Diminished</td>
</tr>
<tr>
<td>Tone</td>
<td>Increased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Paralysis</td>
<td>Spastic</td>
<td>Flaccid</td>
</tr>
<tr>
<td>Babinski &amp; Hoffman</td>
<td>Positive</td>
<td>negative</td>
</tr>
<tr>
<td>Fasciculations</td>
<td>Negative</td>
<td>Positive</td>
</tr>
</tbody>
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NATA GUIDELINES
National Athletic Trainers’ Association
Position Statement: Acute Management of the Cervical Spine– Injured Athlete
http://www.nata.org/sites/default/files/AcuteMgmtOfCervicalSpineInjuredAthlete.pdf
Quadriplegia Statistics

Central Cord Syndrome
- MC of partial cord syndrome in athletes
- Mechanism
  - Hyperextension
  - Traumatic disc herniation
  - Trivial trauma
  - Hyperflexion
- S&S
  - Bilateral paresis
  - UE > LE
  - Varies based on involvement
- TX: Preservation of motor strength
- Px: Good

Categorizing Injury

Soft Tissue
- Muscle spasm
- Ligamentous injury
- Contusion

Neurologic Injury
- Complete vs Incomplete
- Central cord
- Brown-Sequard
- Anterior spinal cord
- Posterior spinal cord
- Vertebral body fracture
- Intervertebral facet fracture
- Vertebral body fracture
- Atlantoaxial
- PLL
- Flavum
- Spondylolysis
- Spondylolisthesis

Skeletal Injury
- Disc herniation
- Vertebral body fracture
- Intervertebral facet fracture
- Ligamentous rupture
- Atlantoaxial
- PLL
- Flavum
- Spondylolysis
- Spondylolisthesis

Complete Spinal Cord Injury
- Complete loss of motor, sensory, and autonomic function below level of lesion
  - Spinal shock: hypotension, bradycardia, loss of thermoregulation
- Mechanism:
  - Trauma
  - Infarction
  - Hemorrhage
  - Acute disc herniation
- Tx:
  - Varying dependent on etiology
- Px: Poor

Anterior Spinal Cord Syndrome
- Direct/Indirect impact
  - Crush injury, compression from hematoma
  - Ischemia due to ASA compression
- Hyperflexion injuries + bony instability
  - Herniation, hematoma
- S&S:
  - Dependent on level, motor weakness
- Treatment:
  - PT/OT/ADL’s
  - Stabilization/Sx intervention for decompression
- Px: Poor if there is an ischemic insult

Brown-Sequard Syndrome
- Rare hemisection
- Mechanism
  - Penetrating/blunt trauma
  - Disc/bone herniation
  - Epidural Hematoma
  - Tumor
- S&S:
  - Ipsilateral:
    - Loss of motor function, vibration, proprioception
  - Contralateral (2 levels below):
    - Loss of pain, temperature
- Tx:
  - PT/OT/ADL
- Px: Best prognosis of incomplete injuries
Posterior Spinal Cord Syndrome

- Not common
- Involvement of dorsal column structures
- Compromise of:
  - Proprioception → Golgi tendon organs
  - Vibratory sense → Pacinian Corpuscle
  - Discriminative touch → Meissner corpuscle
  - Pain
  - Temperature
  - Coarse touch

Cauda Equina Syndrome

- Disc/bone fragments pushing on Cauda Equina
  - Preexisting HNP
  - Fractures with retropulsion
- S&S
  - Urinary retention/incontinence
  - Fecal incontinence, loss of rectal tone
  - "saddle anesthesia"
  - Significant motor weakness
- Tx
  - Steroids
  - Surgical decompression
- Px: good if surgery is done within 48 hours

Transient Spinal Cord Injury

- Occurrence rare, but across all collision sports
- Involvement (80%)
  - All four extremities
  - Weakness/quadruplegia
  - Combined sensory deficits
- S&S
  - Resolves in 15 min to 48 hours
- Px: very good
- RTP: once athlete is pain and symptom free

Vertebrobasilar Insufficiency

- Arterial injury above C6
  - Px of transverse foramen
  - Dissection/vasospasm/thrombosis
  - Bony compression
- Consequences:
  - Hindbrain ischemia
  - Cerebellar structures
  - Brain stem
- S&S
  - #1 dizziness
  - Dysarthria, emesis, ataxia, visual field defects
- Px: dependent on intervention and cause of occlusion

Ligamentous Injury
Ligamentous injury

- serial flexion extension plain films
- MRI
- conservative management

18 y/o high school defensive end
- Hyperextension with rotation
- Left shoulder paraesthesia

Soft Tissue Swelling

Anterior Subluxation

Cervical Traction

Surgical Stabilization of C-spine
**C-spine Injury: Fractures**

![Diagram of C-spine injury and fractures]

**Mechanism for Fracture**

- **Wedge Fracture**
  - **Treatment:**
    - <30% loss of height: limited activity, bracing for 3 months, serial radiographs
    - >30% loss of height: surgical consideration
    - More likely to have neurological symptoms
    - Integrity of PLL is compromised
  - **Jefferson Fracture**
    - Vertical force transmission
      - Occipital condyles → lateral masses of Cl
      - Transverse ligament integrity
    - Management
      - Neuroexam may be stable, or with little deficit
      - Poor handling during immobilization/transport

**Wedge Fracture**

- Extreme flexion
- Considered severe if over 50% loss of height is noted
- Neurologically stable
  - Below C2

**Jefferson’s Fracture**

- ![Image of Jefferson’s Fracture]
Hangman’s fracture & Jefferson

Burst Fractures
- High velocity axial load
- Commonly at thoracolumbar junction
- Varying degrees neurological consequence
- Technically stable
- S&S:
  - Varying depending on extent of bony displacement and concurrent injury
  - Bowel/bladder function

Cage fixation
- Removal of bone from spinal canal
- Oblique approach
- Bone graft in cage
- Three level fusion
**Spondylolysis**

- Stress fracture of pars interarticularis
- Repetitive hyperextension movements
- Sports:
  - Gymnasts, divers, wrestlers, football linemen
- S&S:
  - Insidious onset
  - Increased intensity of training
  - Sciatic symptoms
- PE:
  - Reproduce pain by hyperextension, then single leg hyperextension

**Imaging:**
- Plain films: oblique lateral, A/P
- CT/MRI for subtle stress fx
- Bone scan for acuity

**Treatment:**
- Based on symptoms
- Acute: TLSO Brace
- Chronic: hamstring stretching, abdominal wall strengthening

**Spondylolisthesis**

- MC level: L5-S1
- S&S:
  - c/o LBP, varying degrees of disability and limitation of ROM, paraesthesia
- PHYSICAL EXAM
  - step off deformity, limited ROM (flexion), weakness depending on level
- TREATMENT
  - Conservative
  - Surgical individualized to patient and MD/DO

**Spondylolisthesis**

- Translation of vertebral bodies
  - Grade I: 0-25%
  - Grade II: 25-50% restriction from contact sports
  - Grade III: 50-75%
  - Grade IV: >75%
  - Grade V: >100%
- RF:
  - Early age of onset
  - Female gender
  - Slip of angle Greater than 10%
  - Sacral inclination 30% beyond verticle

**32 y/o equestrian**

- Cannot ride anymore b/c of extreme low back pain
- ADLs are limited as well

**FLEXION**

**EXTENSION**
Herniated Nucleus Pulposus

- Inability of spine to disperse force adequately
- Large force compression of bony spine
- Pre-existing stenosis \(\rightarrow\) higher risk
- S&S:
  - Broad-based
  - Laterally-based

OTHER CONSIDERATIONS

- CONGENITAL DEFORMITIES, STENOSIS
- TRANSVERSE MYELITIS

Transverse Myelitis

- Acute inflammation: segmental
  - Thoracic
  - 1-2 levels
- 1:5,000,000
  - Young children/adults
- Onset: varies
  - 24hr-weeks
- Symptoms
  - Pain & tingling
  - Band/girdle distribution
  - Hypersensitivity
  - Back/radicular pain
  - Bowel/bladder dysfunction

TREATMENT

- Partial recovery
  - Could take 1-3 months
- Poor prognosis if no improvement within 3 months

OUTCOMES

- Partial recovery
  - Could take 1-3 months
- Poor prognosis if no improvement within 3 months

HNP