Sports Related Cervical Spine Injuries: Initial On the Field Management

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18 year old Annapolis High School Football Player

• Strong safety sustaining massive hit
• Semiconscious, difficulty moving arms and legs, neck pain

What do I do now?
Introduction

• Initial evaluation is complex process
• Critically important to be thorough and accurate
• High index of suspicion
• Goal: Make the diagnosis!
On-the-Field Management

- Daunting task
- Visibility
- Uncomfortable environment
- Most injuries are minor
On-the-Field Management

- Preparation
- Suspicion/Diagnosis
- Stabilization/Safety
- Implementation of Treatment
- Return to Play
Preparation

• Proper Training
• Practice in simulated environments
• Emergency plan/ambulance on standby for high impact events
• Necessary equipment available
• Transport equipment available and tested prior to event
Sports Related Spine Injuries

- Football most common sport
- Cervical Strain
- Stingers and Burners
- Cervical Cord Neuropraxia
- Traumatic Disc Herniation
- Cervical Fracture
Cervical Sprain

• “Jammed neck” from collision
• **Symptoms:**
  – Axial pain only; no radicular symptoms
• **Signs:**
  – ↓ ROM
  – ± Focal tenderness
  – Normal neurological exam
Cervical Sprain

• Return-to-play:
  – No significant focal tenderness
  – Full ROM

• Further evaluation:
  – Residual localized pain
  – ↓ ROM
  – Prognosis good c-spine radiographs
  – 1-2 weeks Return to Play
Root/Brachial Plexus Neurapraxia

• “Stinger” (“Burner”)
• Most common spine injury in football
• Compression or traction injury to root(s) or brachial plexus
  – Compression: plexus compressed between shoulder pad and superior medial scapula by shoulder pad
  – Traction: upper trunk tensioned by shoulder depression, lateral head flexion to opposite side and head flexion to same side
  – Hyperextension: Nerve root compresion within neural foramina
Root/Brachial Plexus Neurapraxia

• **Symptoms:**
  – *Unilateral*, transient “dead arm”
  – Burning pain
  – Transient weakness

• **Signs:**
  – Transient weakness in upper trunk innervated muscles
    • Deltoid, biceps, supraspinatus, infraspinatus
Root/Brachial Plexus Neurapraxia

Evaluation and Return-to-play

• Full neurological exam
  – If normal → return-to-play
  – If abnormal → further evaluation

• If 2nd event: withhold

• Proper equipment
  – Thick neck roll
  – Total contact neck-shoulder-chest orthosis
Cervical Disc Injury

- Axial loading impact
- Most common at C3-4 and C4-5
- Defensive Backs and Lineman most common
- Present with Neck pain and Radicular Sx
- May have Motor and Sensory deficits/SCI
- Tx: supportive to operative
### Football Milestones

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>1869</td>
<td>Princeton vs. Rutgers (first game)</td>
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<tr>
<td>1896</td>
<td>Introduction of football helmet</td>
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<td>1905</td>
<td>President Roosevelt condemned brutality of football</td>
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<td>1906</td>
<td>Rules changes to eliminate roughness and to reduce danger</td>
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<tr>
<td>1940’s</td>
<td>Plastic helmet introduced (late 1940’s)</td>
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<tr>
<td>1950’s</td>
<td>Single-bar face mask introduced (early 1950’s)</td>
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<td>1969</td>
<td>National Operating Committee on Standards for Athletic Equipment (NOCSAE) founded</td>
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<td>1971</td>
<td>National Football Head and Neck Injury Registry (Torg)</td>
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<tr>
<td>1976</td>
<td>Rules changes outlawing “spearing”</td>
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<td>1975-94</td>
<td>Reduction in catastrophic head and neck injuries</td>
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Head & Neck Injuries Rate: 1959-1963 vs 1971-1975
(Injury Rates per 100,000)

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<tr>
<td>Schneider (1959-63)</td>
<td>3.39</td>
<td>1.58</td>
<td>1.36</td>
<td>0.73</td>
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<tr>
<td>NHNIR-Torg (1971-75)</td>
<td>1.15</td>
<td>0.92</td>
<td>4.14</td>
<td>1.58</td>
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Head & Neck Injuries Rate: 1959-1963 vs 1971-1975

- 66% ↓ in Intracranial Bleeds
- 42% ↓ in Craniocerebral Deaths
- 204% ↑ in C-spine Fx / Dislocations
Head & Neck Injuries Rate: 1959-1963 vs 1971-1975

• Conclusion
  – Modern helmet: protected head, but *promoted* playing techniques (e.g. “spearing”) which placed cervical spine at risk

Headfirst technique ➔ Axial loading
Spearing: Injury Mechanism

- Axial load to straightened spine (“spearing”)
  - 52% of permanent quadriplegia football injuries from 1971-75 attributed to spearing

Torg, et.al.
JAMA - 1979
Spearing

↑ Axial load

Compressive deformation

Angular deformation

Failure in flexion
Proper Technique

- Keep head *up* to maintain cervical lordosis
- Avoid hitting with crown of head
Quadriplegia in H.S. & College Football Athletes

Effect of 1976 rules changes outlawing “spearing”
Cervical Cord Neurapraxia (CCN)

Sensory Changes
- Burning pain
- Numbness
- Tingling
- Loss of sensation

Motor Changes
- Paresis
- Paralysis
- UE &/or LE

Torg, et.al.
JBJS (68-A) - 1986
Cervical Cord Neurapraxia (CCN)

- 1984 football season
- 344 of 503 (68%) NCAA schools responding
- 39,377 players

- Group I
  - Transient quadriplegia with paresthesia
  - Incidence: 1.3 per 10,000

- Group II
  - Transient paresthesia only (UE &/or LE)
  - Incidence: 6 per 10,000

Incidence: 7.3 per 10,000
Cervical Cord Neurapraxia
(CCN)

• 24 athletes with cervical cord neurapraxia (CCN):
  – Developmental Stenosis: 12
  – Instability / disc disease: 8
  – Congenital anomalies: 5
Cervical Cord Neurapraxia (CCN)

• **Conclusion**: Cervical neurapraxia does **NOT** predispose to permanent neurological injury

• **Caveat**: Avoid contact sports for athletes with cervical neurapraxia plus:
  – cervical instability
  – Acute / chronic degenerative change
Cervical Cord Neuropraxia

• Occurrence of transient cervical neurapraxia and SCI are unrelated

• No association *per se* between developmental narrowing of canal and quadriplegia

• Developmental narrowing *in the absence of instability* does not predispose to permanent injury

• Major factor predisposing to quadriplegia is *spearing* and *head-impact techniques of tackling*
Etiology of SCI

1. Motor Vehicle Accidents (47.5%)
2. Falls (22.9%)
3. Violence (13.8%)
   - primarily firearms.
4. Sports Related Injuries (8.9%)
   - Football and then diving injuries most common.
5. Other (6.8%)

Facts & Figures at a Glance (June 2005),
National SCI Statistical Center
Epidemiology of SCI

- **Incidence**: 40 cases per million, ~11,000 injuries / yr in the U.S.
- **Prevalence**: ~ 250,000 persons in U.S. living w/ SCI
- **Gender**: 80% male (4:1 male-to-female)
- **Mean Age**: 37.6 years since 2000
  - up from 28.7 (1973 - 1979)
- **Tetraplegia to Paraplegia**: ~50:50

Facts & Figures at a Glance (June 2005), National SCI Statistical Center
Neurologic Status

- 55% SCI Cervical Spine
- 15% SCI Thoracic, TL, LS
- 34% Incomplete Quadraplegia
- 22% Complete Quadraplegia
- 44% Intact
Goals of initial management of spinal cord injury

- Identification of the patient at risk for spinal cord injury
- Prevention of secondary injury
  - Management of hypoxia, hypotension
  - Spinal immobilization
Neuroprotection for Acute Spinal Cord Injury

Acute Pathophysiologic Processes

Intact Cord → Mechanical Forces → PRIMARY INJURY → SECONDARY DAMAGE
Who is at risk for cord injury?

• Any patient with significant trauma or any trauma patient with associated alteration in the level of consciousness should be suspected of having a spinal cord injury
  – 5-10% of unconscious patients due to a fall or MVA will have cervical spine injury
Signs of spinal cord injury in an unconscious patient

- Flaccid areflexia
- Diaphragmatic breathing
- Grimaces to pain above, but not below level
- Hypotension and bradycardia without hypovolemia
- Priapism
Field Procedures

- Secure scene
- Situational assessment
- Primary survey
Pre-Hospital/ Field Assessment

- A-B-C’s
- Initial field resuscitation
- C-collar
- Spine board
- The Golden Hour
Field Evaluation and Stabilization (ATLS)
Primary Survey: Airway and breathing issues

- Diaphragm innervated by C3-C5
- Paralysis of intercostal muscles in upper T-cord or higher injuries
- In c-spine injury, prevertebral hematoma or edema may partially obstruct airway
- Pulmonary edema / ARDS
- If intubation needed, endotracheal intubation with no neck movement or blind nasotracheal intubation (LMA)
Emergent Airway Access

- **DO NOT**
  - head tilt
  - chin lift

- Jaw thrust – oral intubation with manual in-line traction

- Blind naso-tracheal
  - r/o mid-face fxs
Sagittal midline MRI image
Hypotension and SCI

- Vascular Access is mandatory
- SCI pts managed in ICU with aggressive cardiovascular support do better than historical cohort
- Mean blood pressure > 90 mmHg for the first 7 days after acute spinal cord injury is recommended to prevent cord ischemia and prevent secondary insults

Levi et al, Neurosurg 33:1007-16, 1993
Neurogenic Shock

- Due to impairment of descending SNS pathways (>>>> in cord injury above T6)
  - **Loss of vasomotor tone** leads to vasodilation of visceral and LE vessels, intravascular pooling and hypotension
  - Loss of sympathetic innervation to the heart causes **bradycardia**
Hemorrhagic Shock

- Massive Blood Loss
- Hypotension with Tachycardia
- Requires fluid resuscitation/inotropic medications
- Can occur with neurogenic shock
Autonomic dysfunction

• Hypothermia:
  – Hypothermia → arrhythmias, coagulopathy, etc.

• Paralytic ileus
  – Need NG (or OG) tube to decompress abdomen
  – Distended abdomen can interfere with respirations

• Urinary retention
  – Foley cath: Prevent bladder overdistension
Neurological assessment
Secondary Survey
Complete or incomplete injury?

• “Incomplete” = preservation of sensory or motor function below the level of the lesion

• Important to look for:
  – Any voluntary movements in the lower extremities (e.g. voluntary toe flexion)
  – Preserved joint position sense
  – “Sacral sparing” = sensation around the anus, voluntary rectal sphincter contraction
Motor testing

- **Upper extremity**
  - C5 – elbow flexors
  - C6 – wrist extensors
  - C7 – elbow extensors
  - C8 – finger flexors (distal phalanx of middle finger)
  - T1 – finger abductors (little finger)

- **Lower extremity**
  - L2 – hip flexors
  - L3 – knee extensors
  - L4 – ankle dorsiflexors
  - L5 – long toe extensors
  - S1 – ankle plantar flexors
Sensory testing

- C3 – supraclavicular fossa
- C4 – top of shoulder
- C5 – lateral elbow
- C6 – thumb
- C7 – middle finger
- C8 – little finger
- T4 – nipple
- T10 – umbilicus
- L2 – medial thigh
- L3 – medial knee
- L4 – medial ankle
- L5 – dorsum of foot between 1\textsuperscript{st} & 2\textsuperscript{nd} digits
- S1 – lateral heel
- S4-5 – perianal region
Neurologic Examination

**ASIA Motor Index**

- **A** – Complete Lesion
- **B** – Incomplete - Sensory Only
- **C** – Incomplete Motor <3
- **D** – Incomplete Motor >3
- **E** – Intact
Immobilization

• All trauma patients with spinal column injury, or with a mechanism of injury having the potential to cause spine injury should be immobilized at the scene and during transport

• Recommend rigid with cervical collar and supportive blocks on a backboard with straps

• Prolonged immobilization = decubitus ulcers
Spine Immobilization
Spine Immobilization

- Extrication – immobilize first
- Goal – neutral alignment
- Rigid backboard – standard
- Supportive Blocks and Straps
- Various patient transfer techniques
Pediatric Considerations

Immobilization

- Immobilize in neutral position
- < age 8: large head :: torso
- *avoid standard spine board*

Nyppaver Ann Emerg Med 1994:
Mean torso elevation = 2.5 cm
Align shoulders with external auditory meatus

Huerta Ann Emerg 1987:
- Collar alone not useful
- Recessed board or should roll

*Half spine board, rigid collar & tape!*
Helmet Removal
Transportation

- Avoid traction
- Supine patient position in Trendelenberg
- Avoid sudden stops and starts
- Tertiary care center if possible
Transport Priority

• Ambulance < 50 miles (81 km)
• Helicopter 50 – 150 miles (81-242 km)
  peak traffic
  severe injuries
• Fixed wing aircraft > 150 miles (242 km)
Multiple Injured Patient
Beware: multiple system trauma

- Trauma associated with spinal cord injury:
  - MSK (18%)
  - Head (16%)
  - Lung (10.5%)
  - Abdominal (2.5%)
  - CV (1.5%)

- The spinal cord injury may mask the presence of other injuries (e.g. abdominal injuries)
The National Acute Spinal Cord Injury Studies (NASCIS)

NASCIS 1 (Jan, 1984)

Efficacy of Methylprednisolone in Acute Spinal Cord Injury

NASCIS 2 (May, 1990)

A randomized, controlled trial of methylprednisolone or naloxone in the treatment of acute spinal-cord injury

NASCIS 3 (May, 1997)

Administration of Methylprednisolone for 48 or 48 Hours or Tirilazad Mesylate for 48 Hours in the Treatment of Acute Spinal Cord Injury
Debating the Merits of Methylprednisolone

Severe criticism of NASCIS II and III, and other human studies of methylprednisolone.

Scientific Review

High dose methylprednisolone in the management of acute spinal cord injury – a systematic review from a clinical perspective

DJ Short*,1, WS El Masry1,3 and PW Jones2,4

1Midlands Centre for Spinal Injuries, Robert Jones & Agnes Hunt Orthopaedic & District Hospital NHS Trust, Oswestry, Shropshire, SY10 9DP, UK; 2Department of Mathematics, Keele University, Staffordshire, ST5 5BG, UK
Criticisms of NASCIS 3

Complications Associated with Prolonged MP Infusion
(48 hour infusion vs 24 hour)

Severe pneumonia: 2x (p=0.02)
Severe sepsis: 4x (p=0.07)
Death due to respiratory complications: 6x (p=0.056)

The additional 24 hours of high dose MP infusion is not without additional risk!
“Treatment with methylprednisolone for either 24 or 48 hours is recommended as an option... that should be undertaken only with the knowledge that the evidence suggesting harmful side effects is more consistent than any suggestion of clinical benefit.”

American Association of Neurological Surgeons & Congress of Neurological Surgeons
- March 2002
Spinal Cord Modest Hypothermia

Potential Benefits

- ↓ volume of damaged tissue
- ↓ # of damaged neurons and axons
- ↓ edema
- ↓ hemorrhage
- ↓ metabolism and energy utilization
- ↓ hypoxic damage
- ↓ decreases blood-brain barrier alterations

- ↓ inflammation (e.g., PMN activity)
- ↓ excitotoxicity
- ↓ free radical production
- ↓ oxidative stress
- ↓ apoptosis
- ↑ functional recovery
Levi et al., Neurosurgery, Feb 23, 2010

Clinical Outcomes Using Modest Intravascular Hypothermia After Acute Cervical Spinal Cord Injury

<table>
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<tr>
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<th>IMPROVED</th>
<th>SURGICAL DECOMPRESSION &lt;24 HRS</th>
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<tbody>
<tr>
<td>Hypothermia N=14</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Matched Controls N=14</td>
<td>3</td>
<td>7</td>
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Radiographic Assessment
Neurological Deterioration Due to Unrecognized Spinal Instability

- Insufficient imaging studies
- Misread imaging
- Poor quality imaging
Optimal Radiographic Analysis

- Fast
- Accurate
- Minimize patient transport
- Cost
Clinical Clearance of Cervical Spine

• Awake, alert, cooperative
• No drugs, alcohol, loss of consciousness
• Low energy mechanism
• No spinal pain
• No distracting injuries
• No neurological complaints nor deficits
Lateral Cervical Radiograph

- Initial screen frequently inadequate
- Most common reason for missed injuries
- Failure to visualize the cervicothoracic and occipital cervical junction

Davis et al., J Trauma 1993
Rationale for Additional Cervical Views

- 74-93% Cervical injuries detected on lateral radiograph
- High false negative rate requires AP/Open mouth view
- 99% Injuries detected on 3 views

Montgomery et al., Neurosurg. 2002
Indications
Radiographs Thoracic/Lumbar Spine

• Cervical spine injury detected: 11% incidence of noncontiguous spine fractures
• Regional pain
• Chest/Abdomen/Pelvis injuries
• Fall from height with calcaneus fractures
• Neurological deficit at thoracolumbar level
• Altered mental status

Vaccaro et al., J Spinal Disorders 1992
Radiographs
Thoracic and Lumbar Spine

• AP/Lateral Thoracic and lumbar spine
• Difficulties visualizing upper thoracic region
• May cut off thoracolumbar spine
• Flexion-extension views play no role in evaluation of injuries
Advanced Imaging Studies
CT Scans

- CT integral part of assessing a trauma patient
- Helical CT scanning (Head-toe) <2 minutes: accurate reconstructions
- CT is becoming initial imaging modality of choice for evaluation trauma patients
- CT scan more sensitive than plain radiographs
- Clear visualization of junctions
- Limited ability to detect pure ligamentous injuries

Grogan et al., J Am Coll Surg. 2005
Brandt et al., J of Trauma 2004
Hauser et al., J of Trauma 2003
Cervical Spine CT Scan

- Poor quality radiographs
- Detection of cervical injury
- Unable to assess patient
- Neurological injury detected
- Neck pain despite negative radiographs
- Sensitivity/Specificity 98%

McCulloh et al., JBJS 2006
MRI

- Role as initial imaging modality debatable
- Superior visualization of soft tissues: discs, ligaments, spinal cord
- Long acquisition time may be dangerous in hemodynamically unstable patient
Indications

MRI

- Unexplained neurological deficit based on boney injury
- Suspect HNP in face of cervical dislocation
- SCIWORA- Child, hematoma, herniated disc
Cervical Spine MRI Uses

- Detection of unstable ligamentous injuries
- Typically a fat suppressed STIR image
- Obtunded patients for C-spine clearance
18 year old Annapolis High School Football Player

- Strong safety sustaining massive hit
- Semiconcious, difficulty moving arms and legs, neck pain
18 yr old High School football player

- Immobilized
- ABC’s
- EMS mobilized
- IV’s placed, BP maintained, steroid started
- Transported to STC
18 yr old Male C6
ASIA C
Conclusion

- Preparedness and organization on the field is mandatory when taking care of athletes
- Always have a high index of suspicion
- Stabilization/Safety always come first
- Understand how to implement acute treatment and appropriate return to play criteria
- SCI are very rare!
Thank you