Cervical Spine Injuries in Hockey

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DISCLOSURES
Case example:
“Hey, doc. My neck hurts.”

- 30 yo NFL lineman involved in head-to-head collision during a preseason game
- Player continued playing for four plays before reporting any symptoms
- No LOC
- Evaluated on sideline immediately and brought to locker room for further evaluation
- No headache, dizziness, or problems with vision
- No neurologic signs or symptoms noted
- Described pain in posterior aspect of neck and stiffness
Cervical Fracture

- Each year there are 6,000 to 10,000 spinal cord injuries.
- 35-45% are due to motor vehicle accidents account for.
- Falls account for 25% to 30%.
- Most of the rest are related to sports, especially football, rugby, ice hockey, soccer, diving, gymnastics, and wrestling.
- Nevertheless, catastrophic neck injuries are infrequent in sports, with a prevalence of less than 2/100,000 neck injuries.
Cervical Vertebrae

- Small vertebral bodies
- Less weight to carry
- Extensive joint surfaces
- Greater ROM
Cervical Fracture

- Hyperflexion was previously thought to be the major cause of injury.
- **Axial loading** is now recognized as the primary cause of injury although flexion-rotation, hyperflexion, or extension may produce significant injuries.
Cervical Fracture: Axial Loading

- When the spine (neck) is slightly extended, external forces to the neck can be dissipated with controlled spinal motion through the muscles and curvature of the spine.
- When the neck is slightly flexed (30°), the vertebra line up in a linear (straight) fashion.
- Under this alignment, the force is absorbed entirely by the bones ligaments and disks, rather than the muscles.
- This is called axial loading.
Most common cause of injury

- Boarding
  - Push/check from behind into boards
  - Forward flexion of head/neck
  - Crown of head into boards
Cervical Fracture

- Injuries may occur at speeds as low as 8-9 miles per hour.
- Head motion seems to have little influence on the injury.
- Most common injuries at C4-C6 but tend to be higher in older individuals.
Cause of injury

- **Bishop, PJ, Wells, RP (1989)**
  - Velocity 1.8 m/s →
    - With axial compression
    - Can reach 75% load failure of C3-5

- **Sim, FH, Chao, EY (1978)**
  - Skating speeds can exceed 12 m/s (~27 mph)
  - Sliding can exceed 6.7 m/s (~15 mph)
Radiographic imaging

Who needs an x-ray of the spine?

- **NEXUS - The National Emergency X-Radiograph Utilization Study**
  - Prospective study to validate a rule for the decision to obtain cervical spine x-ray in trauma patients

- **Canadian C-Spine rules**
  - Prospective study whereby patients were evaluated for 20 standardized clinical findings as a basis for formulating a decision as to the need for subsequent cervical spine radiography
  - Stiell I. *JAMA.* 2001; 286:1841-1846
NEXUS

NEXUS Criteria:
1. Absence of tenderness in the posterior midline
2. Absence of a neurological deficit
3. Normal level of alertness (GCS score = 15)
4. No evidence of intoxication (drugs or alcohol)
5. No distracting injury/pain
Patient who fulfilled all 5 of the criteria were considered low risk for C-spine injury

→ **No need C-spine X-ray**

For patients who had any of the 5 criteria

→ radiographic imaging was indicated
  (AP, lateral and open mouth views)
The Canadian C-spine Rule for alert and stable trauma patients where cervical spine injury is a concern.

<table>
<thead>
<tr>
<th>Any high-risk factor that mandates radiography?</th>
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<tbody>
<tr>
<td>- Age &gt; 65yrs or</td>
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<td>- Dangerous mechanism or</td>
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<td>- Paresthesia in extremities</td>
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</table>

**NO**

<table>
<thead>
<tr>
<th>Any low-risk factor that allows safe assessment of range of motion?</th>
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<tbody>
<tr>
<td>- Simple rear-end MVC, or</td>
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<td>- Sitting position in ER, or</td>
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<td>- Ambulatory at any time, or</td>
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<td>- Delayed onset of neck pain, or</td>
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<tr>
<td>- Absence of midline C-spine tenderness</td>
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**NO**

**YES**

**UNABLE**

**ABLE**

**Radiography**

**No Radiography**
Both have:

▸ Excellent negative predictive value for excluding patients identified as low risk

&

The Canadian C-spine rule
Clearance of Cervical Spine Injury in Conscious, Symptomatic Patients

1. Radiological evaluation of the cervical spine is indicated for all patients who do not meet the criteria for clinical clearance as described above

2. Imaging studies should be technically adequate and interpreted by experienced clinicians
Cervical Spine Imaging Options

- **Plain films**
  - AP, lateral and open mouth view
  - Optional: Oblique and Swimmer’s

- **CT**
  - Better for occult fractures

- **MRI**
  - Very good for spinal cord, soft tissue and ligamentous injuries

- **Flexion-Extension Plain Films**
  - to determine stability
Radiological evaluation

X-ray Guidelines (cervical)

AABBCDS

- Adequacy, Alignment
- Bone abnormality, Base of skull
- Cartilage
- Disc space
- Soft tissue
C/S Fractures

- Unstable
  - Flexion Teardrop
  - Hangman’s
  - Hyperextension fracture dislocation
  - Burst
  - Jefferson’s
  - Odontoid

- Stable
  - Clay Shoveler’s
  - Wedge
  - Extension Teardrop
Fractures of the Atlas

- Jefferson’s fracture (bursting fracture of the atlas)
- Atlas posterior arch fracture
- Atlas anterior arch fracture
- Atlas lateral mass fracture
- Transverse ligament rupture
Jefferson’s Fracture

- Bursting fracture of ring of atlas through both anterior and posterior arches; up to 1/3 of all atlas fxs.
- Compression on vertex of skull transmits forces through occipital condyles to lateral masses of atlas; m.c. MVA or diving accidents
- Death or significant injury is rare; technically decompresses the cord
- Bracing is preferred treatment; malunion may occur
Transverse Ligament Rupture

- If traumatic, usually associated with fxs. Elsewhere
- Also associated with inflammatory arthritides (RA, AS, PA, Reiter’s); Down’s syndrome (20%)
- Rad. signs are increased ADI (>3mm adult, >5mm children) with disruption of spinolaminar line
- Steele’s rule of thirds- atlas ring is 1/3 cord, 1/3 space, 1/3 dens
Ruptured Transverse Ligament

http://www.imageinterpretation.co.uk/images/cervicalspine/FLEXION - SUBLUXATION RA.jpg
Fractures of the Axis

- Hangman’s fracture (traumatic spondylolisthesis)
- Extension teardrop fx.
- Dens fxs.
Hangman’s Fracture

- Forced hyperextension causes B/L pedicle fxs. of C2, usually with anterior displacement of C2 on C3
Extension Teardrop Fx.

- Avulsion of small fragment from anteroinferior body of C2 from hyperextension
- Usually occurs with hangman’s
- Stable on its own
Dens Fractures

- **Type I** - avulsion of the tip
- **Type II** - fracture through the base; unstable; m.c. type
- **Type III** - fx. through body of C2 below base of dens
Vertebral Body Compression Fractures

- Wedge fractures
- Burst fractures
- Flexion teardrop fracture
Wedge fracture

- Caused by hyperflexion with vertical height of the vertebral body decreased anteriorly, as viewed on the lateral film
- The posterior elements remain intact
- This is a stable injury

http://www.imageinterpretation.co.uk/images/cervicalspine/ANTERIOR WEDGE COMPRESSION.jpg
Burst Fracture

- Caused by axial compression, the intervertebral disc is driven into the vertebral body below
- Vertebral body explodes into several fragments; a fragment from the postero-superior surface being driven posteriorly into the spinal canal
- Unstable injury that frequently results in spinal cord injury
  - Important to check the posterior vertebral cortex for evidence of disruption, on an apparently simple wedge compression injury on plain film lateral
- Best appreciated on CT
Flexion Teardrop Fracture

- Fracture of the anteroinferior aspect of a cervical vertebral body due to flexion of the spine along with vertical axial compression
- Usually associated with a spinal cord injury, often a result of displacement of the posterior portion of the vertebral body into the central spinal canal
- Unstable

http://radiographics.rsna.org/cgi/content-nw/full/19/5/1143/F11A
Articular Pillar Fracture

- Combined hyperextension and lateral flexion; usually MVA

[Image: Radiographic scans showing articular pillar fracture]
Clay Shoveler’s Fracture

Stable avulsion fracture through the spinous process of a vertebra occurring at any of the lower cervical or upper thoracic vertebrae, classically at C6 or C7

http://www.mypacs.net/cases/CLAY-SHOVELERS-FRACTURE-C6-SPINOUS-PROCESS-7102696.html
Abnormal Soft Tissue Radiographic Signs

- Retropharyngeal space - anterior to C2 should not exceed 6mm in children or adults.

- Retrotracheal space - anterior to C6 body should not exceed 14mm in children or 22mm in adults.

  - Hematoma, abscess, or edema may cause widening.

*Soft tissue emphysema - Tracheal laceration, pneumomediastinum or pneumothorax may cause gas to be seen in the soft tissues of the neck.*

[Image of radiograph]
Dislocations of the Cervical Spine

- Atlant-occipital dislocation
- Atlantoaxial dislocation
- Bilateral interfacetal dislocation
- Unilateral interfacetal dislocation
Atlanto-occipital Dislocation

- Rare, usually fatal
- Hyperextension and traction

3x more common in pediatric patients
Bilateral Interfacetal Dislocation

- Severe flexion injury
- Both anterior and posterior ligamentous structures are disrupted at site of injury
- Superior vertebra dislocates forward by 50% or more of the body below
- Quadriplegia frequently develops

- If there is a fracture through posterior elements, less chance of neurologic injury as cord can decompress
Unilateral interfacetal dislocation

- Mechanism is flexion/distraction and rotation
- Inferior articular facet of superior vertebral body is locked in front of the superior facet of the more inferior vertebral body but only on one side
- Slight anterior subluxation of one vertebral body on the one below; <25% of width
- On lateral view of cervical spine, some bodies appear true lateral below level of injury and oblique above level of injury
- Bow-tie sign
Unilateral Facet Dislocation

http://www.brooksidepress.org/Products/OperationalMedicine/DATA/operamed/Lab/CSpine/UnilateralLockedFacets.htm
ASIA classification

STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

**Motor**

- **Key Muscles**
  - C2: Elbow flexors
  - C3: Wrist extensors
  - C4: Elbow extensors
  - C5: Finger flexors (distal phalanges of middle finger)
  - C6: Finger abductors (little finger)

**Light Touch**

- **KEY SENSORY POINTS**
  - D: absent
  - I: impaired
  - 2: normal
  - N/I: not testable

**Sensory**

- **Key Sensory Points**

**Grade**

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<tr>
<th>Grade</th>
<th>Definition</th>
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<tbody>
<tr>
<td>A</td>
<td>Complete. No sensory or motor function is preserved in the sacral segments S4-S5</td>
</tr>
<tr>
<td>B</td>
<td>Incomplete. Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5</td>
</tr>
<tr>
<td>C</td>
<td>Incomplete. Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3 (Grades 0-2).</td>
</tr>
<tr>
<td>D</td>
<td>Incomplete. Motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade greater than or equal to 3.</td>
</tr>
<tr>
<td>E</td>
<td>Normal. Sensory and motor functions are normal.</td>
</tr>
</tbody>
</table>

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2009 BCS
Statistics

- Tator, et al. 2015 (from Canadian registry data; Clin J Sports Med)
  - 1943-1973-0
  - 1974-1981-6
  - 1982-1996-286 (94/96-53)
  - 2000-5
  - 2006-2011
    - 44 cases of SCI
Football Rule Change
Hockey Rule Change

Figure 19  Total number of major spinal injuries worldwide from 1966 to 1999 in ice hockey. *1978, Mandatory wearing of full facemask by junior players; **1985, new checking rules CAHA; ***1994, new checking from behind rules, IIHF.
Statistics

- Tator, et al. 2015 (from Canadian registry data; Clin J Sports Med)
  - 48% 16-20yo
  - 21% 11-15yo
  - 64.2% SCI from hitting boards
Statistics

- Tator, et al. 2015 (from Canadian registry data; Clin J Sports Med)

  - ~25% complete loss of motor
  - ~75% some neurologic deficit
Management

- Pre-event action planning
- ABC’s
- C-spine immobilization

- NATA position statement
  - To remove or not to remove?
  - For now, “when appropriate, protective equipment may be removed prior to transport.”
Cervical Fracture: Treatment

- It has been estimated that 50% of neurological damage is created after the initial traumatic event, particularly in uncontrolled (recreational) settings.

- If the player is unconscious, assume cervical damage.
Cervical Fracture: Treatments

- The methods of spinal cord resuscitation seek to
  - Minimize hypoxia by maintaining blood flow and breathing
  - Minimize edema and inflammation with intravenous corticosteroids
  - Minimize damage to nerve cell membrane by not moving the person and eventual reduction of spinal deformity so as to relieve cord deformation
Cervical Fracture: Prevention

1. Continued research.
2. The identification of injury, epidemiologic, and clinical evidence.
3. Education of coaches and players. Keep head up (neck extension) on contact!
4. Establishment and enforcement of appropriate rules.
Look-up Line
“Burner” or “Stinger”

- Experienced by 50% of college football players at one time or another.
- Is not a spinal cord injury.
- Stretching of the cervical nerve roots because of excess lateral flexion of the neck.
- Generally symptoms resolve in 5 to 10 minutes, although permanent deficits have been documented in players who have repeated episodes.
Case example:
“Hey, doc. My neck hurts.”

- 30 yo NFL lineman involved in head-to-head collision during a preseason game
- Player continued playing for four plays before reporting any symptoms
- No LOC
- Evaluated on sideline immediately and brought to locker room for further evaluation
- No headache, dizziness, or problems with vision
- No neurologic signs or symptoms noted
- Described pain in posterior aspect of neck and stiffness
Exam

- Neurologically intact
- TTP over C1-C2 level
- Decreased range of motion with lateral bending and minimal ability to rotate
- Radiographs immediately obtained in locker room
Radiographs

- C1 fracture
Management

- C-spine precautions initiated and patient transported to nearest trauma center
- CT revealed mildly displaced fractures of anterior arch adjacent to lateral masses
  - 7 mm of lateral displacement of R Lateral fragment with sagittal split
  - 4 mm displacement of L lateral fragment
- Negative CT angio
- No MRI performed
Management

- Operative versus non-operative mgmt discussed
  - Fusion
  - ORIF
  - Rigid orthosis or halo immobilization
- Underwent C1 ORIF with placement of 32 mm lateral mass screws bilaterally with 3.5 mm rod
  - Maintained occiput -C2 distance and C1 ring
Follow-up

- Radiographs showed stable healed fracture at 3 months post-operatively
- At 4 months post-operatively patient had hardware removal
THANK YOU
References


