Head and Neck Injuries in Athletes

The Sports Medicine Core Curriculum Lecture Series
Sponsored by an ACEP Section Grant
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Lecture Goals

Discuss head injuries, c-spine injuries, neck injuries occurring in contact sports

Review acute management
  Concussion and cervical spine injuries

Discuss Treatment options
  Including experimental

Demonstrate proper removal of football helmet and pads.
Sports Associated with Catastrophic Injuries

Football
Ice Hockey
Soccer
Basketball
Rugby
Gymnastics
Pole Vaulting
Diving
Case

19 y.o. male, playing soccer
Hit right fronto-parietal head on another’s skull
Unconscious for 20 sec
Brought to ED with amnesia for event, but normal neuro exam
Right frontal scalp contusion
Developed seizure, responded to Ativan
Admitted for observation
Slight psychomotor slowing with slurred speech
Possibly related to Ativan and seizure?
8 hours later developed N/V, and headache
Repeat CT showed development of interval epidural bleed

Bruzzone, AJSM 2000
Head Injuries

Severe: GCS <8
   25% require NS intervention

Moderate: GCS 9-13
   “talk and deteriorate” 75% SDH or EDH.
   - Worse prognosis than when presenting initially with GCS<8

Minor: GCS 14-15
   Sports related account for 5-10% seen in ED.
   3% deteriorate unexpectedly
   <1% require neurosurgical intervention

Rosen’s 6th Ed.
Types of head injuries

- Subdural hematoma
- Epidural hematoma
- Subarachnoid hemorrhage
- Intracranial hemorrhage
- Cerebral contusion
- Diffuse axonal injury
- Concussion
Pathophysiology

Direct Impact
  Skull fracture
  Energy transmitted via shock waves
    • Distort/disrupt contents, altering ICP

Indirect Injury
  Acceleration/deceleration injury
    • Bridging subdural vessels strained → SDH
  Diffuse Axonal Injury
  Concussion
  Contrecoup contusion
Pathophysiology

Primary brain injury: mechanical irreversible damage
  Brain laceration
  Contusion (microvascular injury)
  Tissue avulsion

Secondary brain injury
  Depolarization of brain cells and ionic shifts
  Free radical scavengers overwhelmed

Secondary Systemic Insults
  Hypotension (SBP<90), anemia, hypoxia
Pediatric Considerations

Fewer traumatic hemorrhagic lesions
Fewer contusions
More diffuse brain swelling
More axonal injury
Deterioration more likely 2°/2 edema
Concussion

Concussus- (Latin) “to shake violently”

300,000 US athletes with concussion yearly reported

3-8% high school football players have concussions annually (~150,000/yr)

Up to 19% contact sports players have one concussion per year
Pathophysiology

Alterations in glutamate, potassium and calcium transport

Relative decrease in cerebral blood flow in the setting of an increased requirement for glucose
# Symptoms of Concussion

<table>
<thead>
<tr>
<th>Confusion</th>
<th>Headache</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amnesia</td>
<td>Fatigue</td>
</tr>
<tr>
<td>Loss of consciousness</td>
<td>Dizziness</td>
</tr>
<tr>
<td>Disorientation</td>
<td>Nausea/Vomiting</td>
</tr>
<tr>
<td>Feeling in a ‘fog’</td>
<td>Photophobia</td>
</tr>
<tr>
<td>Vacant stare</td>
<td>Phonophobia</td>
</tr>
<tr>
<td>Inability to focus</td>
<td>Emotional lability</td>
</tr>
<tr>
<td>Delayed verbal and motor</td>
<td>Irritability</td>
</tr>
<tr>
<td>Slurred speech</td>
<td></td>
</tr>
<tr>
<td>Drowsiness</td>
<td></td>
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</tbody>
</table>
Most athletes are symptom free within 15min. Why not return to activity?

Decreased mental ability - judgment, memory

Decreased physical ability - balance, coordination

Re-injury rate high within 10 days of initial injury: 4-6X

Second impact syndrome

Long-term cognitive difficulties

  Relationship to depression in retired NFL players?
Second Impact Syndrome

Second, often minor head trauma, occurred before symptoms from first injury have resolved.

Loss of autoregulation of brain blood supply → vascular engorgement → herniation and death.

Controversial (difficult to prove: only case studies)

Cantu, 2006
College Football Data
Concussion Risk by Position


Copyright JAT.
College Hockey Data
Game Concussion Mechanism


Copyright JAT.
Concussion Grading

Cantu Grading System
Roberts Grading System
Torg Grading System
American Academy of Neurology 1997

All segregate severity by loss of consciousness which does not clinically correlate with severity of symptoms
All recommend return to play guidelines based upon duration of symptoms or loss of consciousness
To CT or not CT

Goal to Find:
1. clinically relevant head injuries
2. injuries requiring neurosurgery intervention

New Orleans Criteria:
1. Headache
2. Vomiting
3. Older than 60yrs
4. Drugs or EtOH
5. Persistent anterograde amnesia
6. Visible trauma above clavicle
7. Seizure

Canadian CT Head Rules:
1. GCS <15 2hr after event
2. Suspected open/depressed skull Fx
3. Sign of basilar skull Fx
4. 2 or more episodes of vomiting
5. >65 yr old
6. Amnesia of >30 min prior to event
7. Dangerous mechanism.
CT rough guidelines

All with GCS <15
Anterograde amnesia
LOC
Persistent vomiting
Seizure
Trauma above clavicles
Age >65

*Role for reliable observation instead of imaging
Neurocognitive Scoring

Baseline score at start of season

Head injury Occurs

Re-score when symptom free

Goal is to assist with return to play decision
ImPACT scoring sheet

High school athletes

Baseline testing (20min computerized test: cognitive and motor skills/reaction time)

Re-test after injury on day 2, 7, 14.

ImPACT Conclusions

Concussion grade not related to recovery time
Some ‘Grade 1’ concussions took as long as 14 days to recover
Grading scale not consistent with neurocognitive scores
Amnesia better predictor for outcomes than loss of consciousness

Recovery may not be linear

Neurocognitive defects took longer to recover than self reported symptoms (speed, visual and verbal memory).

Consensus Conferences on Concussion

Vienna Conference 2001
Symptomatic athletes should be withheld from returning to play
No athlete should be returned to play until medically evaluated

Prague Consensus Guidelines 2004
Classify as Simple (resolves <10d) vs. Complex
(persistent symptoms, seizure, easy recurrence)
New SCAT card

Zurich Consensus Guidelines 2008
Review of evidence based medicine
Gradual step-wise return to play outlined
Return to Play guidelines

Withhold from play immediately

Step-wise progression of activities
1) Complete rest.
2) Light aerobic exercise
3) Sports specific exercises with resistance training
4) Non-contact training drills
5) Full contact training/practice
6) Game play

Caution on side of withholding
(especially given high likelihood of underreporting of symptoms)
Utilization of scoring tests (need accurate baseline score)
Concussion discharge instructions

Where to get → cdc.gov

Acute Concussion Evaluation (ACE)

Case Plan

Patient Name: ____________________________ Age: ____________________________
DOB: ____________________________ Date: ____________________________
ID #: ____________________________ Date of injury: ____________________________

You have been diagnosed with a concussion (also known as a mild traumatic brain injury). This personal plan is based on your symptoms and is designed to help speed your recovery. Your careful attention to it can also prevent further injury.

Rest is key. You should not participate in any high risk activities (e.g., sports, physical education [PE], riding a bike, etc.) if you still have any of the symptoms below. It is important to limit activities that require a lot of thinking or concentration (homework, job-related activities), as this can also make your symptoms worse. If you no longer have any symptoms and believe that your concentration and thinking are back to normal, you can slowly and carefully return to your daily activities. Children and teenagers will need help from their parents, teachers, coaches, or athletic trainers to help monitor their recovery and return to activities.

Today the following symptoms are present (circle or check):

<table>
<thead>
<tr>
<th>Physical</th>
<th>Emotional</th>
<th>Sleep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headaches</td>
<td>Sensitivity to light</td>
<td>Feeling mentally foggy</td>
</tr>
<tr>
<td>Nausea</td>
<td>Sensitivity to noise</td>
<td>Problems concentrating</td>
</tr>
<tr>
<td>Fatigue</td>
<td>Numbness/Tingling</td>
<td>Problems remembering</td>
</tr>
<tr>
<td>Visual problems</td>
<td>Feeling more emotional</td>
<td>Feeling more stressed</td>
</tr>
<tr>
<td>Balance problems</td>
<td>Dizziness</td>
<td>Nervousness</td>
</tr>
</tbody>
</table>

Red Flags: Call your doctor or go to your emergency department if you suddenly experience any of the following:

| Headache that worsens | Look very sleepy, can’t stay awakened | Can’t concentrate, cannot read, people in places |
| Dizziness | Seizures | Increasing irritability |
| Neck pain | Speech changes | Increasing irritability |
| Swollen or bruised ear or leg |

Returning to Daily Activities

1. Get lots of rest. Be sure to get enough sleep at night—no late nights. Keep the same bedtime weekdays and weekends.
2. Take daytime naps or rest breaks when you feel tired or fatigued.
3. Limit physical activity as well as activities that require a lot of thinking or concentration. These activities can make symptoms worse.
   - Physical activity includes PE, sports practices, weight training, running, exercising, heavy lifting, etc.
   - Thinking and concentration activities (e.g., homework, classroom work, job-related activity).
4. Drink lots of fluids and eat carbohydrates or protein to maintain appropriate blood sugar levels.
5. As symptoms decrease, you may begin to gradually return to your daily activities. If symptoms worsen or return, lessen your activities, then try again to increase your activities gradually.
6. During recovery, it is normal to feel frustrated and sad when you do not feel right and you can’t be as active as usual.
7. Repeat evaluation of your symptoms is recommended to help guide recovery.

Returning to Work

1. Planning to return to work should be based upon careful attention to symptoms and under the supervision of an appropriate health care provider.
2. Limiting the amount of work you do soon after your injury may help speed your recovery. It is very important to get a lot of rest. You should also reduce your physical activity as well as activities that require a lot of thinking or concentration.

   - Do not return to work. Return on (date) ____________.
   - Return to work with the following supports. Review on (date) ____________.

Schedule Considerations

| Shortened work day | ____________ hours |
| Allow breaks when symptoms worsen | ____________ |
| Reduced task assignments and responsibilities | ____________ |

Safety Considerations

| No heavy lifting or working with machinery | ____________ |
| No heights due to possible dizziness, balance problems | ____________ |

American College of Emergency Physicians
ADVANCING EMERGENCY CARE

SportsMed
Returning to School

1. If you (or your child) are still having symptoms of concussion you may need extra help to perform school-related activities. As your (or your child’s) symptoms decrease during recovery, the extra help or supports can be removed gradually.

2. Inform the teacher(s), school nurse, school psychologist or counselor, and administrator(s) about your (or your child’s) injury and symptoms. School personnel should be instructed to watch for:
   - Increased problems paying attention or concentrating
   - Increased problems remembering or learning new information
   - Longer time needed to complete tasks or assignments
   - Greater irritability, less able to cope with stress
   - Symptoms worsen (e.g., headache, tiredness) when doing schoolwork

~Continued on back page~

Returning to School (Continued)

Until you (or your child) have fully recovered, the following supports are recommended: (check all that apply)

__ No return to school. Return on (date)____________________

__ Return to school with following supports. Review on (date)____________________

__ Shortened day. Recommend ___ hours per day until (date)____________________

__ Shortened classes (i.e., rest breaks during classes). Maximum class length: _____ minutes.

__ Allow extra time to complete coursework/assignments and tests.

__ Lessen homework load by ________%. Maximum length of nightly homework: _______ minutes.

__ No significant classroom or standardized testing at this time.

__ Check for the return of symptoms (use symptom table on front page of this form) when doing activities that require a lot of attention or concentration.

__ Take rest breaks during the day as needed.

__ Request meeting of 504 or School Management Team to discuss this plan and needed supports.
Returning to Sports

1. **You should NEVER return to play if you still have ANY symptoms** – (Be sure that you do not have any symptoms at rest and while doing any physical activity and/or activities that require a lot of thinking or concentration.)

2. Be sure that the PE teacher, coach, and/or athletic trainer are aware of your injury and symptoms.

3. It is normal to feel frustrated, sad and even angry because you cannot return to sports right away. With any injury, a full recovery will reduce the chances of getting hurt again. It is better to miss one or two games than the whole season.

   **The following are recommended at the present time:**
   
   ___ Do not return to PE class at this time
   ___ Return to PE class
   ___ Do not return to sports practices/games at this time
   ___ **Gradual** return to sports practices under the supervision of an appropriate health care provider (e.g., athletic trainer, coach, or physical education teacher).
   
   - Return to play should occur in **gradual steps** beginning with aerobic exercise only to increase your heart rate (e.g., stationary cycle); moving to increasing your heart rate with movement (e.g., running); then adding controlled contact if appropriate; and finally return to sports competition.
   
   - Pay careful attention to your symptoms and your thinking and concentration skills at each stage of activity. Move to the next level of activity only if you do not experience any symptoms at each level. If your symptoms return, let your health care provider know, return to the first level, and restart the program gradually.

Gradual Return to Play Plan

1. No physical activity

2. **Low** levels of physical activity (i.e., symptoms do not come back during or after the activity). This includes walking, light jogging, light stationary biking, light weightlifting (lower weight, higher reps, no bench, no squat).

3. Moderate levels of physical activity with body/head movement. This includes moderate jogging, brief running, moderate-intensity stationary biking, moderate-intensity weightlifting (reduced time and/or reduced weight from your typical routine).

4. Heavy non-contact physical activity. This includes sprinting/running, high-intensity stationary biking, regular weightlifting routine, non-contact sport-specific drills (in 3 planes of movement).

5. Full contact in controlled practice.

6. Full contact in game play.

*Neuropsychological testing can provide valuable information to assist physicians with treatment planning, such as return to play decisions.*
Neck injuries

Fractures (stable vs unstable):
  - Compressive-flexion (teardrop)
  - Vertical compression (burst)
Subluxation/Dislocation
Vascular injury
Intervertebral disk herniation
Brachial plexus injury
Nerve root injury

Spinal Cord Injury:
  - Transverse myelopathy
  - Central cord syndrome
  - Anterior spinal cord syndrome
  - Brown-Sequard syndrome
  - Posterior spinal cord syndrome
  - Transient quadriplegia
Spinal Cord Lesions

Complete
Mimicked by spinal shock (<24hr)
Check for sacral sparing (central cord)

Incomplete
Central cord
- UE > LE
- Older (OA) with hyperextension
Brown-Sequard
- Penetrating most common
- Ipsilateral motor, contralateral sensory
Anterior Cord
- Hyperflexion
- Cord contusion → bony fragments or disk
- Preservation of position, touch, proprioception
Figure 9, p1085. Algorithm for work up of neck injury. Rahul Banerjee, Mark A. Palumbo and Paul D. Fadale
Case

HPI:
17 y.o. high school football linebacker
Intermittent stinging/"lightening" pain down right arm with some tackles
Started last season, but is more frequent now

PE:
Healthy appearing
RUE: No muscle wasting, and normal sensation to light touch, temperature, and pain, transiently weaker strength in proximal arm
“Stingers”

Key points:
- Unilateral
- Symptoms are temporary
- Full recovery of normal function
- No neck pain noted

C5-6 dermatome most often involved - traction or compression of brachial plexus or cervical nerve root
*Up to 50% football players have an episode
Treatment of Stingers

Conservative treatment
Sling, Rest, Ice

Return to play:
Full cervical range of motion
Normal strength
No symptoms
Case: 18 yo F college gymnast falls onto head coming off of vault c/o neck pain- backboard and c-collar on site
‘Injuries to the Cervical Spine in American Football Players’

1965 – 1974
40 fatalities
1975 – 1984
14 fatalities
1985 – 1994
5 fatalities

*primarily due to tackling

The effect of the 1976 rule changes banning spearing and head-impact playing techniques was dramatic, with a sustained decrease in the number of players who sustained permanent cervical quadriplegia.

www.jbjs.org

Figure 4. Torg et al. Injuries to the Cervical Spine in American Football Players. JBJS 84-A (1):112-122, 2002
Mechanics of injury

Axial loading with cervical flexion (30°)
Excessive forces -> segmental buckling, fractures or dislocation

Figure 3. Torg et al. The epidemiologic, pathologic, biomechanical, and cinematographic analysis of football induced cervical spine trauma. AJSM 18 (1):50-57, 1990

Figure 5. (A) Axial loading of the cervical spine (B) first results in compressive deformation of the intervertebral discs. As the energy input continues and maximum compressive deformation is reached, angular deformation and buckling occur (C). The spine fails in a flexion mode, with resulting fracture, dislocation, or subluxation (D and E).
When to Image Neck Injuries?

**NEXUS Low-risk Criteria**
- No posterior midline cervical tenderness
- No intoxication
- Normal mental status
- No focal neurologic deficits
- No painful distracting injuries

**Canadian C-Spine Guidelines**
- Midline tenderness
- Age >65
- Dangerous mechanism
- Neurologic symptoms
- Supine position
- Immediate onset of neck pain
- Able to rotate neck
Does Hypothermia Work?
Moderate Hypothermia

Hyperthermia following trauma or ischemia aggravates brain injury

Neuroprotective effects of cooling demonstrated

Theoretically, moderate hypothermia reduces inflammation that can cause secondary injury
Moderate Hypothermia

Cooling to 33 degrees Celsius (92 F)

Maintain for 48 hours

Gradually rewarm (1 degree/8 hours)
Moderate Hypothermia

Experimental
- Unknown who (if anyone) benefits
- Unknown who may be harmed
- NOT recommended as routine treatment

Everett = case of 1
- Vertebrae 3, 4 fracture/dislocation
- On-field care
- Hypothermia, steroids
- Top-notch surgical treatment
Special Teams Plays

1 head down contact per 1.8 kick returns
Education on proper tackling technique
All head down contact at risk for cervical spine injury

*Heck et al.:*
Risk of head down in high school football:
all plays = 25%, kick returns 38%

See NATA video “Heads Up: Reducing the Risk of Head and Neck Injuries in Football video”
http://www.nata.org/consumer/headsup.htm
Treatment options

Neurosurgical involvement
   Halo: spinal traction
   Facet relocation/spinal fusion
High dose steroids?:
   Methylprednisolone 30mg/kg over 15min,
   then 5.4mg/kg/hr over next 23hr if treated within 3hr.
   (If started at 3-8hr, continue for total of 48hrs)
   Do not start if not within first 8hr
   NFL guidelines: “use the institution’s standard”
Total body cooling (experimental)
Steroids

High dose methylprednisone for 24hr

Significant risk of detrimental outcome, especially if extend treatment

“evidence of harmful side effects is more consistent than any suggestion of clinical benefit.”
Transient quadraplegia

- Sensation: burning pain, numbness, tingling,
- Motor: weakness to complete paralysis.
- **Transient** and complete recovery usually 10-15min, although gradual resolution occurs over 36-48 hr rarely.
- Except for burning paresthesia, no neck pain
- Complete return of motor function and full, pain-free motion of the cervical spine.

Pincer effect
Adults: spinal stenosis
Children: spinal column mobility
Spinal Stenosis

Injuries related to congenital stenosis
Diameter: 18.4 mm
  Spinal Stenosis: <14mm
  Congenital or Acquired
    • Degenerative osteophyte formation: repetitive trauma
Torg ratio: (vertebral canal/body) <0.8 is not a reliable measure

*Functional Reserve: CSF around cord better predictor
Facemask removal

Remove facemask in the field:

gain access to airway for transport

Leave helmet on, otherwise

pads elevate body causing extension of neck

NCAA recommends Xray/CT w/ Helmet On

MRI: too much artifact with metal from straps

Facemask Removal

New Riddell Revolution Helmet
Concussion: 5.4 % of Revolution wearers vs 7.6 % other

FM Extractor

Trainer’s Angel

Cordless Screwdriver
less movement (any one plane, 2.8°–13.3°) was faster (mean 42.1–68.8 seconds)
*Rust/damaged screw head 6%-8% failure

Helmet Removal

Only remove helmet/pads if absolutely necessary on field
   Need to gain airway access
   Broken equipment

Always remove both pads and helmet as a unit

Use team of experienced caregivers
(data on cervical spine movement)
Pad/Helmet removal

Cut Jersey in front and at sleeves
Cut straps on shoulder pads (front and sleeves)
One person maintains cervical alignment
Cut chin strap (do not unsnap)
Remove ear pads & release air from helmet
Place responders hands directly on skin in thoracic region, with additional people added down the body.
Head person removes helmet, rotating anteriorly, then shoulder pads by spreading apart front panels and pulling over the head. Lower the patient, place c-collar.
Imaging


The answer is on! Clin J Sport Med 2003 Jan;13(1):57-8


Computed tomography is diagnostic in the cervical imaging of helmeted football players with shoulder pads. J Athl Train 2004 Sep;39(3):217-222
Preventative Measures

Helmets?
  Increase mass.
Concussion data
Mouth guards
Rule Changes
Technique changes (head up tackling)
Take Home Points

Do not return an athlete to competition the same day after sustaining even a mild transient concussion
Keep the helmet and shoulder pads on for transport and initial imaging of head and neck injuries
Be aware that symptoms of bilateral stingers require workup
Hypothermia for spinal cord injuries is still experimental
NATA References

Heads Up: Reducing the Risk of Head and Neck Injuries in Football video
http://www.nata.org/consumer/headsup.htm

Prehospital Care of the Spine-Injured Athlete
http://www.nata.org/statements/consensus/NATAPreHospital.pdf
Additional Resources

Sport Concussion Assessment Tool
http://www.newamssm.org/SCAT_v13_-_Side_1.doc
http://www.newamssm.org/SCAT_v13_-_Side_2.doc

CDC Resources
http://www.cdc.gov/ncipc/tbi/TBI.htm
Heads Up: Concussion in High School Sports (for coaches)
http://www.cdc.gov/ncipc/tbi/Coaches_Tool_Kit.htm
Heads Up: Brain Injury in Your Practice (for physicians)
http://www.cdc.gov/ncipc/tbi/physicians_tool_kit.htm
Heads Up: Concussion in Youth Sports (for parents and coaches)
http://www.cdc.gov/ConcussionInYouthSports/default.htm
References


References


Stiell IG, McKnight RD, Schull MJ. The Canadian C-Spine Rule versus the NEXUS Low-Risk Criteria in Patients with Trauma. NEJM. Dec 2003;349(26):2510-2518.
