Mild Traumatic Brain Injury In Sports

Brian Im MD
Jaime Levine DO
March 2014
Epidemiology

- Mild TBI constitutes 80-90% of TBI cases
- According to a Healthcare Cost and Utilization Project (HCUP) Report on data from 2008:
  - Approximately 44,000 sports related concussions and 550,000 non-sports related concussions
  - Only 3.7 percent of sports related concussion patients treated in the ED were admitted to the same hospital or transferred to another hospital for further treatment and 17.3 percent non-sports related concussion patients were admitted or transferred to another hospital
  - Males accounted for more than three-quarters of ED visits for concussion related to sports. This compares to 58.3 percent of males with non-sports related concussions.
- Underestimates the true incidence
  - Athletes often do not report symptoms for fear of being held out of sporting events. (ACSM)
Mild TBI:

- LOC < 30 min
- PTA < 24 hours
- Initial GCS > 12

These are some simple criteria to try to classify TBIs but many other factors go into what the severity and recovery course will be.
Glascow Coma Scale

- Scale for assessing depth of coma
- Lowest score = 3
- Highest score = 15
- *Best motor response*, best verbal response, eye opening
Posttraumatic Amnesia

• Interval of permanently lost memory following TBI

• End of PTA: GOAT score of 75% or greater on two consecutive days
Concussion:

- Poorly Defined
  - One definition is brain dysfunction without identifiable structural damage
  - Another definition is traumatic induced alteration in brain function that may or may not be accompanied by loss of consciousness
  - According to the 4th Zurich conference, sports concussion is “a complex patho-physiological process affecting the brain, induced by traumatic biomechanical forces”
Concussion:

• Further key points
  – May be caused by a blow to the head, neck, face, or elsewhere with a force transmitted to the head
  – Usually causes rapid short lived symptoms that gradually improve but in some cases, symptoms may take minutes to hours to develop and can also persist and take longer to recover
  – Most commonly causes alterations in function as opposed to structural changes

• Is it the same as Mild TBI?
Concussion:

NFL Headlines

• N.F.L. Issues New Guidelines on Concussions
  Published: December 2, 2009

• N.F.L. Acknowledges Long-Term Concussion Effects
  Published: December 20, 2009

• N.F.L. Asserts Greater Risks of Head Injury
  Published: July 26, 2010

• N.F.L. Will Expand Concussion Efforts During Games
  Published: February 26, 2013

• Study Analyzing Concussion Data for NFL Players May Provide Insight That Could Lead to Safer Play
  Published: February 4, 2014
Concussion:

But its not just football

• Earnhardt Jr. had concussion concerns before Daytona 500
  Published: March 1, 2013

• Manny Pacquiao Suffering Concussion Symptoms After Getting Punched Over and Over in the Head
  Published: December 10, 2012

• Rays catcher Robinson Chirinos suffers concussion
  Published: Mar 14, 2012

• Soccer Player Sues DC United for Career-Ending Concussion
  Published: September 27, 2012
Concussion:

And its not just men

- Concussion crisis growing in girls' soccer
  Rock Center with Brian Williams
  Wed May 9, 2012 9:50 AM EDT

- At the Mayo Clinic: Women’s Hockey, a Most Dangerous Game
  Published: October 19, 2010
  ROCHESTER, Minn. — In terms of concussions, women’s ice hockey is the most dangerous N.C.A.A. sport.
Concussion:

And its not just sports

- Hillary Clinton faints, has concussion
  Published: December 17, 2012

- Man Suffers Possible Concussion After Vehicle Flips Tuesday
  Published: February 6, 2013
Or just adults…

- **Childhood: Athletes’ Concussions Have Doubled**
  Published: August 30, 2010

- **Doctors See an Increase in Concussions Among Student Athletes**
  Published: Mar 5, 2013

Source: CDC
Relevant Anatomical Differences between Infants/Peds and Adults

Infants
- Flexibility of sutures
- Open fontanelle
- Significant alterations in the force transmitted to the brain
- Different responses to increased ICP

Pediatrics
- Size of head relative to body is disproportionally large
- Neck musculature less developed
- Cervical ligaments and joints are more flexible
Big Heads

Weaker Necks

Less body mass
Sports and Concussion

• Occurs in both helmeted and non-helmeted sports

• Most common in collision sports (Cantu)

• Sports with likelihood of blows to the head: boxing, football, ice or roller hockey, soccer, baseball, basketball, wrestling, gymnastics, cheerleading, and snow skiing
Relative Risk

• Once a person suffers a concussion, he/she is 4X more likely to sustain a second one.

• Can lead to much more severe symptoms if repeat concussion occurs before not fully recovered from prior concussion.

• After several concussions, it takes less of a blow to cause the injury and requires more time to recover.
Although Concussion Suggests a Milder Injury…

• Sports head injuries can be severe as well
  – At least 50 high school or younger football players in more than 20 states since 1997 have been killed or have sustained serious head injuries on the field, according to research by The New York Times in 2007
What happens initially to the brain?

- Pathophysiology of concussion is not well understood

- TBI in general has some characteristic injuries
  - Intracranial hemorrhage
  - Contusions or bruising
  - Diffuse axonal injury
Diffuse Axonal Injury

- Immediate disruption of axons due to acceleration-deceleration and rotational forces that cause shearing upon impact
- Axonal disruption and swelling
- Brain damage is most severe along midline structures (corpus callosum, brainstem)
- White matter petechial hemorrhages on CT or MRI suggestive of diffuse axonal injury
Recovery

• In the general population, about 60% of people are better in 2 weeks
  – Sports concussion research suggests closer to 80-90% of athletes recover within 1-2 weeks

• About 80 to 90% of people are better in 2 to 3 months

• About 10 to 20% of people have symptoms which linger
Commonly Seen Features Initially

1. Vacant stare
2. Delayed verbal and motor responses
3. Confusion and inability to focus attention
4. Disorientation
5. Slurred or incoherent speech
6. Gross observable lack of coordination
7. Emotions out of proportion to circumstances
8. Memory deficits
9. Any period of loss of consciousness
Later that Evening or the Next Day

- Headache
- Dizziness
- Nausea or vomiting
- Photophobia
- Phonophobia
- Inability to concentrate
- Sleep disturbances
- Fatigue
- Memory disturbances
- Emotional lability

- Sometimes, there may be no initial symptoms and onset of findings are delayed for a few hours
Long Term or Chronic

• Decline in academic performance
• Loss of employment
• Major social, societal & family consequences
• *Post-Concussive Syndrome*
  – Prolonged and persistent concussive symptoms lasting for longer than they should where findings are seemingly out of proportion to the inciting injury
  – Debilitating and life-changing
  – Misunderstood and under-diagnosed
  – Incorporates somatic, emotional, behavioral, and cognitive difficulties
Postconcussive Syndrome

- Symptoms fall into 3 categories
  - **Somatic**: headaches, balance problems, sleep problems, dizziness, noise and light sensitivity, fatigue
  - **Neurocognitive**: problems with memory, processing, retrieval, concentration, attention, focus, decreased awareness
  - **Emotional**: mood changes, personality changes, irritability, anxiety, impulsivity
Postconcussive Syndrome Rehabilitation

- Vestibular therapy/PT
  - Treats gait and balance problems, dizziness
  - Headache management
- Occupational Therapy
  - Vision rehab
  - IADL/community retraining
- Vocational Counseling
  - Work/school

- Neuropsychology
  - Comprehensive neuropsych testing
  - Cognitive rehabilitation
  - Psychological support/Psychotherapy
  - Behavioral modification
  - Coordinates with schools and workplace
Sideline Assessment
Sideline Assessment of mTBI

- ABCs, then Stabilize C-spine
- SCAT3
  1. GCS
  2. Maddocks Score
  3. Symptom Evaluation
  4. Cognitive Assessment- SAC (immediate)
  5. Neck Examination
  6. Balance Examination
  7. Coordination Exam
  8. Cognitive Assessment- SAC (delayed recall)
SCAT3™
Sport Concussion Assessment Tool – 3rd Edition

What is the SCAT3™?

The SCAT3™ is a validated tool for assessing athletes for concussions and can be administered prior to a game, season, or practice. The SCAT3™ was published in 2017 and includes new elements to the previous SCAT, providing a comprehensive tool to assess concussions.

What is a concussion?

A concussion is a brain injury that occurs when the brain is hit or shaken. It results in a range of symptoms, with or without the loss of consciousness. The SCAT3™ is designed to be used by healthcare providers to screen for a concussion and to assess the severity of the injury.

SIDELINE ASSESSMENT

Indications for Emergency Management

In the case of a head injury, an athlete should be immediately removed from the field and evaluated by a medical professional. If the athlete is diagnosed with a concussion, they should be removed from the field and a plan for return to play should be developed.

Glasgow coma scale (GCS)

The Glasgow coma scale is a tool used to assess the level of consciousness and is a key component of the SCAT3™. The scale ranges from 3 to 15, with lower scores indicating more severe injuries.

Maddocks score

The Maddocks score is a tool used to assess the severity of a concussion and to determine the need for further medical evaluation. The score ranges from 0 to 4, with higher scores indicating more severe injuries.

Potential signs of concussion:

If any of the following signs are observed after a direct or indirect blow to the head, it should be considered a possible concussion and should be evaluated by a medical professional. If a concussion is suspected, the athlete should not return to play on the same day.

1. Vomiting
2. Changes in behavior
3. Changes in vision
4. Changes in hearing
5. Changes in balance
6. Changes in memory
7. Changes in speech

What is Child-SCAT3™?

The Child-SCAT3™ is a modified version of the SCAT3™ designed for children ages 5 to 12 years. It includes modifications to the assessment tools to better suit the needs of young athletes.

Child-SCAT3™ indications for emergency management:

A child with a suspected concussion should be immediately removed from activity and evaluated by a medical professional. If a concussion is suspected, the athlete should not return to play on the same day.

Potential signs of concussion:

If any of the following signs are observed after a direct or indirect blow to the head, it should be considered a possible concussion and should be evaluated by a medical professional. If a concussion is suspected, the athlete should not return to play on the same day.

1. Vomiting
2. Changes in behavior
3. Changes in vision
4. Changes in hearing
5. Changes in balance
6. Changes in memory
7. Changes in speech

Children-SCAT3™ indications for emergency management:

A child with a suspected concussion should be immediately removed from activity and evaluated by a medical professional. If a concussion is suspected, the athlete should not return to play on the same day.

Potential signs of concussion:

If any of the following signs are observed after a direct or indirect blow to the head, it should be considered a possible concussion and should be evaluated by a medical professional. If a concussion is suspected, the athlete should not return to play on the same day.

1. Vomiting
2. Changes in behavior
3. Changes in vision
4. Changes in hearing
5. Changes in balance
6. Changes in memory
7. Changes in speech

NYU Langone Medical Center
Rule of Thumb:

- *When in doubt, sit them out.*

- If you feel they need a concussion assessment, best course of action is to remove them from play at least for the remainder of the day.
Send to ED If…

- Repeated vomiting
- Severe or progressively worsening HA
- Seizure
- Unsteady gait
- Slurred speech
- Weakness
- Numbness
- Unusual behavior
- Signs of basilar skull Fx
- GCS < 15
- Focal neurological deficit
- Mental status change
Imaging

• Non-contrast CT of the head is study of choice for initial acute TBI evaluation
  – Relatively quick study
  – Assesses for acute findings that require intervention
  – Not always necessary
  – Mild TBI cases often do not show positive findings
Further diagnostic testing

- Imaging studies such as spectroscopy, MR spectroscopy, PET, fMRI, QEEG, DTI, DKI are not yet part of standard clinical practice

- Currently many research studies searching for biomarkers for brain injury
  - No conclusive findings as of yet
Baseline Neuropsych Testing

• Many college, pro, and some high school sports programs require baseline testing so repeat testing can be compared to it when determining return to play.

• However it has its problems:
  – Faking to do better on retest
  – Effort
  – Test retest reliability
  – Fatigue
  – Environment/equipment changes
  – Stress
Other testing options

• King Devick Test
• Clinical Reaction Time Tests
• Computerized Testing
  – Such as ImPACT being used more and more for baseline and follow up tracking after a sports concussion
  – Efficacy somewhat controversial
## Colorado Medical Society guidelines for return to play

<table>
<thead>
<tr>
<th>Grade</th>
<th>First concussion</th>
<th>Subsequent concussions</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>15 minutes</td>
<td>1 week</td>
</tr>
<tr>
<td>II</td>
<td>1 week</td>
<td>2 weeks, with physician approval</td>
</tr>
<tr>
<td>IIIa (unconscious for seconds)</td>
<td>1 month</td>
<td>6 month, with physician approval</td>
</tr>
<tr>
<td>IIIb (unconscious for minutes)</td>
<td>6 month</td>
<td>1 year, with physician approval</td>
</tr>
</tbody>
</table>
Grading

- As with the definition, historically there has been a lack of agreement over the grading and management of concussion
- Many systems have been proposed but none is able to encompass the full range of symptoms
- Latest consensus statements on concussion in sport (3rd and 4th Zurich Conferences) have abandoned attempts to come up with a grading and classification system
4th Zurich Conference

- More emphasis on conservative return to play guidelines with a graduated return to play protocol
  - No same day return to play
  - Stages of return to play protocol: 1. no activity, 2. light aerobic exercise, 3. sport-specific exercise, 4. non-contact training drills, 5. full contact practice, 6. return to play
  - Overall timeframe left to discretion of medical professionals based on each patient’s presentation and recovery
Modifying Factors (Zurich)

- How long did symptoms last? (>10 days?) How severe?
- Loss of consciousness lasting >1 minute, amnesia
- Repeated concussions, concussions occurring close together in time (within 10 days), or recent concussion
- Repeated concussions with progressively less impact force or slower recovery after each
- Seizures

- Child or adolescent <18 years
- Comorbidities: Migraine, depression, other mental health disorders, attention deficit hyperactivity disorder, learning disabilities, sleep disorders
- Psychoactive drugs, anticoagulants
- Dangerous style of play
- High-risk, contact, and collision sports, “high sporting level”
Treatment

• Treat symptoms
  – Role for both medications for symptom management and non-pharmacological interventions including rehabilitation program
  – Be aware of medication side effects

• Gradual return to activities
  – Including pre-return to play aspects of life such as cognitive and social activities
  – Return to academics before sports
Treatment

• Role for physical and cognitive rest
  – General rule for those who are following pattern and timing for typical recovery is physical and cognitive rest until symptoms are resolved at rest
  – However, for those with persistent symptoms, recent studies suggest a graded sub-symptomatic exercise program is beneficial
  – Key is to avoid activities that exacerbate symptoms
Return to Play Qualifiers

- For repetitive SRC, consider need to retire from specific sport or contact activities in general
- Be more conservative with kids
Other Concerns

• Seizures

• Second Impact Syndrome

• Chronic Traumatic Encephalopathy
Seizures

• Seizures usually not as much a concern with mild TBI/concussions

• 7 day AED prophylaxis for high risk patients
  – Usually means more severe TBI
  – However, very young children or persons with predisposition to seizure based on PMHx may be exceptions
Second Impact Syndrome

• Repeated mild brain injuries occurring within a short period prior to complete recovery (i.e., hours, days, weeks) can be catastrophic or fatal.
  – Concussions that separately might be considered mild but in additive effect can be fatal
  – Still controversial
Pathophysiology of Second Impact Syndrome

- Characteristic ionic fluxes, acute metabolic changes, and cerebral blood flow alterations that occur after a TBI make the brain vulnerable to impaired regulatory function.
- When the patient sustains a “second impact,” the brain loses its ability to auto regulate intracranial and cerebral perfusion pressures.
- In severe cases, this may lead to cerebral edema followed by brain herniation.
Chronic Traumatic Encephalopathy (CTE)

- Histopathological Dx
- A progressive, degenerative disease
- Building up \textit{tau} protein
- Features include:
  - Impulsivity
  - Depression
  - Dementia
  - Movement disorders
  - Motor neuron disorders
Chronic Traumatic Encephalopathy (CTE)

- Repeated mild brain injuries occurring over an extended period (i.e., months or years) may result in cumulative neurologic and cognitive deficits

- However, unclear relationship between histological findings and traumatic injuries
Invisible Concussions?

• Brain damage found in college football players who didn't suffer concussions, study suggests

Published: March 7, 2013
– New study proposes that multiple subconcussive hits may even lead to deficits
Psychiatric Ramifications

- Former Bengal Henry Found to Have Had Brain Damage
  Published: June 28, 2010

- Ryan Freel, Concussion-Plagued Baseball Player, Dies at 36
  Published: December 24, 2012

- CTE Detected in Living Ex–NFL Players; Junior Seau’s Family Sues: What Now for Football and Concussions?
  Published: January 24, 2013
Education is the Key to Prevention

• Avoidance of unnecessary risks
  – Pre-season counseling and education regarding concussion and associated symptoms
  – Less full contact practices

• New rules to make play safer
  – No spearing
  – No helmet-helmet hits

• Paradoxic effect of protective equipment
  – Makes you feel safer and hit harder (equipment does not prevent movement inside the skull)
Secondary Prevention Pearls

• Avoid anything that impairs or tests the limits of: *Balance, Vision, or Judgment*

• Avoid any activity where people normally wear helmets.

• Avoid any activity where there is an increased risk of head making contact with another person or implement.

• Do not climb ladders.

• Wear sensible shoes.
Awareness is Improving

• Citing player safety, NBA institutes new concussion policy

Published: Dec 12 2011
– The NBA joins the NFL, NHL and Major League Baseball in instituting a concussion protocol.
But Challenges Still Remain

- **Study finds need for better concussion prevention in youth sports**
  
  Published: February 19, 2015

- **Helmet add-ons may not reduce risk of concussion in athletes, study finds**
  
  Published: February 25, 2015
Thank You
References