Diagnosis and Management of Sports Concussion

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National Collegiate Athletic Association (NCAA)
Concussion Task Force

Medical Advisory Physician (MAP)
National Football League (NFL) Player Benefits

Unaffiliated Neurotrauma Consultant (UNC)
National Football League
CLASSIFICATION OF ATBI

- CONCUSSION
- DIFFUSE AXONAL INJURY
- FOCAL BRAIN INJURY
- SKULL FRACTURES
- PENETRATING BRAIN INJURY
CEREBRAL CONCUSSION

- An alteration of mental status/neurological function due to mechanical forces affecting the brain
- May or may not be associated with LOC
- Essentially a reversible syndrome without detectable pathology
- Represents a functional disturbance rather than a structural injury
- No abnormalities on standard neuroimaging studies
EPIDEMIOLOGY
EPIDEMIOLOGY

- More recent and accurate approximation may be 1.6-3.8 million sports related TBI
EPIDEMIOLOGY

- Concussions per every 100,000 games and/or practices at the collegiate level
  - Football: 27
  - Ice Hockey: 25
  - Men’s soccer: 25
  - Women’s soccer: 24
  - Wrestling: 20
  - Women’s basketball: 15
  - Men’s basketball: 12
EPIDEMIOLOGY

- Risk of concussion in football is 4-6 times higher in players with a previous concussion
- ? Females more susceptible
  - Soccer
  - Basketball
- Recurrent concussion is more likely to occur within 10 days of a prior concussion
- Genetic predisposition - APOE promoter gene
EPIDEMIOLOGY

- Factors associated with delayed recovery:
  - Previous history of concussion
  - Early posttraumatic headache
  - Fatigue/fogginess
  - Early amnesia, alteration in mental status or disorientation
  - Age
  - Body checking in pee wee hockey
EPIDEMIOLOGY

- Other factors associated with delayed recovery (weak):
  - Prior history headache
  - Dizziness
  - Playing quarterback position
  - Wearing a half-face shield
  - Playing on artificial turf
MECHANISMS OF INJURY
1. Brain rotates on axis causing stretching/tearing of axons
2. Stretching/tearing of blood vessels results in hematoma
3. Brain strikes skull causing contusion

ROTATIONAL INJURY
3. Rebound (contre-coup) injury to occipital lobe.

1. Brain moves forward in skull.

2. Frontal lobes strike inside of skull (contusion)

DECELERATION INJURY (LINEAR)

stretching / tearing or neurons in brain stem and throughout brain
Impact deceleration
Top (6 concussions)

Case 9: 107.07 g
Case 1: 60.51 g
Case 7: 100.36 g
Case 10: 109.88 g
Case 5: 85.10 g
Case 3: 77.68 g

All Injuries (13 total)

Case 11: 119.23 g
Case 6: 99.74 g
Case 8: 102.39 g
Case 12: 157.50 g
Case 2: 63.84 g
Case 4: 84.07 g

Back (1 concussion)

Front (4 concussions)
Location of Concussions

Struck Players
Concussed

Striking Players
No Injury
Neurometabolic Cascade of mTBI: Basic Pathophysiology

- Energy Crisis
- Axonal injury
- Protease activation
- Altered neurotransmission
- Ionic flux
- Cell Death
- Ca²⁺
- Glutamate
- K⁺
- ADP
- ATP
- Pump
CLINICAL PRESENTATION

- Physical
- Cognitive
- Behavioral
Clinical Presentation - Physical

- Headache
- Incoordination
- Impaired balance
- Dizziness/vertigo
- Nausea/vomiting
- Blurred vision
- Fatigue
- LOC
Clinical Presentation - Cognitive

- Disorientation
- Memory deficits
- Impaired concentration
- Decreased attention
- Feel “in a fog”
- Amnesia
Clinical Presentation-Behavioral

- Irritability
- Inappropriate emotions
- Sleep disturbance
- Personality change
- Sadness/depression
- Easily distracted
Clinical Management and Guidelines
Concussion Evaluation-Sideline

- Evaluation
  - sideline evaluation including neurological assessment and mental status testing is essential (e.g. McGill, SAC, SCAT3)
  - memory assessment is better than orientation
ATBI

- **SERIOUS SIGNS AND SYMPTOMS**
  - Focal weakness
  - Seizures
  - Pupillary asymmetry (in setting of unresponsiveness)
  - LOC with a delayed recovery
Glasgow Coma Scale

**Eye opening (E)**
- Spontaneous = 4
- To speech = 3
- To pain = 2
- Nil (no response) = 1

Response to speech ≥ 3

**Motor response (M)**
- Obeys = 6
- Localizes = 5
- Withdraws = 4
- Nil (no response) = 1

**Verbal response (V)**
- Oriented = 5
- Confused conversation = 4
- Incomprehensible sounds = 2
- Nil = 1

Coma score (E + M + V) = 3 to 15
Glasgow Coma Scale

Eye opening (E)

Spontaneous = 4
Response to speech = 3
Nil (no response) = 1

Open your eyes

To pain = 2
To speech = 3
Spontaneous = 4
Nil

E
Verbal response (V)

Oriented = 5
Confused conversation = 4

Yesterday Mother
Inappropriate words = 3

Scream, groan, moan
Incomprehensible sounds = 2

1983
1972

Nil = 1

Coma score (E + M + V) = 3 to 15
SEVERITY-GCS

- MILD  13-15
- MODERATE  9-12
- SEVERE  3-8
Concussion Evaluation

- Clinical History
  - previous concussions and concussion symptoms
  - disproportionate impact and matching of symptoms (i.e. more pronounced persistent symptoms from smaller hits)
Concussion Evaluation

- Clinical history
  - PTA may be a surrogate marker of injury severity
  - LOC may not be a useful marker of severity
Concussion Evaluation

- Neurodiagnostic Testing
  - Neuroimaging
  - Neuropsychological Testing
  - Objective Balance Assessment
  - Genetic testing
  - Biomarkers of brain injury
Clinical Management

- Not be allowed to return to play in current game or practice while symptomatic
- Should not be left alone
- Should be medically evaluated after injury
- Mainstay of management is physical and cognitive rest until symptoms have resolved at rest and exertion
Clinical Management

- Return to Competition
  - Return to play on an individual basis (avoid the use of grading scales)
    - All symptoms have resolved
    - Neurological examination is normal
    - Cognitive function has returned to baseline
  - Not only symptom free but also not on any medications for concussion
  - Return to play should must follow a medically supervised stepwise process
<table>
<thead>
<tr>
<th>Rehabilitation stage</th>
<th>Functional exercise at each stage of rehabilitation</th>
<th>Objective of each stage</th>
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</thead>
<tbody>
<tr>
<td>1. No Activity</td>
<td>Complete physical and Cognitive Rest.</td>
<td>Recovery</td>
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<tr>
<td>2. Light aerobic exercise</td>
<td>Walking, Swimming, Stationary Bike, HR&lt;70% Maximum</td>
<td>Increased heart rate</td>
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<td>3. Sport Specific Exercise</td>
<td>Skating or Running Drills without contact.</td>
<td>Add Movement</td>
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<td>4. Non Contact training</td>
<td>More complex Drills without contact.</td>
<td>Exercise, coordination and cognitive load.</td>
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<td>5. Full Contact</td>
<td>Normal Training</td>
<td>Restore confidence</td>
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<tr>
<td>6. Return to Play</td>
<td>Game Play</td>
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# Concussion Recovery and Graded Exercise Program Log

Name: ____________________________________________
Injury Date: _______________________________________
First Asymptomatic Date: ____________________________
Cleared for Full Recovery Date: ______________________

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity</th>
<th>Signs/Symptoms</th>
<th>Comments</th>
<th>Signature</th>
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<tbody>
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Return to Play (BRAIN)

- **Bike**
- **Run**
- **Agility**
- **In red (drills no contact)**
- **No restriction**
Management and Rehabilitation of Atypical Cases

Prolonged or persistent symptoms!
Recovery From Sports Concussion: How Long Does it Take in HS Football Players?

N=134 HS Football Athletes

Collins et al., 2006, Neurosurgery
Clinical Management and Rehabilitation

- Gagnon et al (2009)
  - Developed a rehabilitation program for children and adolescents who were considered slow to recover (> 1 month) from a sports related concussion
  - Controlled and closely monitored rehabilitation program in the post acute period
Gagnon et al. (2009) (cont’d)

- 16 cases (11.2%) with persistent symptoms
- Aged 10-17 years
- All cases showed rapid and significant improvement in symptoms
- Were able to resume their normal physical activity at the end of the program
- Mean duration was 4.4 weeks
Clinical Management and Rehabilitation

- Graded Rehabilitation Program
  - Aerobic phase
  - Coordination phase
  - Home program phase
  - Standard return to activity protocol if asymptomatic at rest for 1 week
Graded Rehabilitation

- Aerobic phase
  - Sub-maximal (50-60% maximal capacity) aerobic capacity either on a treadmill or a stationary bike for 15 minutes
  - Any increase in symptoms the activity was stopped
Graded Rehabilitation

- Coordination phase
  - Light coordination exercises tailored to the athlete’s favorite or main sport
  - Performed up to 10 minutes
  - Purpose of this phase is to continue light aerobic exercises and introduce familiar activities
  - Any increase in symptoms the activity was discontinued
Graded Rehabilitation

- Home Program
  - Allows for continued training outside of the clinic
  - Facilitate school attendance
  - Minimize disruptions to daily life
  - Consists of light aerobic and coordination exercises
  - Any increase in symptoms the activity was discontinued
Graded Rehabilitation

- Standard RTP protocol
  - Symptom free for 1 week
  - Standard graduated return to activity
When should an athlete retire?

- No consensus
- Extent and duration of neurological signs and symptoms
- Evidence of Chronic Traumatic Brain Injury (CTBI)
Prevention Goals

- Identification of concussion
- Implementing sideline evaluations & treatment recommendations
- Recognize and treat post concussion syndrome
- Prevent second impact syndrome
- Prevent chronic traumatic brain injury
- Prevent additional morbidity and mortality
Prevention Tools

- Rule changes
- Use helmets and other protective equipment
- Education
- Proper medical surveillance
- Ongoing research
THANK YOU

QUESTIONS?