Sports-Related Concussion

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Outline

- Definition
- Epidemiology
- Pathophysiology
- Imaging
- Evaluation
- Management
- Pediatric Population
- Chronic Traumatic Encephalopathy
- Summary
Definition

• Concussion

  • “A complex physiological process affecting the brain, induced by traumatic biomechanical forces”
    International Conference on Concussion in Sport
    • GCS > 13
    • LOC
Definition

- mild-Traumatic Brain Injury (m-TBI)

  - “Traumatically induced physiologic disruption of brain function”

    Head Injury Interdisciplinary Special Interest Group of PM&R

    - Any period of LOC
    - Any loss of memory before or after accident
    - Any alteration in mental state at time of accident
    - Focal neurological deficits
      - LOC < 30 minutes
      - GCS 13 – 15
      - Post Traumatic Amnesia (PTA) < 24 hours
Definition

- Sports-related Concussion
- m-TBI
  - TBI that is non-sports related
    - MVA
    - Blast Injury
    - Occupational
Epidemiology

- CDC
  - 1.7 million patients with TBIs present to ER or are hospitalized annually
  - 80% discharged same day
  - 1.4 – 3.8 million concussions per year in U.S.
  - 6 – 10 patients per 100,0000 per year die
Epidemiology

- Sports-related Concussion
  - Incidence
    - 135,000 concussions per year present to ED
    - 24 per 100,000 for high-school athletes
  - Trends
    - Incidence of concussion appears to be increasing
    - May be due to increased awareness of detection and management

Epidemiology

- Sports-related Concussion
  - Risk Factors
    - Sport
      - Football accounts for majority (75%) of concussions in males
      - Soccer accounts for majority (50%) of concussions in females
    - Play
      - Player to player contact
      - Game versus practice
Epidemiology

- Sports-related Concussion
  - Risk Factors
    - Position
      - Football
        - Quarterback
        - Running back
      - Baseball / Softball
        - Batter
      - Soccer
        - Goalkeeper
    - Gender
      - Females have 2x rate of concussion when comparing similar sports
Pathophysiology

- **Mechanical Injury**
  - Sudden stretching of neuronal membranes initiates cascade of metabolic events

- **Neurochemical Cascade**
  - Release of EAA (Glutamate) and influx of ions (Ca\(^{2+}\))
  - Overloading of mitochondria
    - Uncoupling of oxidative phosphorylation
    - Organelle swelling
    - Production of Reactive Oxygen Species (ROS)

Pathophysiology

- Neurochemical Cascade
  - Na/K ATP pumps work to re-establish ionic balance
  - Lack of ATP due to mitochondrial injury
  - “Energy Crisis”
  - Disturbance of cellular energetic metabolism
    - Compromised synaptic plasticity
    - Cognitive deficits

Pathophysiology

- N-Acetylaspartate (NAA)
  - Brain specific metabolite
  - Identified using proton magnetic spectroscopy (H-MRS)
  - Biomarker for Concussion
    - NAA production occurs in mitochondria
    - Reduction in NAA levels appears to be proportional to severity of TBI
    - Vulnerability of neurons post-concussion and second impact syndrome

Signoretti S, et al. The Pathophysiology of Concussion. *PM&R*
Pathophysiology

- N-Acetylaspartate (NAA)
  - Measuring NAA after initial concussion may offer a means in quantifying post-concussive metabolic disturbances
  - By day 30 NAA levels returned to normal
  - Patients reported clearance of symptoms by day 15

Signoretti S, et al. The Pathophysiology of Concussion. *PM&R*
Imaging

- **Structural**
  - Computerized Tomography (CT)
  - Magnetic Resonance Imaging (MRI)
    - T1, T2, Fluid Attenuated Inversion Recovery (FLAIR)
    - Susceptibility Weighted Imaging (SWI)
    - Diffusion Weighted Imaging (DWI)

- **Functional**
  - Functional Magnetic Resonance Imaging (f-MRI)
  - Positron Emission Tomography (PET)
  - Single-photon Emission Computed Tomography (SPECT)
  - Magnetic Resonance Spectroscopy Imaging (MRSI)
Imaging

- **CT**
  - Mainstay in evaluation of TBI in acute setting
    - Used to identify intracranial lesion requiring neurosurgical intervention, hospitalization or intensive follow-up
    - Less than 10% of CT scans are abnormal with m-TBI
    - Guidelines for imaging m-TBI
      - Headache
      - Vomiting
      - Age > 60
      - Persistent anterograde amnesia
      - Visible trauma about clavicle
      - Seizure

Gonzalez P. Imaging Modalities in Mild Traumatic Brain Injury and Sports Concussion. *PM&R*
Imaging

- MRI
  - Sensitive at detecting microhemorrhage associated with capillary damage
  - Typically used in outpatient setting and with post-concussive symptoms
  - SWI increases sensitivity for white matter tract changes

Gonzalez P. Imaging Modalities in Mild Traumatic Brain Injury and Sports Concussion. PM&R
Imaging

- f-MRI, SPECT
  - Functional studies
  - More sensitive than MRI and CT at detecting sub-acute injuries
  - May have a prognostic role in terms of recovery and outcome after brain injury

Gonzalez P. Imaging Modalities in Mild Traumatic Brain Injury and Sports Concussion. *PM&R*
Evaluation

- Sideline Assessment
  - Primary Survey
    - Airway / Breathing / Circulation
    - Cervical Spine
  - Secondary Survey
    - History
      - Mechanism of Injury
    - Symptom Survey
      - Graded Symptom Checklist (GSC)
    - Neuropsychological Function
      - Standardized Assessment of Concussion (SAC)
  - Physical Exam
    - Palpation / Motor Strength / ROM
    - Balance
      - Balance Error Scoring System (BESS)
Evaluation

- Outpatient
  - History
    - Mechanism of Injury
    - LOC
    - Symptoms
      - Posttraumatic Headache (PTH) – 83%
      - Dizziness – 65%
      - Confusion – 57%
  - Medical History
    - Neurological
    - Psychological

### Graded Symptom Checklist (GSC)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Time of Injury</th>
<th>2-3 Hours Postinjury</th>
<th>24 Hours Postinjury</th>
<th>48 Hours Postinjury</th>
<th>72 Hours Postinjury</th>
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</thead>
<tbody>
<tr>
<td>Blurred vision</td>
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<td>Dizziness</td>
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<td>Drowsiness</td>
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<td>Excess sleep</td>
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<td>Easily distracted</td>
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<tr>
<td>Fatigue</td>
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<tr>
<td>Feel “in a fog”</td>
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<td>Feel “slowed down”</td>
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<tr>
<td>Headache</td>
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<tr>
<td>Inappropriate emotions</td>
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<td>Irritability</td>
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<td>Loss of consciousness</td>
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<td>Loss or orientation</td>
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<td>Memory problems</td>
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<tr>
<td>Nausea</td>
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<tr>
<td>Nervousness</td>
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<td>Personality change</td>
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<tr>
<td>Poor balance/coordination</td>
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<td>Poor concentration</td>
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<tr>
<td>Ringing in ears</td>
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<tr>
<td>Sadness</td>
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<tr>
<td>Seeing stars</td>
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<tr>
<td>Sensitivity to light</td>
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<tr>
<td>Sensitivity to noise</td>
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<tr>
<td>Sleep disturbance</td>
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<td>Vacant stare/glassy eyed</td>
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<tr>
<td>Vomiting</td>
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</table>

NOTE: The GSC should be used not only for the initial evaluation but for each subsequent follow-up assessment until all signs and symptoms have cleared at rest and during physical exertion. In lieu of simply checking each symptom present, the ATC can ask the athlete to grade or score the severity of the symptom on a scale of 0-6, where 0=not present, 1=mild, 3=moderate, and 6=most severe.
Evaluation

- Physical Exam
  - Neurological
    - Motor Strength
    - Sensation
    - Cranial Nerves
    - Balance
  - Musculoskeletal
    - Palpation
    - ROM
Evaluation

- Neuropsychological Evaluation
- Surveys
  - Standardized Assessment of Concussion (SAC)
- Montreal Cognitive Assessment
- Neuropsychological Testing
- Cognitive domains
- Psychological functioning
Evaluation

- Prognostic Factors
  - Symptoms
    - Post-traumatic amnesia
    - LOC > 30 seconds
    - Dizziness
  - Age
    - Adolescent vs Collegiate
  - Repetitive Concussion
    - Delayed recovery with history of concussion
  - Gender
Management

- Rest
  - The “Tincture of Time”

- Return to Play
  - Graduated Protocol
    - No activity until asymptomatic at rest
    - Light aerobic exercise / no resistance training
    - Sport-specific exercise and increased aerobic exercise
    - Non-contact practice and resistance training
    - Full-contact practice
    - Return to play

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Management

- Post-traumatic Headache (PTH)
  - Secondary HA resulting from trauma
  - Symptoms can be similar to tension-type HA and migraine without aura
- Pharmacologic Treatment
  - Prevention
    - Antidepressant (TCA, SSRI)
    - CV (B-Blocker, Ca Channel Blocker)
    - Antiepileptic
Management

- PTH
  - Pharmacologic Treatment
    - Acute
      - Triptans
      - NSAIDs
  - Non-pharmacologic Treatment
    - OMM / Trigger Point Injection
    - Facet Injection
    - Acupuncture
    - Cognitive Behavioral Therapy
    - Exercise
Management

- Insomnia
  - Non-pharmacologic Treatment
    - Sleep Hygiene
    - Relaxation Techniques
  - Pharmacologic Treatment
    - Melatonin
    - Trazadone
    - Amytriptyline
    - Avoid use of benzodiazepines
Management

- Behavioral and Emotional Symptoms
  - Non-pharmacologic Treatment
    - Neuropsychological Testing
    - Cognitive Behavioral Therapy
  - Pharmacological Treatment
    - Anti-depressant medication
      - TCA
      - SSRI
    - Caution in adolescent population
Pediatric and Adolescent Concussion

- Epidemiology
  - Concussion most likely to occur during organized sports

- Pathophysiology
  - Brain appears to be more venerable
  - Recovery can be 2x longer when compared to collegiate athletes

- Return to Play
  - Graduated return to play
    - More conservative
    - Never same day
Pediatric and Adolescent Concussion

- Sequelae
  - Second Impact Syndrome
    - Immature brain may be more susceptible
    - All reported cases of SIS have occurred in athletes < 20 y/o
  - Legislation
    - Zachery Lystedt Law
  - Academic Performance
Chronic Traumatic Encephalopathy

- Epidemiology
  - More common among contact sports athletes

- Etiology
  - Repetitive exposure to concussive and subconcussive impacts
  - Genetic

- Clinical Course
  - Progressive decline in cognitive and behavioral function
  - Typically presents mid-life after end of exposure to repetitive trauma
Sports-Related Concussion

- A very common occurrence that rarely results in death or a catastrophic event (SIS)
- An injury that results in impaired neuronal functioning and metabolism versus structural damage
- Structural imaging studies (CT and MRI) are rarely abnormal and indicated in the outpatient setting
Sports-Related Concussion

- Evaluation involves a multi-faceted approach
  - Symptom survey
    - Post-traumatic amnesia
  - Physical Examination
    - Balance testing
    - Neuropsychological Testing
- Return to Play
  - Graduated protocol
  - Conservative approach with pediatric / adolescent population
    - Never same day return
Sports-Related Concussion

- Consider both pharmacologic and non-pharmacologic treatments
  - Post-traumatic headache
  - Insomnia
  - Behavioral and emotional issues
References


References

References

