What Is Concussion: The Science of Neurotrauma

Presented by:

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Apr 9, 2022

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Team Physician USA Rugby
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WHO AM I

- Naval Medical Center Portsmouth
- Joint Expeditionary Base Little Creek-Fort Story, Virginia Beach VA
  - General Medical Officer Naval Special Warfare Group 2 Logistic and Support Unit
- Naval Medical Center Portsmouth/Naval Station Norfolk, Portsmouth/Norfolk VA
  - General Medical Officer Occupational Health
  - Naval Medical Center Portsmouth and Joint Enabling Capability Command
- Naval Undersea Medical Institute & Naval Diving Salvage and Training Command
  - Undersea/Diving Medical Officer Candidate
- Naval Base Kitsap, Silverdale WA
  - Undersea Medical Officer, Lead PRP CMA
- St Petersburg General Hospital Family Medicine Residency
- Auburn University
  - 22 Sports
  - 570+ athletes
- Auburn University at Montgomery
  - 10 Sports
  - 170+ athletes
- Tuskegee University
  - 10 Sports
  - 170+ athletes
- Central-Phenix City High School
  - 7A Alabama High School
OVERVIEW

- What is neurotrauma?
- What are the symptoms of a concussion?
- How are concussions recognized?
- How is a concussion treated?

NEUROTRAUMA

- The mTBI to TBI continuum

![Classification of Head Injury](image-url)
COMMON CAUSES

- Motor Vehicle Collisions
- Military Combat
  - Blast injuries
  - 20% of soldiers in Iraq and Afghanistan
- Falls
  - Toddlers
  - Elderly
- Sports
  - Most common between 15-25 years of age

WHAT IS A CONCUSSION?

- Definition: “Complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces”
  - Physical force disrupting brain function
- Any change in neurologic/mental function
  - About 10% involved loss of consciousness
- Referred to as mild traumatic brain injury (mTBI)
- Majority of the time without CT/MRI changes
WHAT IS A CONCUSSION?

- Trauma that causes the brain to shake inside the skull
- Wave of motion causes damage to brain tissue
- Nerves and vessels can shear
- Brain cells are affected through direct damage, chemical changes and

MECHANISM OF INJURY

- Bottom line up front
  - DESPITE ADVANCES - THE UNDERLYING MECHANISMS ARE YET OT BE FULLY ELUCIDATED

- Brain insult
- Mechanical injury
- Physiological response
- Resolution vs persistence
MECHANISM OF INJURY

- Animal studies show rupture of bridging subdural veins and brain contusions with straight or translational forces
- ...diffuse brain injury from shearing forces with rotation or angular acceleration/deceleration forces
- Remember the brain stem is literally suspended in cerebral spinal fluid
  - Coup - brain affected directly at site of impact
  - Countracoup - opposite side
- Categories
  - Closed head
  - Penetrating
  - Explosive blast

PATHOPHYSIOLOGY

- Primary
  - From mechanical forces
- Secondary
  - Further tissue and cellular damages

AXONAL INJURY

Normal Neuron
- Nerve Cell Body
- Axon
- Synapse

Damaged Neuron
- Nerve Signals Stop at Severed Axon

Diffuse Axonal Injury
- Axon Swelling
- Axon Degeneration
- Nerve Signals Stop at Damaged Synapse
SECONDARY CHANGES

- Cerebral hypoxia
- Local acidosis
- Lactic acid accumulation
- Disruption of neural-active peptides
- Petechial hemorrhages
- Cell loss
- Mitochondrial dysfunction

CONCUSSION STATISTICS

- 1.5-3.8 million people experience these injuries yearly
  - 9% of high school athletes
- 85% of people experience no long term symptoms
- >62000 concussions per year in high school contact sports (63% from football)
  - 15-20% of high school football players annually
- Likely under reported
RISK FACTORS

- Increased risk
  - Past concussion
  - Female athletes
  - Contact sports

- Prolonged recovery
  - Number, severity and duration of symptoms
  - H/O migraines, depression, mood disorders, developmental disorders

SYMPTOMS

Various symptoms may occur, may not occur immediately

- Headaches
  - Most common symptom
- Nausea
- Confusion
- Slow thinking

- Sleep changes
- Mood changes
- Dizziness
- Balance problems
- Feeling irritable/emotional
- Visual changes
SYMPTOM PROGRESSION

- Concussions are not linear correlated injuries
- Premorbid conditions
- Mechanistic load
- Vulnerability - Development

SIGNS AND SYMPTOMS OF CONCUSSION

- Irritability
- Sadness
- More emotional
- Nervousness

- Drowsiness
- Sleeping more than usual
- Sleeping less than usual
- Difficulty falling asleep

- Headache
- Nausea
- Vomiting
- Dazed
- Stunned

- Feeling “foggy”
- Feeling slowed down
- Difficulty concentrating
- Difficulty remembering
- Confused about recent events
- Answers questions slowly
- Repeats Questions

- Fatigue
- Light Sensitivity
- Sound Sensitivity
- Balance problems
- Vision Problems

*PEDIATRICS Vol. 126 No. 3 September 1, 2010*
CLINICAL SCIENCE - PATHWAYS

• Predominant concussion subtypes
  • Cognitive
  • Ocular-motor
  • Headache/migraine
  • Vestibular
    • Vestibulo-ocular, visual motion sensitivity, vestibule-spinal and gait disturbance
  • Anxiety/mood
• Concussion-associated conditions
  • Sleep disturbance
  • Cervical strain

• Is healing linear, step wise, undulating
• Can we switch subtypes?

DIAGNOSIS

• Clinical diagnosis
  • Trained healthcare provider
• Graded system checklist
  • Objective tool
  • Tracking over serial exams
• Standardized assessment tools
  • Provides structure for evaluation
  • Limited validity
SIDELINE ASSESSMENT/MANAGEMENT

- Remove from play
- Assessment
  - Symptoms checklist
  - SCAT
  - Cognitive evaluation
  - Balance tests
  - Neurological physical examination

SCAT5 ©
SPORT CONCUSSION ASSESSMENT TOOL – 5TH EDITION
DEVELOPED BY THE CONCUSSION IN SPORT GROUP
FOR USE BY MEDICAL PROFESSIONALS ONLY

BESS Balance testing errors
- Hands lifted off iliac crest
- Opening eyes
- Step, stumble, or fall
- Moving hip into >30 degrees abduction
- Lifting forefoot or heel
- Remaining out of test position >5s

Cognitive assessment
Standardized Assessment of Concussion (SACC)

<table>
<thead>
<tr>
<th>Orientation (0 yes/1 no correct answer)</th>
<th>0</th>
<th>1</th>
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<tbody>
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<td>What is the day today?</td>
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<td>1</td>
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<tr>
<td>What is the day of the week?</td>
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<td>1</td>
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<tr>
<td>What year is it?</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>What time is it right now (up to 1 hour)</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
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Immediate memory

| Immediate memory score total | 4/14 |

Concentration: Digits Forward

| Total of 4 | 6/4 |

Concentration: Months in reverse order (up to 3 words, score correct)

| Total of 4 | 3/4 |

TREATMENT

- Remove from play
- Must individualize
- Return to learn protocol
  - Accommodations
- Return to play protocol – once symptom free
  - Physical rest
  - Cognitive rest
- Treatment of sequela
  - Pain relief
  - Sleep improvement
  - Psychological treatment
CONCUSSION MANAGEMENT
PREVENT INJURY & DECREASE SYMPTOM BURDEN

GOLD STANDARD TREATMENT
Prevention
WHAT CAN WE DO?

• Take every injury to the head seriously
• Take every precaution to prevent injuries
  • Safe techniques in practice and play
• Encourage recognition and reporting of symptoms
• Seek additional, more specialized care if necessary
• Aid patients/students in recovery
• As you know your students consider investigation is you note changes in communication, personality, behavior, cognitive behavior, etc

NO PAIN NO GAIN!

• Pressure from coaches
• Pressure from teammates
• Pressure from family members
• Pressure from self
SECOND IMPACT SYNDROME

- Repetitive concussion
- An injury soon after a concussion increases the likelihood of experiencing a repeated concussion
- The risk of sustaining a concussion is increased in those who have a history of previous concussion

**Figure 1.** In second impact syndrome, vascular engorgement within the cranium increases intracranial pressure, leading to herniation of the uncus of the temporal lobes (arrows) below the tentorium in this frontal section (a), or to herniation of the cerebellar tonsils (arrows) through the foramen magnum in this midsagittal section (b). These changes compromise the brain stem, and coma and respiratory failure rapidly develop. The shaded areas of the brain stem represent the areas of compression.

![Diagram showing the onset and resolution of typical concussion, repeat injury, and post-concussive syndrome](image-url)
CONCUSSION AND CTE

• Concussion and post concussive syndrome - temporary states of neuronal and axonal derangement
• Chronic traumatic encephalopathy - a progressive neurodegeneration that is triggered by repetitive mild TBI, including concussion and subconcussive blows, but evolves slowly over decades in genetically susceptible individuals. Symptoms are not usually apparent until many years lately
• Reptitive neuronal and axonal disturbance superimposed on unresolved injury - initiates a series of metabolic, ionic, membrane, and cytoskeletal disturbances that trigger the pathological cascade that leads to CTE
• Definitive diagnosis only by direct tissue analysis

PRINCIPAL OF EARLY DETECTION

• Complete recovery is the goal
• Sound medical judgement must prevail
• If a patient reports or is suspected of having head injury and you notice abnormal actions, sensorium or psychological status intervene
THINGS TO WALK AWAY WITH

• All concussions are serious
  • Don’t hide it
  • Report it
  • Take time to recover

SUMMARY

• Sport-related concussions are COMMON
• A concussion is a brain injury
• Symptoms last on average 7 to 14 days but can last weeks to months
• Assessment of concussed athlete is multi tiered
• Diagnosis is based on clinical examination by experienced health care professional
• Treatment must include physical and cognitive rest until asymptomatic – Follow Return To Play Protocol
THE BOTTOM LINE

• Educate the public and raise awareness
• Identify potential injuries that could cause mTBI
• Protect athletes with proper equipment
• Seek medical help as soon as symptoms or concerns occur

REFERENCES


Reisener, A; et al (2015), The Central Role of Community-Practicing Pediatricians in Contemporary Concussion Care: A Case Study of Children’s Healthcare of Atlanta’s Concussion Program. CLIN PEDIATR October 2015 vol. 54 no. 11 1031-1037.

