Concussions
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Concussion

- What is it?
- What to Watch for?
- Treatment?

Concussion: What is it?
- Mild Traumatic Brain Injury
- No gross structural damage
  - Normal CT
  - Likely normal MRI

Are Concussions a Problem?
- Jan. 15, 2004: Federal judge rejects NFL $765 million initial settlement because it’s likely not enough
- Nov. 2013: 10 ex-NHL players file suit against league for improper head injury prevention
Concussion Incidence

Gessel, et al., 2007

<table>
<thead>
<tr>
<th>Sport</th>
<th>Divisions</th>
<th>No. of Concussions</th>
<th>Rate per 1000 Athlete-Exposures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Football</td>
<td>HS, Coll.</td>
<td>331</td>
<td>0.07</td>
</tr>
<tr>
<td>Soccer</td>
<td>HS, Coll.</td>
<td>263</td>
<td>0.04</td>
</tr>
<tr>
<td>Basketball</td>
<td>HS, Coll.</td>
<td>237</td>
<td>0.02</td>
</tr>
<tr>
<td>Field Hockey</td>
<td>HS, Coll.</td>
<td>216</td>
<td>0.02</td>
</tr>
<tr>
<td>Boys' Soccer</td>
<td>HS, Coll.</td>
<td>193</td>
<td>0.02</td>
</tr>
<tr>
<td>Girls' Soccer</td>
<td>HS, Coll.</td>
<td>167</td>
<td>0.02</td>
</tr>
<tr>
<td>Volleyball</td>
<td>HS, Coll.</td>
<td>151</td>
<td>0.02</td>
</tr>
<tr>
<td>Softball</td>
<td>HS, Coll.</td>
<td>122</td>
<td>0.02</td>
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<tr>
<td>Boys' Sports</td>
<td>HS, Coll.</td>
<td>126</td>
<td>0.02</td>
</tr>
<tr>
<td>Girls' Sports</td>
<td>HS, Coll.</td>
<td>124</td>
<td>0.02</td>
</tr>
<tr>
<td>Overall</td>
<td>HS, Coll.</td>
<td>661</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Practice: 0.24/1000 exposures
Games: 6.16/100 exposures

Concussion Incidence

J. Pediatrics Sept. 2013
- 468 male football players ages 8-12 in PA
- 45% of concussions from head-to-head contact
- Incidence
  - Practice: 0.24/1000 exposures
  - Games: 6.16/100 exposures

Concussion Incidence

JAMA Pediatrics study Jan 2014
- Young women’s soccer ages 11-14 in Puget Sound
- 59 concussions per 43,742 exposure hours (1.2/1000)
- 9.4 day mean length of sx
- Heading accounted for 30.5%
- 58.6% played with sx
- 44.1% sought medical attention

Concussion: Primary Injury

- Axonal disruption
- Acceleration / deceleration
- Shear
- Tensile
- Compressive forces
- Mass Lesions
  - SDH/EDH/Contusion/Edema
- Nonhuman primate models
  - ½ of concussion potential related to head rotation
  - Other ½ related to the contact phenomena

Concussion: Secondary Injury

- Impaired blood flow regulation
- 3-phases in severe TBI
  - 1. acute hypoperfusion lasting for ~1 day
  - 2. increased CBF begins on days 2
  - 3. vasospasm begins ~day 4 and lasts for weeks

Traumatic Brain Injuries

- 1,365,000 Emergency Room visits / yr
- 275,000 Hospitalizations
- 52,000 Deaths
- $76 Billion in direct and indirect costs
- 173,000 sports / recreation-related TBI each year from 0-19yo
Concussion: Secondary Injury
- Structural changes in microtubules and neurofilaments
  - Blebbing (focal swelling)
  - Impaired axonal transport
  - Can be seen within 4 hours, may last for days to weeks

Concussion: Secondary Injury
- Excitotoxicity
  - Shear stress causes dysregulation of protein channels
  - Uncontrolled ion flux
  - Release of K and glutamate
  - Release of glutamate causes release of Ca (NMDA receptors)
  - ATP-dependent pumps overworked to restore homeostasis
  - Hypometabolic state can be seen within 30 minutes

Concussion: Secondary Injury
- Hypometabolic state
  - Happens after 5-6 hours
  - Can persist for days
  - Glycolysis / anaerobic respiration
  - Further membrane permeability

Concussion: Secondary Injury
- Blood/brain Barrier Breakdown
  - Can last for weeks to months after injury
  - Shear forces disrupt endothelium
  - Increased small vessel permeability
  - Exudation causes cerebral edema
  - Excitatory molecule influx

Concussion: Secondary Injury
- Inflammation
  - Microglia activated
  - Release of inflammatory products
  - Present from 1hr to up to 30

Concussion: Secondary Injury
- Mitochondrial dysfunction
  - Downregulated cytochrome oxidase for up to 10 days in rat model
  - Caused by increased Ca

Concussion Mechanism
- Rat Model
  - Period of vulnerability after a mild injury
  - Two mild TBIs within 3 days had same mortality as single severe TBI

Why Does it Matter?
- Chronic Traumatic Encephalopathy
  - Significant similarities with Alzheimer'sDs
  - Tau-protein neurofibrillary tangles: brain scarring
Why Does it Matter?
- Chronic Traumatic Encephalopathy
  - Motor Symptoms
    - Speech difficulty, tremors, poor coordination, can lead to parkinsonism
  - Cognitive Symptoms
    - Slowed thought, speech, attention deficits, poor executive function
  - Psychiatric Symptoms
    - Can range from emotional lability to frank psychosis

Why Does it Matter?
- Second Impact Syndrome
  - Period of brain vulnerability after even a mild injury
  - Second injury occurs before brain has a chance to heal from first injury
  - More likely in kids/teens
  - Malignant, uncontrolled brain swelling
  - Mortality 50-100%
  - Of people who survive, most have severe, permanent deficits

Concussion: Symptoms
- Physical
  - Loss of Consciousness (<20%)
  - Fatigue
  - Headache
  - Nausea/Vomiting
  - Dyscoordination

Concussion: Symptoms
- Emotional
  - Irritability
  - Depression
  - Emotional lability

Concussion: Symptoms
- Cognitive
  - Confusion
  - Amnesia
  - Delayed verbal or motor responses
  - Easy distractability
  - Disorientation
  - Executive function deficits
  - Attention / Memory deficits
  - Sleep disturbances
    - Hypersomnia
    - Insomnia

Concussion: Symptoms
- New paper this month: J. Adolescent Health
  - Retrospective cohort National Survey of Children's Health 2007-2008
  - Identified 36,060 kids ages 12-17 without a current concussion
  - Evaluated association between prior concussion and current depression dx
  - History of concussion associated with 3.3 fold increased risk of depression

Concussion: ACSM 2011 Updates
- No same-day return to play
  - Health professionals should use standardized concussion assessment tools
    - NFL baseline / Sideline tool
  - Assessment tools should use pre-injury baseline compared to post-injury
  - Neuropsychiatric testing is one tool
  - Understand state laws
What is the Law?

- No Federal Law

As of Jan. 2014, all 50 states and D.C. have youth sports concussion laws

Nevada Law

- Effective July 1, 2011
- Prior to play and every year, player/guardian
  - Are to be given policy statement
  - Must sign form acknowledging receipt
- Immediate removal from activity/event if suspected/known concussion
- Parent/guardian must provide letter from health care provider consenting to return to play
- Health care provider means:
  - Physician
  - PT
  - Athletic Trainer
- Covers school-sponsored teams and club sports

California Law

- Only applies to school-district activities
- Remove from play the remainder of the day
- Return to play only with written permission of licensed health care provider
  - Trained in concussion mgmt
  - Within scope of practice
- Yearly, must sign form
- Doesn’t apply to school-hours, or as part of school PE classes...

NIAA Rules

- Any athlete who exhibits signs, symptoms, or behaviors consistent with a concussion shall be immediately removed from the contest and shall not return to play until cleared by an appropriate health care professional.
- Who decides if an athlete has had a concussion?
  - An MD (Medical Doctor)
  - DO (Doctor of Osteopathy)
  - PA (Physician’s Assistant)
  - ARNP (Advanced Registered Nurse Practitioner)
  - LAT (Licensed Athletic Trainer),
  - Paramedic
  - School Nurse
- If any one of these individuals has answered “yes” and determined that there has been a concussion, that decision is final.

NIAA Rules

- Under no circumstances can that athlete return to play in that event that day.
- Once a concussion has been diagnosed by one of the above listed on-site providers, only an MD or DO can authorize subsequent return to play, and such shall be in writing to the administration of the school.
- School administration shall then notify the coach as to the permission to return to practice or play.
- After medical clearance, return to play should follow a step-wise protocol with provisions for delayed return to play based upon the return of signs or symptoms

Concussion: Recovery

- Physical Rest
- No Return to Play until sx resolved at rest and with activity
- Return to Play in graduated, controlled manner
  - Light aerobic
  - More strenuous aerobic
  - Full practice
  - Game
- If sx return at any step, go back to previous step

Concussion: Recovery

- Cognitive rest improves sx and cognitive function
  - ? Keep out of school
  - Minimize “thinking” activities
  - Reading
  - Video games
  - Texting
  - Computer Use
  - Light Mental Activities ok if they don’t provoke sx
  - TV
  - Family interaction
- When to Return to School / Learning
  - Depends on Sx severity
  - May need IEP (Individualized Education Plan)
Concussion: Evaluation

- Evaluate for symptoms using neuro-cognitive test
- SCAT2: Sport Concussion Assessment Tool
- ImPACT
- ACE: Acute Concussion Evaluation

Concussion: Recap

- No Same-Day Return to Play!
- If symptoms at rest or with exertion: No Play!
- Return to Play should be gradual

Thank You!

References

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