Sports Concussions: Return to Learn

Jonathan Santana, DO
Adolescent & Sports Medicine

Objectives

• Be able to perform a brief cognitive assessment in the athlete with a head injury
• Be able to prescribe return to school guidelines for the athlete with a head injury
Outline

• Epidemiology
• Pathophysiology
• Office Evaluation
• Return to Learn

Epidemiology

3.8 million instances of sports related concussions (SRC) in any given year – CDC estimate

62% increase in non-fatal traumatic brain injuries 2001—2009

SRC comprise 70% of sport-related head injuries in people under 18 years of age

1 in 4 young people will have at least one concussion before they finish high school

SRC comprise 21% to 27% of all sport-related injuries in high school students

Harris AW, 2012
What is a Concussion?

- Traumatically, or biomechanically, induced alteration of brain function
- Results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously
- Emphasis on a functional disruption, as opposed to structural or tissue injury
- May not involve LOC
  - Only 10% involve LOC
- Resolution of the clinical and cognitive features typically follows a sequential course. However, symptoms may be prolonged.
  - 10-14 days in adolescents, shorter in college athletes
  - 10-20% have prolonged symptoms

General Pathophysiology

- Results in a predominantly metabolic insult
  - Ion shifts
    - Calcium influx and sodium/potassium shifts
    - Calcium interferes with cell function
  - Neurotransmitters
    - Release of glutamate
Pathophysiology, cont.

Injured cells up regulate glucose fueled Na/K ATPase dependent ion membrane transport to restore intracellular balance

Pathophysiology, cont.

- Cincinnati Children’s Study on Cerebral Blood Flow
  - Improvement toward control values occurred in only 27% of the participants at 14 days and 64% at 30 days after SRC
    - Possibilities include alterations in cerebral autoregulation, reduction of large artery caliber (i.e., vasospasm), or extensive regional perfusion perturbations
- Why is this important?
  - CBF allows glucose to travel to the brain
  - After initial injury CBF decreases to minimize brain swelling
- **This leads to metabolic mismatch in the initial days after injury**
  
Maugans et al, 2012
Vulnerability Window

Office Evaluation

• Detailed concussion and medical history
• SCAT5 – brief cognitive exam
• Vestibular/ocular exam
• Balance test
• Neurocognitive testing
Clinical Evaluation

- **History**
  - Mechanism of injury
  - Symptom onset

- **Symptoms**
  - Somatic: headache, nausea, sensitivity to light, and/or noise
  - Cognitive: confusion, “fogginess”, difficulty concentrating and remembering
  - Emotional/Behavioral: more emotional than usual, irritable, sadness, and nervous/anxious

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### Clinical Evaluation

<table>
<thead>
<tr>
<th>Physical Signs</th>
<th>Past Medical History</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Loss of consciousness, amnesia, neurological deficit</td>
<td>- Factors for prolonged recovery</td>
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<tr>
<td>- Balance impairment (e.g., gait unsteadiness)</td>
<td>- Neurological</td>
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<tr>
<td>- Cognitive impairment (e.g., slowed reaction times)</td>
<td>- Seizures, migraines, vision d/o, strabismus, speech therapy, previous concussion</td>
</tr>
<tr>
<td>- Sleep/wake disturbance (e.g., somnolence, drowsiness)</td>
<td>- Mental health</td>
</tr>
<tr>
<td></td>
<td>- Anxiety, ODD, substance abuse, Family history of mental disorder</td>
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<tr>
<td></td>
<td>- Learning difficulties</td>
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<td></td>
<td>- ADD/ADHD, IEP, learning disorder</td>
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</tbody>
</table>
Initial Physical Exam

- Detailed neuro exam
  - Cranial nerves, DTRs, muscle strength

- Neck
  - Midline tenderness
  - ROM

- Ocular/vestibular screen
  - Saccades, gaze stabilization, convergence

- Balance testing
  - BESS, tandem walk (heel to toe)

- Cognitive function
  - SCAT5, computerized neurocognitive testing
Over 400 high schoolers from Wisconsin
- Average SAC scores: 26 (+/- 2)
  - Females performed better than males
- Average BESS errors: 3 (+/-2)
- Symptom score was different for athletes with concussions within the past 12 months
- Athletes with comorbid conditions all reported higher symptom and severity score totals at baseline, and lower total SAC scores

Eye Exam

- Saccades
  - Horizontal/Vertical
- Gaze Stabilization
  - Horizontal/Vertical
- Convergence
  - Adults = 10 cm
  - Children = < 6 cm
- Accommodation
Neurocognitive Testing

- Computer-based test
  - Evaluates short term memory, reaction time, visual motor speed
  - Not an IQ test. Scores indicate performance
  - Several factors affect score
    - Environment: large gymnasium vs office setting, prior attempts at test
    - Personal: low motivation, testing anxiety
    - Physical: eye tracking difficulties, fatigue
- Several questions regarding testing
  - Timing of administration
  - Baselines
Neurocognitive Testing

Just one piece of the puzzle

**Positives**
- May help identify the ‘not so forthcoming’ athlete

**Negatives**
- Predict length of recovery
- Provide prognosis for future problems
- Act as the sole determining factor for return to play
- Act as only indication of concussion

Return to Sports ≠ Return to Learn
Factors to Consider

1. **Symptom load/severity**
   - Higher symptom loads and more severe symptoms = more missed days and longer recovery

2. **Types of symptoms**
   - Somatic symptoms, visual disturbances and vestibular abnormalities

3. **Duration of symptoms**
   - Longer duration of symptoms; high cognitive loads after injury

4. **Age/grade or school level**
   - Adolescents/high school: more post-concussion symptoms, greater severity of symptoms, and longer recovery

5. **Course load**
   - Math is most problematic, followed by reading/language, arts, science and social studies

6. **Rest following injury**
   - Initial rest after injury
   - High cognitive loads/increased school attendance exacerbate symptoms

When Should Athletes Go Back to School?

**Too Soon**
Increase in symptoms and a prolonged recovery with an early return to higher cognitive demands

(Shkoon AY, 2014)

**Too Long**
Increased number and slower resolution of symptoms
10 days after injury (Thomas DG, 2014)

Increased anxiety regarding school entry
Consequences of School Absence

**Short-term**
- Child stress
- Declining academic status
- Loneliness and social alienation
- Family conflict
- Child maltreatment

**Long-term**
- Decreased rates of college enrollment
- Occupational and marital problems
- Chronic anxiety and depression

Allowing a low level of activity with both physical activity (such as walking) and mental activity (such as listening to schoolwork) early in the concussion process does not impair recovery.
Association Between Early Participation in Physical Activity Following Acute Concussion and Persistent Post-concussive Symptoms in Children and Adolescents

Grool AM et al JAMA 2017

- Prospective study of 3063 children and adolescents (5 to 18 years) with acute concussion (9 Canadian EDs)
- Follow up survey of association between early participation in Physical Activity within 7 days of injury and symptoms at one month
- Physical activity within 7 days of injury compared with no physical activity was significantly associated with reduced risk of symptoms at 28 days (24.6% vs. 43.5%)

Recommendations

- Short period of rest from demanding physical and cognitive activities
- Followed by a gradual progression back to regular activity
Return to Learning After a Concussion and Compliance With Recommendations for Cognitive Rest

Robert P. Olympia, MD,* Jed T. Ritter, BS,† Jodi Brady, MD,‡ and Harry Bramley, DO†

TABLE 3. Compliance of Schools With Guidelines or Protocols to Assist a Student’s Return to School After a Concussion as Delineated by National Guidelines*

<table>
<thead>
<tr>
<th>Guideline or Protocol</th>
<th>Affirmative Response (% = 548)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excuse from team sports practice and gym activities</td>
<td>479, 55% (54-80)</td>
</tr>
<tr>
<td>Operation of assignment deadlines</td>
<td>465 (68-84)</td>
</tr>
<tr>
<td>Excused absence from class</td>
<td>467, 64% (84-60)</td>
</tr>
<tr>
<td>Rest periods during the school day</td>
<td>461, 84% (81-87)</td>
</tr>
<tr>
<td>Postponement or rescheduling of tests</td>
<td>472, 75% (73-79)</td>
</tr>
<tr>
<td>Extended testing time</td>
<td>460, 74% (76-77)</td>
</tr>
<tr>
<td>Reduced workload</td>
<td>402, 75% (76-77)</td>
</tr>
<tr>
<td>Accommodation for light or noise sensitivity</td>
<td>350, 64% (64-68)</td>
</tr>
<tr>
<td>Excise from (or substitute) specific tests and assignments</td>
<td>265, 40% (44-53)</td>
</tr>
<tr>
<td>Preferential classroom seating</td>
<td>243, 40% (40-49)</td>
</tr>
<tr>
<td>Use of a smaller quieter examination room</td>
<td>216, 39% (25-44)</td>
</tr>
<tr>
<td>Use of a note taker or scribe</td>
<td>185, 34% (30-38)</td>
</tr>
<tr>
<td>Temporary use of a tutor</td>
<td>120, 31% (27-35)</td>
</tr>
<tr>
<td>Limiting backpack weight</td>
<td>131, 25% (22-29)</td>
</tr>
<tr>
<td>Limiting stair usage</td>
<td>122, 25% (21-28)</td>
</tr>
<tr>
<td>Use of an e-reader (not scrambled) for assignments or testing</td>
<td>111, 20% (17-24)</td>
</tr>
<tr>
<td>Use of dull colored paper to reduce light sensitivity</td>
<td>48, 9% (7-11)</td>
</tr>
</tbody>
</table>

*All values expressed as number of affirmative responses of the 548 schools that have guidelines or protocols to assist students when returning to school after a concussion. % (95% confidence interval)

TABLE 2. School’s Role in the Management of Concussion in Students*

<table>
<thead>
<tr>
<th>School’s Role</th>
<th>Affirmative Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does your school district have a policy in place to help students recovering from a concussion succeed when they return to school?</td>
<td>486 (10-48)</td>
</tr>
<tr>
<td>Does your school have guidelines or protocols to assist students when returning to school after a concussion?</td>
<td>548 (50-53)</td>
</tr>
<tr>
<td>Does your school perform comprehensive baseline cognitive testing on student athletes?</td>
<td>362 (30-41)</td>
</tr>
<tr>
<td>Who is most responsible for determining when students return to school after a concussion?</td>
<td>720 (67-77)</td>
</tr>
<tr>
<td>Primary care physician</td>
<td>720 (67-77)</td>
</tr>
<tr>
<td>Athletic trainer</td>
<td>101 (58-77)</td>
</tr>
<tr>
<td>Concussion specialist</td>
<td>82 (67-10)</td>
</tr>
<tr>
<td>Psychologist</td>
<td>58 (44-74)</td>
</tr>
<tr>
<td>School ophthalmologist</td>
<td>33 (25-57)</td>
</tr>
<tr>
<td>Other</td>
<td>41 (10-77)</td>
</tr>
</tbody>
</table>

*All values expressed as number of responses. % (95% confidence interval)

Table 3: Graduated return to school strategy

<table>
<thead>
<tr>
<th>Mental activity</th>
<th>Activity at each step</th>
<th>Goal of each step</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Daily activities that do not give the child symptoms</td>
<td>Typical activities that the child does during the day as long as they do not increase symptoms (e.g., reading, testing, screen time). Start with 5–15 min at a time and gradually build up</td>
<td>Gradual return to typical activities</td>
</tr>
<tr>
<td>2. School activities at home</td>
<td>Homework, reading or other cognitive activities outside of the classroom. Start with 5–15 min at a time and gradually build up</td>
<td>Increase tolerance to cognitive work</td>
</tr>
<tr>
<td>3. Return to school part-time</td>
<td>Gradual introduction of schoolwork. May need to start with a partial school day or with increased breaks during the day</td>
<td>Increase academic activities</td>
</tr>
<tr>
<td>4. Return to school full-time</td>
<td>Gradually progress school activities until a full day can be tolerated</td>
<td>Return to full academic activities and catch up on missed work</td>
</tr>
</tbody>
</table>
Sample School Accommodations

**General Accommodations**
- Reduce the student’s homework by 50%
- Provide pre-printed teachers notes instead of note taking (eliminates looking up and down at the screen/board)
- Please limit screen time (computers, phones, etc.)
- Please allow student to wear sunglasses/earplugs during class
- Please allow student to visit the nurse as needed

**Testing**
- Can do testing after patient has caught up on missed work.
- Please give extra time for testing.
- Please allow the student to take breaks during tests
- If written tests provoke too many symptoms, then verbal tests are OK.
- Should only take one test daily
- Student athlete should NOT be required to attend team functions (practice, meetings should be optional)

**Accommodations Should Be…**
- No more than needed
- Individualized and specific
- Time-limited
- Designed to minimize effect of secondary gain