Special Considerations for the Young Athlete

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Overview

- Pediatric sports-related concussion
- Concerns with the developing brain
- Complications of concussion
- Recovery following concussion
- Assessing pediatric concussion
- Management issues with pediatric concussion
Pediatric Sports-Related Concussion

- Mild head injury (MHI) accounts for 3-8% of all sports-related injuries (Kelly et al, 2001; Boyce & Quigley 2003)
- 24% of all serious head injuries were from a sports-related MOI (Kelly et al, 2001)
- Among 5-14 year olds, 37% of MHI occurred in school or leisure activities (Engberg & Teasdale, 1998)
- 15% admitted following sports-related MHI (Adams, 2001)
  - Mean cost of admission = $13,459 (Jaffe et al, 1993)
Concerns with the Developing Brain

- **Vulnerability**
  
  (Aldrich et al, 1992; Giza & Hovda, 2000; Kraus et al, 1986; Prins & Hovda, 1998)

  - Periods when the brain is more susceptible to injury and recovery is more difficult
  - Thinner frontal and temporal cranial bones
  - Diffuse and more prolonged cerebral swelling
Concerns with the Developing Brain

- Metabolic differences
  - Differences in $lCMR_{gluc}$ between children ≤15 years and adults
  - Children are at a greater risk for secondary ischemia
Repeated Concussion

- Elicits a neurometabolic cascade of acute ionic changes, metabolic perturbations, and axonal dysfunction

- Longer term derangements include
  - $\text{Ca}^{2+}$ accumulation
  - Elevations in lactate
  - Decreased glucose metabolism
  - Decreased cerebral blood flow
  - Axonal disconnection
  - Neurotransmitter disturbances

- During the post-injury period the cell is most vulnerable to further insults
Second Impact Syndrome

- Catastrophic occurrence
- Relatively minor second trauma superimposed on a brain recovering from an initial injury
- Leads to rapid neurologic deterioration, cerebral edema, and death
- Strong tendency to occur in children and adolescents

  - Athletes under the age of 18 (Cantu & Voy, 1998; Cantu, 1995; McCrory & Berkovic, 1998)
Second Impact Syndrome

- Mortality rates near 50% and morbidity rates of 100% (Cantu, 1990)
- Impaired autoregulation in the injured developing brain leads to hyperemia and edema
- Higher risk of cerebral swelling due to different autoregulatory responses to trauma (Snoek et al, 1984; Schnitker, 1949; Bruce et al, 1981)
Second Impact Syndrome

Cantu RC. *Neurologic Athletic Head and Spine Trauma*, 2001
Recurrent Concussion and Cumulative Effects
Recurrence of Concussion

- 4-6 times ↑ risk for subsequent concussion (Gerberich et al, 1983; Wilberger, 1993; Zemper, 1994)
- 3 times more likely to sustain 2nd in same season (Guskiewicz et al, 2000)
- Increased severity with subsequent concussion (Guskiewicz et al, 2000)
- 10.3% of high school athletes sustaining concussion had subsequent injury (Powell & Barber-Foss, 1999)
  - 65.3% in same season, 19.4% in next season
Cumulative Effects of Concussion

- College FB players with 2+ injuries performed worse than controls and athletes with 1 previous MHI on NP tests (Collins et al, 1999)
- 3+ previous concussions reported more headaches, memory problems, and taking longer to think (Gaetz et al, 2000)
- HS athletes with 3+ concussions were more likely to experience on-field LOC, anterograde amnesia, and confusion after subsequent MHI (Collins et al, 2002)
Are previous concussions a predisposition to future injury?

- Risk of incident concussion:
  - players with 3+ previous concussions, are 3.5x (95%CI: 1.8-6.5) more susceptible to concussion than a player with no concussion history
  - players with 2 previous: 2.8x (95%CI: 1.6-4.7) risk
  - players with 1 previous: 1.5x (95%CI: 1.0-2.1) risk

Guskiewicz et al, JAMA 2003
Recurrent Concussion
(within season)

- 11 of 12 (92%) in-season repeat concussions occurred within 10 days of the first injury
- 9 of 12 (75%) occurred within 7 days of the first injury

Guskiewicz et al, JAMA 2003
Are previous concussions a predisposition to future injury?

Frequency of injured players’ recovery when categorized by concussion history. Fisher’s Exact Test (14.12; p=.04)

<table>
<thead>
<tr>
<th>No. Previous Concussions</th>
<th>Rapid recovery (S/S &lt; 1 day)</th>
<th>Gradual recovery (S/S 1 day-1 wk.)</th>
<th>Prolonged recovery (S/S &gt;1wk.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (n=118)</td>
<td>33 (28.0%)</td>
<td>76 (64.4%)</td>
<td>9 (7.6%)</td>
</tr>
<tr>
<td>1 (n=38)</td>
<td>14 (36.8%)</td>
<td>18 (47.4%)</td>
<td>6 (15.8%)</td>
</tr>
<tr>
<td>2 (n=15)</td>
<td>5 (33.3%)</td>
<td>7 (46.7%)</td>
<td>3 (20.0%)</td>
</tr>
<tr>
<td>3+ (n=12)</td>
<td>0 (0%)</td>
<td>7 (58.0%)</td>
<td>5 (42.0%)</td>
</tr>
</tbody>
</table>

Guskiewicz et al, JAMA 2003
Recurrent and Cumulative Concussion

Collegiate Athlete

8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

High School Athlete

8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

Pediatric Athlete

8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Recovery Following Concussion

- Comparison of college and high school concussed athletes (Field et al, 2003)
  - No differences on HVLT at baseline or 1st injury follow-up (within 24 hrs)
  - HS athletes performed poorer on the HVLT and Delayed Recall than college athletes on Day 3 post-injury
  - Increase in PCSS vs. controls until Day 3 in the college athletes and Day 5 in the HS athletes
Recovery Following Concussion

- HS athletes following a concussion where mental status changes and symptoms resolved within 15 minutes (AAN Grade 1) (Lovell et al, 2004)
  - Memory deficits found at 36 hours postinjury
  - Increase in self-reported symptoms at 36 hours postinjury
Assessing Pediatric Concussion
Assessments for High School Athletes

- **Traditional Neuropsychological Tests** (Field et al, 2003; Brown et al, 2003; Daniel et al, 1999)
- **ImPACT** (Collins et al, 2002, 2003; Lovell et al, 2003)
- **Headminders (CRI)** (Erlanger et al, 2001)
Pediatric Cognitive Assessments

- Comprised of downward extensions of the tests used in adult populations (Spreen & Strauss, 1998)

- Widely used in children with head injuries (Gulbrandsen, 1984; Ewing-Cobbs & Fletcher, 1990; Donders & Strom, 2000; Silver, 2000; Catroppa & Anderson, 1999; Kinsella et al, 1997; Levin et al, 1997; Max et al, 1999; Anderson et al, 1997)
Pediatric Cognitive Assessments

- Long-term deficits following MHI in studies up ranging from 4 months (Gulbrandsen, 1984) to 5 years (Klonoff & Lowe, 1977)
  - Scored significantly lower on problem solving, sensorimotor integration, and subsets of the WISC 4-8 months post-injury (Gulbrandsen, 1984)
  - Deficits in language, visual spatial functioning, memory, & motor performance in children and adolescents with MTBI (Levin & Eisenberg, 1979)

- Other studies have found no cognitive deficits (Fay et al, 1993; Roman et al, 1998; Anderson et al, 1997)
Standardized Assessment of Concussion

- Valid and reliable in young athletes (McCrea, 2003)
- Appropriate for 9-14 y/o athletes (26.8±2.1)
- Test-retest reliability: r= .573, SEM=1.39 (Valovich et al. 2003)
- Reliable change index ± 3 (Valovich et al. 2003)
Balance Error Scoring System

- Appropriate for 9-14 y/o athletes (15.5±5.8 errors)
- Test-retest reliability: r=.673, SEM=3.87 (Valovich McLeod et al, In review)
- Reliable change index ± 6 errors (Valovich McLeod et al, In review)
Assessing Pediatric Concussion

- Lack of prospective investigations in younger athletes
  - Uncertain about acute and residual effects of concussion
- Lack of trained medical personnel on-site with younger athletes
- Many of the assessments studied in collegiate and high school athletes are likely appropriate in their current form or downward extensions
Assessing Pediatric Concussion

- Assessments need to be easy to administer, time and cost effective
- More frequent baseline assessments due to development and maturation (Daniel et al, 1999; Valovich McLeod et al, 2004)
- Dissemination of study findings to those caring for younger athletes
Managing Pediatric Concussion
Management Issues in Pediatric Athletes

- ATC’s are not employed at every HS
  - RTP decisions made by other health care personnel

- Survey regarding RTP to pediatric, family practice, ER physicians and nurse practitioners (Bazarian et al, 2001)
  - 7.6% correct RTP for grade 1 scenario
  - 56% correct RTP for grade 2 scenario
  - 28% correct RTP for grade 3 scenario
Management Issues in Pediatric Athletes

- Hospital discharge instructions following athletic mild concussion were inadequate in 69.7% of children (Genuardi & King, 1995)
  - 13% instructed to return too soon
  - 87% were not given any instructions
- Oral and written instructions should be given to the athlete and a responsible adult
- ATC and physician should agree on a standard concussion home instruction form

(Guskiewicz et al. J Athl Train, 2004)
Management Issues in Pediatric Athletes

- High school athletes are not aware of the signs and symptoms of concussion (McCrea et al, 2004)
- 47.3% reported their concussion
- When asked why they did not report the injury:
  - 66% did not think it was serious enough
  - 36% did not know they suffered a concussion
Management Issues in Pediatric Athletes

- Youth sports coaches lack knowledge to recognize signs and symptoms of concussion (Schwartz et al., 2005 [abstract])
  - Coaches who participated in a coaching education program identified more symptoms
  - Those with first-aid and CPR certifications were not able to identify more symptoms
  - More than 50% thought LOC needed for concussion
Managing Pediatric Concussion

- Education of athletes, parents, and coaches regarding signs and symptoms
- More conservative approach to return-to-play decisions
  - Are current grading scales and RTP guidelines too liberal for younger athletes?
Guidelines and Recommendations
Practice Guideline: The Management of Minor Closed Head Injury in Children
- Evidence based parameter for health care professionals
- Initial management (within 24 hours)
- “Minor closed head injury”
  - Normal mental status at initial exam
  - No abnormal or focal findings on neurologic exam
  - No physical evidence of skull fracture
AAP Practice Parameter

- Mild head injury with no LOC
  - Observation
  - Regular monitoring by a competent adult
  - Do not recommend CT, skull films, MRI

- Mild head injury with LOC
  - Observation
  - Cranial CT scan
    - Skull films and MRI are not recommended
National Federation of State High School Associations (NFHS)

- Athletes who sustain their 1st concussion can only RTP when clear for 15 minutes at rest and with exertion
- Prohibits the return of any athlete who lost consciousness
- Encourage the use of checklists and the SAC
NFHS Sideline Management

- Following a head injury, an athlete should be returned to practice or a game ONLY if he/she meets ALL of the following criteria
  - Head injury did not result in any LOC
  - Any “confusion” or altered mental status clears in < 15 minutes
  - The injured athlete has no history of previous concussion
  - The athlete checks out “clear” by a medical professional on mental status, concentration and memory tasks before and after exertional provocative tests
NFHS Sideline Concussion Management

**MHI (No LOC)**
- **First MHI**
  - Clears in 15 min at rest and with exertion
  - OK to return to game or practice

**MHI (With LOC)**
- **First MHI**
  - Does not clear in 15 min
  - Should not return to game and should have medical clearance before further participation in competition or practice even if athlete seems OK. This includes any other strenuous activity

- **History of previous MHI**

NFHS rules PROHIBIT return to contest

State Association Rules

- Check with your state interscholastic association regarding sports medicine rules and position statements
  - Arizona Interscholastic Association Sports Medicine Committee
- AIA has a list of specific medical professionals allowed to clear athletes
  - Allopathic and osteopathic physicians
  - Chiropractors are NOT allowed
Appropriate Medical Care of the Secondary School-Aged Athlete

- Concussion Hx should be asked on the PPE
  - Specific questions regarding number, severity, & recovery times

- Immediate recognition of the initial concussion by members of the Athletic Health Care Team, as well as team members and coach is necessary
  - Allows for quick initiation of appropriate medical treatment

NATA Recommendations

- Young athletes experience sport-related concussion
- ATCs should help to educate about the dangers of repeated concussions
- Continued research into the epidemiology of sport-related injuries in young athletes
- Prospective investigations to determine the effects of concussion and recovery curves in younger sports participants, are warranted

Guskiewicz KM et al. J Athl Train. 2004
ATCs working with younger (pediatric) athletes should be aware that recovery may take longer when compared to older athletes. Additionally, these younger athletes are maturing at a relatively fast rate and will likely require more frequent updates of baseline measures compared to older athletes.

Guskiewicz KM et al. *J Athl Train*. 2004
NATA Recommendations

- Continued effort should be put forth to evaluate the long-term effects from multiple concussions in younger athletes. Until further information is available, younger athletes (under age 18 years) should be managed with extra caution, using more strict RTP guidelines than those used to manage concussion in the more mature athlete.

Guskiewicz KM et al. *J Athl Train.* 2004
Take Home Points

1. Developing brain may be more susceptible to injury
2. Young athletes may have a prolonged recovery
3. Cognitive and postural stability assessments can be used
4. More frequent baseline tests to account for development
5. ATC’s should be more conservative with returning young athletes to activity
Thank You