Return-to-Play After Concussion: Clinical Guidelines for Young Athletes

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Financial Disclosures: None reported.

Support: None reported.

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Submitted March 28, 2018; revision received May 16, 2019; accepted June 12, 2019.

The National Center for Injury Prevention and Control at the Centers for Disease Control and Prevention (CDC) identified concussion and mild traumatic brain injury as not only a major public health concern but an epidemic.[1] The annual incidence of concussion in the United States is estimated to be as high as 6 per 1000 people or 0.6% of the population.[2] Concussion is one of the most commonly encountered conditions in sports medicine. While concussions are certainly not limited to sports, it is an area of intense national focus and debate. There are certain high-mechanism contact sports that have a higher risk of producing concussions, including high-speed collisions in baseball, falls from heights in gymnastics, checking in ice hockey, falling onto hardwood floors in basketball, and head-on collisions in soccer. Perhaps the most damaging sport of all is boxing, during which athletes take repeated blows to the head consistently in every encounter and are declared winners by "knockout," when the opponent loses consciousness. The mechanism of concussion is not limited to the force of impact but is also influenced by an acceleration/deceleration injury.

Clinical Question: How is a concussion diagnosed and graded? What are the most current clinical guidelines published by authoritative medical societies based on expert consensus? When does the physician treating a young athlete who has just sustained a concussion allow the patient to return to play in competitive sports?

Evidence: The American Academy of Neurologists, the American Osteopathic Association, and other professional medical societies and commissions have all issued official statements about the danger of returning to play too early after an acute concussion or mild traumatic brain injury based on evidence that demonstrates concussions have additive effects, and patients are more vulnerable to secondary injury.

Recommendation: This review of the methods of diagnosing and grading concussion and mild traumatic brain injury and the official return to play guidelines will allow physicians to make the safest medical decisions about when an athlete will return to play to protect the patient from further injury poised by the risk of acute and subacute repetitive head trauma.

The physician responsible for patients with concussion often faces pressure from players, coaches, parents, academic institutions, professional teams, sponsors, and others to return the player to the sport as soon as possible. A physician must recognize concussion, resist persuasion for early return to play, and educate the patient, family, and team regarding the effect concussion may have in the future. The incidence of concussion was significantly higher among high school athletes than collegiate athletes.

The aim of this review was to explore recent literature regarding the ramifications of concussions and current concussion guidelines to raise awareness so physicians caring for a patient with concussion can better diagnose concussion and treat and educate their patients.

Defining and Diagnosing Concussion

A concussion is a mild traumatic brain injury that can result in amnesia, confusion, and loss of consciousness. Contrary to common belief, any amnesia or confusion after a head injury is consistent with a concussion even without loss of consciousness. Approximately 10% of persons with concussion do not lose consciousness, which may lead to underreporting and underdiagnosis.[3] Concussions can produce immediate, subacute, and chronic cognitive, behavioral, social, occupational, and academic impairment. The neurophysiologic symptoms are a manifestation of pathologic changes at the microscopic level that disrupt normal neurophysiologic dynamics. The consequences are additive, and each successive concussion results in an increased level of damage to the cerebrum, causing further neurocognitive impairment and is thought to lead to chronic traumatic encephalopathy (CTE).

Our understanding of concussion is continuing to expand, with new discoveries that will help physicians diagnose concussion with objective biochemical laboratory tests in addition to classic clinical assessment. It was long believed that concussion was strictly a functional and not a structural injury because of the grossly negative findings on imaging obtained during the immediate postinjury period. We now have a better understanding of the structural consequences thanks to advances in research and the advancement of neuroimaging modalities such as magnetic resonance imaging and diffusion tensor imaging, which have shown chronic manifestations of concussion involving white matter tracts in patients with a history of concussion.[4] New tests have been developed to assess injury at a cellular level.[5] In February 2018, the US Food and Drug Administration approved a novel blood test, the Brain Trauma Indicator (Banyan Biomarkers), to evaluate the presence of mild traumatic brain injury and concussion. This test measures the serum levels of the proteins ubiquitin carboxy-terminal hydrolase L1 and glial fibrillary acidic protein, which are released into the bloodstream after the brain sustains an injury.[5]

Grading Concussion and Determining Return to Play

At least 41 different grading systems have been used to classify the severity of mild traumatic brain injury documented in the literature.[6] Currently, the most

Table 1.
Clinical Guidelines for the Assessment and Grading of Concussion

Grading Scale	Criteria
Colorado Sports Concussion Grading Scale	
Grade I	Confusion without amnesia, no loss of consciousness
Grade II	Confusion with amnesia, no loss of consciousness
Grade III	Loss of consciousness
American Academy of Neurology Concussion Grading Scale	
Grade I	Transient confusion no loss of consciousness, concussion symptoms <15 minutes
Grade II	Transient confusion, no loss of consciousness, concussion symptoms >15 minutes
Grade III	Any loss of consciousness brief or prolonged
Cantu Sports Concussion Grading Scale	
Grade I	No Loss of consciousness, posttraumatic amnesia <30 minutes
Grade II	Loss of consciousness <5 minutes of posttraumatic amnesia lasting from 30 minutes to 24 hours
Grade III	Loss of consciousness >5 minutes or posttraumatic amnesia >24 hours

widely used and accepted clinical guidelines were developed by the Colorado Medical Society, the American Academy of Neurology (AAN),[7] and Cantu[8] (Table 1). Loss of consciousness is considered a grade III concussion in these grading scales.[9] The Colorado Sports Concussion Grading Scale incorporates the concepts from most grading scales, producing a progression of severity (grades).

The return-to-play guidelines incorporate the grade of concussion, number of prior concussions, and time between concussive episodes and the patient's post-concussive performance on neurologic, physical, and neuropsychologic examination. The return-to-play guidelines in Table 2 are based on the most recent grading system of the AAN and are recommended for physicians to determine an athlete's ability to return to play.[7]

Contrary to the AAN's use of concussion grading scales, the International Conference on Concussion recommends against using standard grading scales to ensure individualized care.[10] A stepwise approach to recovery is based on the Concussion in Sport Group's "11 R's": recognize, remove, reevaluate, rest, rehabilitation, refer, recover, return to sport, reconsider, residual effects and sequelae, and risk reduction. This approach incorporates neuropsychiatric testing using tools such as the Standardized Assessment of Concussion and the Maddocks Questions Test. The fifth International Conference on Concussion in Berlin recommends a graduated return to sport, with each step encompassing 24 to 48 hours.[11] In addition, they recommend the use of the latest Sport Concussion Assessment Tool, as it is the most developed and established tool for evaluating concussion within the first 3 to 5 days.[11] For graduated return to sport, they recommend the following:

1. Symptom-limited activity
2. Light aerobic exercise
3. Sport-specific exercise
4. Noncontact training drills
5. Fully contact practice
6. Return to sport

Table 2.
Return-to-Play Guidelines for Athletes With Concussion[7]

Grade	Guideline
Grade I (confusion)	
First concussion	Remove from play; observe every 5 minutes for 20 minutes with neurologic examination; return to play if no signs or symptoms
Second concussion	Remove from play for 2 weeks; possible CT
Third concussion	Remove from play for season; CT scan
Grade II (confusion and amnesia)	
First concussion of season	Remove from play for 1 week
Second concussion of season	Remove from play for 1 month; CT scan
Third concussion of season	Remove from play for season; CT scan; consider any further contact sport contraindicated
Grade III (confusion, amnesia, and loss of consciousness)	
First concussion of season	Remove from play for 2 weeks if loss of consciousness <1 minute, otherwise 1 month; transport to hospital; CT scan; rule out any additional cervical spine injury
Second concussion of season	Remove from play from season, follow above guidelines; consider any further contact sport contraindicated

Abbreviation: CT, computed tomography.

The American Osteopathic Association also issued guidelines pertaining to return to play activity following concussion in Resolution No. H 352.[12]

- Young athletes with concussion should stop playing the sport immediately.
- Sideline assessments for athletes with suspected concussion should be performed by appropriate licensed/certified professionals.
- If concussion is suspected after assessment, athletes should be examined by a physician.
- Physician will develop treatment plan for return to sport and return to learn.

A study[13] performed at the University of Pittsburgh Medical Center found that young athletes who continued to play a sport immediately after a concussion took twice as long to recover from their symptoms and had more severe symptoms compared with an equivalent group removed from play. Removal from play was the strongest predictor of a fast recovery, more so than any other factor, such as age or sex.

At the start of the athletic season, all athletes should receive baseline testing that evaluates their balance and cognitive function. For athletes who later sustain a concussion, these baseline assessments can be compared against postconcussion testing to determine whether their function has been affected. When the results of cognitive, physical, neurologic, and neuropsychiatric examinations are in doubt, players should be removed from play.

Return to Learn

The CDC released official return-to-learn guidelines in 2017 that specifically addressed the cognitive and emotional consequences of concussion.[14] Concussion can cause residual difficulty with focus, memory, task completion, goal-oriented behavior, irritability, somnolence, fatigue, emotional lability, headache, photophobia, nausea, and disequilibrium. The CDC's return-to-learn guidelines are based on the level of residual symptoms the patient experiences. A more comprehensive review of these guidelines can be accessed at https://www.cdc.gov/HEADSUP/.

Severe Outcomes of Concussion

Postconcussion Syndrome

Primary and secondary brain injury in concussion can produce a constellation of physical, cognitive, emotional, and behavioral symptoms, referred to as postconcussion syndrome (PCS). Although it is not uncommon for a patient with concussion to have symptoms that last for up to 4 weeks, patients and their families should be counseled on the potential of PCS developing.[15] Symptoms usually consist of headaches, dizziness, inability to concentrate, depression, memory impairment, anxiety, and sleep disturbances. They are usually self-limited and resolve within days to weeks but may persist for months to years, leading to long-term disability.[16,17] Often, establishing a diagnosis may be a challenge, as minor head trauma may be overlooked. Moreover, diagnosing PCS has proven to be a challenge, with much variation in presentation.[18,19] Symptoms can begin shortly after the injury but can take up to 3 months to manifest and can persist for months and, rarely, years after the initial injury.[20]

Chronic Traumatic Encephalopathy

The development of CTE has been directly linked to sustaining multiple successive concussions, but this theory remains controversial.[8] It can often take several years for the progressive effects of successive concussions to present with the initial signs and symptoms associated with CTE.[21] This condition can produce profound cognitive and psychiatric impairment that can significantly interfere with patients' ability to perform socially, academically, and occupationally. Many of these patients are too cognitively impaired to actively participate in the labor force and become unemployed at a rate 60% higher than the general population.[22] They have a higher incidence of psychiatric disturbances, with increased aggression and a higher propensity toward violence, which can lead to incarceration.[23,24] These patients also exhibit increased rates of depression with tendency toward suicide and are 3 to 4 times more likely to commit suicide.[25] The pathologic

manifestations of CTE as revealed on autopsy demonstrate neurofibrillary tangles and deposition of tau protein, with a histologic appearance similar to that in elderly persons with Alzheimer disease.[26]

Other Neuropsychiatric Disorders

Repeated traumatic insults to the brain can also result in other severe neuropathologic conditions, particularly in boxers. A form of Parkinson disease caused by repeated blunt force trauma to the head, as well as an array of complex movement disorders, has been reported in boxers.[27,28] These patients also have much higher incidences of psychiatric disorders, including depression, anxiety, and psychosis.

Conclusion

Physicians who evaluate young patients with concussion can protect them from sustaining further injury by using the return-to-play guidelines and educating patients and their families. When implemented, these clinical scales and guidelines can prevent secondary injury and improve the ongoing care and long-term outcomes of these patients. We recommend that parents, guardians, and students learn about the health risks and warning signs of concussion through evidence-based information disseminated by schools and youth sports organizations. (doi:10.7556/jaoa.2019.135)

Author Contributions

All authors provided substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; all authors drafted the article or revised it critically for important intellectual content; all authors gave final approval of the version of the article to be published; and all authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Published online November 25, 2019.

Keywords: brain injury, concussion, sports

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