Abstract:

Concussion is a common injury that emergency medicine physicians will be called upon to evaluate. A comprehensive history and physical examination, cognitive evaluation, and balance testing are important in the assessment of a head injury. Assessment tools have been developed and are widely available. Their inclusion in the initial evaluation of suspected concussion may aid diagnosis and management. Athletes should never be allowed to return to play on the same day they suffer a concussion. Follow-up with a primary care physician, sports medicine specialist, or neurologist is recommended before return to play. Accurate anticipatory guidance has been shown to be beneficial in concussion recovery and can be instituted in the emergency department setting. Familiarity with legislation within your state is important in understanding the regulations for medical clearance for return to play for competitive athletes.

Keywords:

head injury; mild traumatic brain injury; adolescents; athletes

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Sports-Related Concussion

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Concussion is a form of mild traumatic brain injury (TBI) that results when a direct blow to the head, neck, face, or elsewhere on the body produces biomechanical forces that are subsequently transmitted to the brain. It usually results in rapid onset of signs, symptoms, and neurologic impairment, which typically resolve spontaneously. Although the pathophysiology of concussion is not yet completely understood, it is currently theorized to be a functional disturbance that is due to a complex metabolic cascade that occurs within the brain as a result of trauma. Typically, no structural disturbance can be visualized on advanced imaging.[1,2] Resolution of signs and symptoms occurs in less than 10 days for 80% to 90% of individuals who suffer a concussion. However, children and adolescents are more likely to have a delayed recovery beyond 10 days.[3]

EPIDEMIOLOGY

Each year an estimated 1.6 to 3.8 million sports-related concussions occur in the United States, with most individuals not seeking medical care.[4] Within the last decade, there has been a 62% increase in the number of children and adolescents presenting to an emergency department (ED) for sports- and recreation-related TBI.[5] Media attention and improved awareness and recognition of concussion have likely contributed to a dramatic increase in the number of individuals presenting for medical evaluation and management of suspected head injuries.

From 1997 to 2008, Lincoln et al[6] collected data showing an overall annual increase in concussion rate of 16.5% in high school athletes. At the high school level, the overall concussion rate is 2.4 to 2.5 per 10 000 athletic exposures (AEs). An *AE* is defined as 1 athlete participating in 1 practice or competition.[6,7] Marar et al[7] studied high school athletes across all sports and found consistently higher concussion rates in competition than in practices. Overall, boys have a total concussion rate almost 2 times that of girls (3.1 vs 1.6 per 10 000 AEs). This is because essentially only boys play football, which is the sport that accounts for the largest number of

concussions. However, in gender comparable sports (ie, boy's vs girl's soccer), girls have a total concussion rate almost 2 times that of boys, 1.7 vs 1.0 per 10 000 AEs (Table 1).[7]

DIAGNOSIS

The 4th International Conference on Concussion in Sport was held in Zurich in November 2012, and proceedings from this meeting have been published in both the Clinical Journal of Sports Medicine and the British Journal of Sports Medicine and represent a revision and update of the recommendations developed following the 1st (Vienna 2001), 2nd (Prague 2004), and 3rd (Zurich 2008) International Consensus Conferences. These most recent guidelines are commonly referred to as the Zurich guidelines. From these meetings, the following consensus definition of concussion was established: concussion is a brain injury and is defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces. Several common features that incorporate clinical, pathologic, and biomechanical injury constructs that may be used in defining the nature of a concussive head injury include the following:

1. Concussion may be caused either by a direct blow to the head, face, neck, or elsewhere on the body with an "impulsive" force transmitted to the head.
2. Concussion typically results in the rapid onset of short-lived impairment of neurologic function that resolves spontaneously. However, in some cases, symptoms and signs may evolve over a number of minutes to hours.
3. Concussion may result in neuropathological changes, but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury, and as such, no abnormality is seen on standard structural neuroimaging studies.
4. Concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness (LOC). Resolution of the clinical and cognitive symptoms typically follows a sequential course. However, it is important to note that, in some cases, symptoms may be prolonged.[1]

It is important to note that the diagnosis of concussion is clinical and relies on patient-reported symptoms. Physical examination frequently reveals deficits in balance and cognitive function; however, it may also be normal. Because of their limited clinical utility in predicting prognosis, previously published concussion grading scales were abandoned in 2008.[8]

TABLE 1. Concussion rates in high school athletics.[6,7]

Sport	Rate per 10 000 Athletic Exposures
Football	6.0-6.4
Boys' ice hockey	5.4
Boys' lacrosse	3.0-4.0
Girls' lacrosse	2.0-3.5
Girls' soccer	3.4-3.5
Boys' wrestling	1.7-2.2
Girls' field hockey	1.0-2.2
Girls' basketball	1.6-2.1
Boys' soccer	1.7-1.9
Boys' basketball	1.0-1.6
Girls' softball	1.1-1.6
Boys' baseball	0.5

SYMPTOMS

The symptoms of concussion are numerous and can be grouped into 4 categories: physical, cognitive, emotional, and sleep (Table 2). The most commonly reported symptom in concussion is headache, with dizziness as the next most common.[9,10] Headache is frequently bilateral but may be unilateral and is often exacerbated by bright light and loud noise. Loss of consciousness only occurs in 10% of concussions but, when prolonged, may indicate a need for neuroimaging to rule out structural injury.[7,10] The presence of amnesia, which may be either retrograde (preceding the injury) or anterograde (after the injury), may be predictive of longer recovery time.[11,12] Dizziness at the time of injury and total number and severity of symptoms have also been associated with prolonged recovery.[9,13] Cognitive impairment after concussion may be dramatic but is more commonly subtle. Athletes may be confused about recent events, answer questions slowly, or may even repeat questions. Sleep disturbance is common in concussion, although athletes will typically complain of fatigue and sleeping more than usual acutely after concussion.[11]

Athletes often have difficulty recognizing concussion symptoms and, therefore, may be less likely to accurately report probable concussion. In the acute stage, concussion should be seen as an evolving injury. Symptom onset may not occur or be