Sports Related Mild Traumatic Brain Injury in Adolescents

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Abstract. While head injuries are not common in youth sports, they may have catastrophic results. Concussion is also referred to as mild traumatic brain injury (MTBI). Although the occurrence of head injuries has been studied more extensively in American football, the findings have wider application for any MTBI. Recently, more attention has been directed at other sports in which both boys and girls participate. The diagnosis of MTBI is based on subjective findings and subtle changes in mental status. Other cerebral injuries requiring emergent or urgent neurosurgical attention should be ruled out. Objective tests such as CT scans and Magnetic Resonance Imaging (MRI) are usually without significant findings in MTBI. Neuropsychological testing may demonstrate areas of deficiencies, however, results may be difficult to interpret because of confounding factors. Complications following MTBI have been known to occur. The most catastrophic of these is second impact syndrome. There are a variety of guidelines for return to play following a concussion, which have been designed in an effort to avoid problems such as second impact syndrome. These guidelines are based more on clinical experience than on scientific evidence. Education, good training and coaching techniques, improved equipment, and rule changes and enforcement, can all help in curbing the sports related head injuries in adolescents. [Indian Journal of Pediatrics, 2000; 67 (5) : 317-321]

Key words : Concussion; Mild traumatic brain injury; Adolescents

Severe head injuries are relatively rare occurrences in youth sports. The vast majority of head injuries may be of mild severity, however, these may result in significant complications, both acute and long term. Lack of a uniform definition of concussion has contributed to considerable confusion in the literature. More recently, any head trauma related change in mental status, has been referred to as concussion or mild traumatic brain injury (MTBI). While loss of consciousness is an indicator of a more severe head injury, it does not necessarily need to be associated with MTBI. This has traditionally been a misconception regarding concussion.

The medical practitioner may first encounter the athlete with a head injury seeking clearance to return to sports or during the sports pre-participation evaluation. Sometimes the athlete may first come to medical attention because of long term complications, such as deterioration in cognitive functions or post-concussive headaches. The patient may not recall the original head injury or might have not considered it significant enough to seek medical attention at the time. This article provides an overview of MTBI or concussion in sports.

Epidemiology

The highest number of sports-related head injuries in adolescents have been reported in American football, and have been studied extensively. Head injuries also occur in other popular youth sports including soccer, rugby, wrestling, ice hockey, field hockey, snowboarding, martial arts and lacrosse. In the U.S. alone, the estimated sports-related traumatic brain injury incidence in 300,000 per year. Most of these are mild to moderate in severity. This may be an underestimation because athletes with mild head injuries may not always seek medical aid, and injuries thus may go unreported. Some athletes may be reluctant to report head injuries out of fear of risking loss of playing time.

Soccer is the most recent sport to come under scrutiny in terms of head injury risk. Repeated head trauma, especially from heading the ball, has been a major area of debate. In a recent study, the incidence of head injury in college athletes was found to be about 0.5 injuries per 1000 athlete exposures, equal for men and women, and 83% were considered mild injuries. The most common mechanism was a combined contact with an opponent's head as well as the ball. A similar study of college soccer players found that 68% of injuries were mild, and 70% occurred as a result of collision with other players. The head injury rate for soccer, on the high school level, has been reported to be lower than that for American football.

In the adolescent age group, boys tend to represent a higher proportion with head injuries. This may, in part,
be a reflection of boys being involved in more high-risk behavior. Traditionally, boys have participated in high-risk sports such as American football, rugby, wrestling, ice hockey. One study found a higher incidence of head injuries in boys during bicycling\textsuperscript{4}. In basketball and soccer, in which both boys and girls participate equally, girls tend to have slightly higher head injury rates. Injury rates for selected sports are given in Table 1\textsuperscript{5,6,7}.

Pathophysiology

The primary forces leading to brain injury are compression, tensile strain, and shearing forces\textsuperscript{8}. Of these forces, shearing appears to be the most destructive to brain tissue. This force is associated with axonal injury, and if great enough, with the condition of diffuse axonal injury. Deep coma or death may result. Findings at autopsy show damage primarily to the pons and midbrain\textsuperscript{14}.

Such repeated blows may or may not result in mild acute episodes, but rather have cumulative effect over time resulting in brain damage, more apparent in functional deficits rather than structural. The exact mechanism by which this occurs is not clear. A repeat head injury, prior to full neuronal recovery from the previous head injury, can result in second impact syndrome\textsuperscript{12}. This acute complication is characterized by loss of vascular auto-regulation, vasogenic edema, increased intracranial pressure and rapid neurological deterioration\textsuperscript{16,12}. There are measurable changes in cerebral metabolism with the formation of oxygen free radicals following brain injury. These substances have been known to cause cellular damage, but their significance in the brain is not completely known. Second impact syndrome has been reported in American football players at both the high school and college levels\textsuperscript{1}. Athletes with previous head injuries are four to six times more susceptible to subsequent head injuries\textsuperscript{5-10}. While no direct mechanism has been determined, symptoms of the head injury alone, if not cleared, may potentially interfere with the athlete's ability to protect himself.

Clinical Features

Because the damage in MTBI is diffuse, multiple global brain functions are affected, resulting in generalized symptoms. Most commonly reported immediate symptoms, which occur within several minutes to hours

<table>
<thead>
<tr>
<th>Sport</th>
<th>Study</th>
<th>Rate*</th>
<th>Sport</th>
<th>Study</th>
<th>Rate*</th>
</tr>
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<tr>
<td></td>
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<td>0.78(10AY)</td>
<td></td>
<td>Barnes, 98</td>
<td>0.3(10AY)</td>
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<td>Softball</td>
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</table>

* per 1000 athlete-exposures unless specified (1 athlete exposure=1 athlete participating in one practice or game in which there is a potential for any injury); /10AY=per 10 athlete years, 100kA=per 100,000 athletes

The cerebral spinal fluid acts as a cushion in linear acceleration and deceleration head injuries\textsuperscript{10}. When the force or the blow is to a resting movable head, injury to the brain tends to be directly beneath the site of contact. On the other hand, when the head collides with a resting stationary object the maximal injury is to the brain directly opposite the impact site. The former is the coup injury, and the latter is the contra-coup injury.

Repeated low level impact to head has been investigated as a mechanism for long-term brain injury. The Indian Journal of Pediatrics, 2000; 67 (5)