

Sport Related Concussions: An overview

With an ever-increasing involvement of children and youth in athletic endeavors, sport-related concussion has received considerable attention over the last decade (Bailes & Cantu, 2001; Guskiewicz et al., 2004; Piland, Motl, Ferrara, & Peterson, 2003). Mild traumatic brain injury (MTBI) is the most common form of head injury in recreational and competitive sports and has recently been identified as a major public health concern worldwide (Jantzen, Anderson, Steinberg, & Kelso, 2004; McCrea et al., 2003). Epidemiological studies indicated that approximately 300,000 sports-related traumatic brain injuries or head injuries occur annually in the United States (Covassin, Swanik, & Sachs, 2003; Guskiewicz, Weaver, Padua, & Garrett, 2000). In a three year study conducted by Covassin, Swanik, and Sachs (2003), it was found that concussion among intercollegiate athletes accounted for 6.2% of all reported athletic injuries. In Canada, where hockey is the number one past time, Hockey Canada reported there were over 550,000 minor hockey participants in Canada last year (2009-2010), with an incidence of concussion in hockey being conservatively estimated at 8%, although recent statistics suggest this figure is likely much higher (Emery et. al, 2010).

In 1989, Dr. Geoff Barth conducted one of the first systematic investigations of sport concussion, where he tested several hundred athletes with tests measuring attention and concentration (Barth et. al, 1989). He compared athletes who suffered concussions with those who suffered orthopedic injuries. Result indicated that athletes with concussions showed immediate impairments of their cognitive functioning and did not improve until 10 days later. In the 20 years that have followed Barth's initial study, other research has identified that concussions have both short-term and long-term consequences. Short-term outcomes include problems with physical symptoms (eg headaches), cognitive symptoms (eg feeling like in a fog)

and emotional symptoms (eg irritability). While CT and MRI scanning of the brain after concussion almost never yields positive findings (suggesting that concussions don't change brain structure), newer technologies like functional MRI (fMRI), objective balance assessments (eg. balance error scoring system or BESS), and neuropsychological assessment often identify immediate functional difficulties following concussion. These findings led to the growing concern about how best to manage an athlete once they've suffered a concussion.

Until 2002, there was a wide range of opinions about how to: 1) define a concussion; 2) grade the severity of a concussion; and 3) what steps should be taken before returning an athlete to play. In 2002, a multidisciplinary team of professionals formed the Concussion in Sport Group and created a consensus definition for MTBI (Aubry et al., 2002; P. McCrory et al., 2005). Their definition included the clinical, pathological, and biomechanical aspects of concussion to systematically diagnose and manage athletes with concussion. The same group met in Prague in 2004, and more recently year in Zurich, Switzerland (2009), where a new consensus statement was proposed (McCrory et. al, 2009).

The important outcome of this recent consensus statement was redefining a concussion. The new model suggested that a concussion is caused by any direct *or indirect* blow to the head, and that an athlete does not necessarily have to lose consciousness to have sustained a concussion. Furthermore, it was agreed that a majority of concussions resolve within a short period of time (7 to 10 days). In order to best manage a concussion, the Zurich group recommended the need to immediately remove an athlete from play and not return them until their symptoms had improved (McCrory et al., 2009). In addition, a 6 step process was recommended before an athlete could return to competition. Daily monitoring of an athlete was an important component of a return-to-play guideline. The first step included complete physical

and cognitive rest until symptoms improve. This was based on research that suggested the brain undergoes a period of complex pathophysiological changes including increased demand for glycolytic energy and a sharp rise in extra cellular potassium (Wojtys et al.,1999). Rest allows the brain to slowly return to its baseline, resting state. Subsequent steps involve a progressive return to physical activity. At each step, ensuring the athlete's symptoms do not return was paramount. If the physical or cognitive symptoms did return, the athlete was to needs to rest for 24 hours before returning to that step. The final step was a return to game-playing activity (McCrory et al., 2009).

Long-term outcomes of concussions are less understood but have grabbed the attention of the public, media, and sports community within the last several years. Select studies showed that athletes who suffered multiple concussions were at much greater risk for psychiatric difficulties, cognitive problems, and behavioral changes in later life, usually starting in a person's mid 30's (McKee et al, 2009). Recently, the Centre for the Study of Chronic Traumatic Encephalopathy (CTE) began collecting the brains of athletes who subsequently passed away. Initial results suggest that many athletes demonstrate advanced pathological outcomes, with evidence of Tau proteins that are thought to disrupt normal brain functioning (McKee et al, 2009). Other studies, like DeBeaumont et al. (2009) suggest that even after 30 years post-concussion, there are subtle electrophysiological changes in the brain. At present, professional sports associations like the NHL and NFL have taken steps to limit targeted head shots and implement stricter rules for assessing a player once they've had a concussion.

In general, adolescents are at highest risk for concussions within the entire life-span. This age group has the highest participation in recreational activities and most likely to engage in adventure seeking behavior. Surveillance studies suggested approximately 5% to 7% of college

athletes sustained a head injury during the course of a competitive season (McCrea et al, 2003). In contrast, younger adolescents appear to be at greater risk for concussions and for complicated outcomes following a concussion with select studies at the high school level indicating that approximately 10% of high school athletes sustain a concussion during the competitive season. In addition, high school athletes compared with college athletes required a longer period of time, on average, to recover following a concussion (Field et al, 2003). Other studies also suggest children and adolescents appear to be at greater risk of sports-related head injury than adults (Kelly, 1999), and males are at greater risk than female players (Covassin et al., 2003) although the gap appears to be closing.

In summary, sport concussions have become an important topic in the sports medicine literature. There are still many unknowns about the causes of concussions and who might be at risk. Recent studies suggest that an athlete's level of conditioning may contribute to increased susceptibility of concussions (Lebrun et al, 2010). Much research will continue to be conducted about this important issue.

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