

Concussions in Ice Hockey

Is it Time to Worry?

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Recent events have highlighted the issue of concussions in sports, particularly in ice hockey. A concussion is an injury to the brain caused by acceleration forces imparted on the brain. Symptoms vary in severity from confusion and minor headaches to loss of consciousness and amnesia. Concussions are a common sports injury that have been associated with neurological and psychiatric impairment, and second-impact syndrome may even lead to death. The serious nature of these injuries has evoked calls from the scientific community to make hockey a safer game by modifying current rules and regulations. This Critical Review summarizes recent research on concussions and discusses the implications in the context of sports.

After receiving two hits to the head in the span of two games, Sidney Crosby was sidelined from hockey in February.¹ The long and arduous recovery process that ensued garnered continuous questions about when Crosby would return, and upon his return, whether he would be able to regain his high calibre of play.¹ A concussion with consequences of this magnitude is by no means a rare occurrence in sport; in fact, head injuries are the most common cause of death amongst athletes.² However, Sidney Crosby's reputation as one of the best in the game has pointed the public spotlight on the severity and consequences of concussions and head injury. Since the incident, researchers have seized the opportunity eager to engage the general public in dialogue regarding the issues of aggression and unnecessary physicality in sport.

DEFINITION OF CONCUSSION

A concussion is defined by the American Association of Neurological Surgeons (AANS) as, "a clinical syndrome characterized by immediate and transient alteration in brain function, including alteration of mental status and level of consciousness, resulting from mechanical force or trauma."³ Immediate symptoms vary from case to case, ranging from a temporary loss of consciousness to amnesia, dizziness, and prolonged confusion.⁴

The generally accepted guidelines for what constitutes a concussion have evolved greatly over recent years as the scientific community has furthered its understanding and knowledge of traumatic brain injuries. In the past, researchers and clinicians characterized loss of consciousness as a necessary and defining symptom of concussions. Furthermore, concussions were not believed to result in long-term debilitations.⁵ In contrast to these old beliefs, recent research has found that concussions are a serious risk factor for neurological disorders that may only become apparent years after the original incident.^{5,6}

The development of modern diagnostic techniques has decreased the number of concussions that go undetected and thus untreated. Neurological testing and on-field evaluations for potentially concussed athletes are now more robust and comprehensive. In particular, 'day-after-concussion' examinations are valuable diagnostic

tools, since the onset of symptoms may only present themselves at a later time.⁷ The injured individual is able to report any changes in mood, appetite, tiredness and sleep patterns. Computerized neuropsychological testing is a recent development that allows athletes, trainers, and parents to monitor cognitive functioning.⁸ After a concussion, results from this test can be compared to baseline scores (from a test done prior to any injury) to monitor an individual's recovery process.

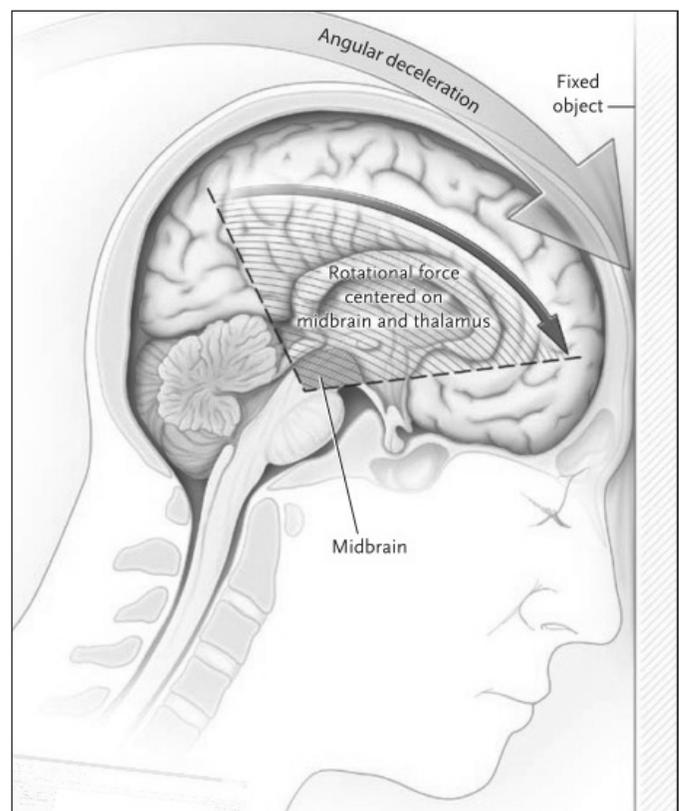


FIGURE 1: Rotational force on the brain due to impact of collision.⁴

Biomechanical research suggests that concussions results primarily from rotational motion of the cerebral hemispheres in the anterior-posterior plane in response to acceleration forces. The brain rotates around the fulcrum of the midbrain, which is fixed in place. This can lead to extensive shearing and damage of brain tissue, as well as an increase in intracranial pressure.

THE MECHANISM OF CONCUSSION

Concussions are generally a functional injury and can often occur without any externally visible impression or contusion to the body.⁹ They occur when the brain is accelerated into the skull due to some sort of impact or external force. Concussions are caused by a combination of two major types of forces: translational and rotational.⁵ Translational forces cause linear accelerations, resulting in stretching and compression of the brain.¹⁰ The collision of the brain against the inner walls of the cranium causes brain tissue damage and elevated intracranial pressure. Conversely, rotational forces cause the brain to accelerate angularly along its mid-vertical axis. This force often results in the shearing of brain tissue and temporary loss of consciousness due to the impact from rotation at the midbrain (Figure 1).⁴ Current evidence suggests that rotational accelerations imparted on the brain are the more severe and important force implicated in the onset of concussions.⁵

CONCUSSIONS IN SPORT

Concussions are most commonly a result of falling or striking an object or another person.¹¹ Athletes are prone to such injuries due to the physicality and aggressive behaviour often associated with sport. Amongst individuals 16—34 years of age, a Canadian National Population Health Survey found that 85% of concussions are sport-related.¹² A study in Alberta monitoring the number of emergency department visits due to sport and recreational head injuries reported that ice hockey players accounted for the largest proportion of head injuries, at about 21%.¹³ This may be due to the excessively physical nature of the game, or simply because of the sheer number of participants in the sport, which is after all ‘Canada’s game’. Other major causes of head injuries were – in order from least to most frequent—cycling, playground activities, soccer, football, and rugby.¹³ It is clear, therefore, that concussions and head injuries are of concern across a variety of sports and activities, and an exploration of both general and activity-specific intervention methods is warranted.

Recent studies have associated concussions in sports with a decline in long-term brain function.^{14,15} Athletes incurring a concussion in early adulthood were found to score lower on neuropsychological testing and suffer from bradykinesia (slowed movement) decades after diagnosis.¹⁵ A link between concussions and the onset of clinical depression in later life has also been made; athletes who have incurred one or two concussions are 1.5 times more likely to suffer from depression in later years.¹⁶

Youth athletes are prone to the most negative sequelae of concussions. Concussions can inhibit proper development of the brain resulting in developmental disabilities, severe motor dysfunctions and psychiatric conditions that will burden the child for the entirety of their life.¹⁷ This is of great concern when considering that 10-12% of Canadian minor league hockey players aged 9-17 report being victims of head injuries each season.¹⁷

Rehabilitation Stage	Functional Exercise at each stage	Objective of each stage
1. No Activity	Complete physical and cognitive rest	Recovery
2. Light aerobic exercise	Walking, swimming or stationary cycling keeping intensity <70% MPRH No resistance training	Increase HR
3. Sport-specific exercise	Skating drills in ice hockey, running drills in soccer. No head impact activities.	Add movement
4. Non-contact training drills	Progression to more complex training drills e.g. passing drills May start load progressive resistance training	Exercise, coordination, and cognitive
5. Full contact practice	Following medical clearance participate in normal training activities	Restore confidence & assess functional skills by coaching staff
6. Return to play	Normal game play	

TABLE 1: Guidelines for appropriate Return to Play.⁹ An athlete should follow this stepwise progression in the rehabilitation and return to play process, advancing to the next level only if asymptomatic at the current one. Each step should take about 24 hours; if symptoms are present, athletes should return to the previous level, get sufficient rest, and seek medical attention.

Second-impact syndrome is a condition that has gained scientific and media recognition in recent years. Essentially, this refers to incurring a second concussion while an individual is still suffering from the adverse effects of an earlier one.^{17,18} It is possible that the two concussions have a compounding effect in terms of the damage caused to the brain. Even a very minor blow to the head after an initial concussion has been associated with sharp increases in intracranial pressure, haemorrhaging, and subsequent death.¹⁸ Due to the severity of concussions and the danger of second-impact syndrome, it is important for players, coaches, trainers, and team doctors to follow appropriate return-to-play guidelines (Table 1).

Increased awareness of the consequences of concussions in sport has prompted many athletes to donate their brains towards concussion research.¹⁹ These donations have fuelled much research towards discerning important details about the mechanisms and long-term impacts of concussions. For example, researchers at Boston University recently studied the brain of Rick Martin, a former NHL star. Analysis of Martin’s brain revealed that he had chronic traumatic encephalopathy, a disease which leads to cognitive decline and ultimately dementia.²⁰

IMPLICATIONS ON THE CULTURE OF ICE HOCKEY

Concussions in hockey are most often caused by body checking,²¹ a form of physical contact between players, which is legal in the NHL and many minor leagues. However, the newfound dangers of concussions in recent findings has called into question the current culture that exists around aggression and fighting in hockey and other sports.¹⁷

Athletes, officials, fans, and the general public often become desensitized to aggression in sport and begin to accept it as part of the game.²² In fact, many individuals display elevated levels of aggression while engaged in sports,²³ which begs the question of why physical aggression is accepted and legal in athletics but not in other facets of everyday life.

In the past, proponents of physical contact in sports have argued that safety equipment such as helmets and mouthguards provide ample protection from injuries. While there is evidence of a reduced number of general injuries, there is little scientific evidence demonstrating that current equipment is capable of preventing concussions.^{9,24} Furthermore, while helmets do indeed reduce the force of impact to the head, there is no evidence that wearing helmets corresponds to a reduced rate of concussions in athletes.⁹ As such, there has been a gradual paradigm shift in the scientific community regarding the best means of reducing concussions. Rather than advocating for increased use of safety equipment, there is now an increased focus on changing rules, regulations, and the culture of sport to reduce the number of falls and hits to the head in the first place.^{9,21}

The minimum age at which hockey associations should allow participants to body check has become a highly controversial and debated topic in the hockey community. Proponents for lowering the minimum age argue that it allows youth to properly learn and adjust to the techniques behind giving and taking a hit. However, a systematic review exploring the relationship between body checking and injuries found that leagues which permit checking in younger players are associated with higher rates of injuries and fractures.²¹ Based on their findings, the authors recommended that body checking be removed from leagues for younger athletes, with the minimum age for introduction of physical contact being at least 13 years. In line with this, the Ontario Hockey Federation recently introduced new regulations that effectively banned body checking in all house leagues and some select leagues.²⁵

CONCLUSION

Concussions are serious injuries with potential serious long-term neurological and psychiatric consequences. Based on current scientific evidence, it is apparent that modifications to the rules surrounding hockey are warranted and could potentially reduce rates of concussion. Imposing greater sanctions on actions such as head hits and checks from behind may help to make Canada's game safer for all participants. Only 1 in every 4000 minor hockey league players will ever fulfill the ultimate dream of playing in the NHL.¹⁷ In this light, is it reasonable for our youth to have to—or be allowed to—put their future livelihoods on the line every time they step onto the ice? ■

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