Concussions in a Nutshell

A guide for journalists prepared by the Science Media Centre of Canada.

This is part of the Science in a Nutshell series produced by the SMCC. It offers a simple explanation of the science of concussions.

What is a concussion?

A concussion is a brain injury that occurs when the head or body hits an object. In sports, it often occurs when an athlete hits a playing surface or another athlete. The sudden blow violently shakes the brain inside the skull, much like a whiplash motion, sending it into the bony skull. High-speed collisions can lead to serious brain tissue damage. As the brain skids around the bony knobs inside the skull, nerve cells can be sheared and shredded in the process.

This momentary force applied to the brain, and consequently its cells, causes a cascade of chemical changes in the brain that impairs neurological function. Shortly after impact, there seems to be an immediate release of potassium outside the cell membranes, which triggers the release of other chemicals in an effort to restore the normal chemical balance between cells. One outcome is a build up of localized lactic acid in the brain, and another is an alteration in cerebral blood flow. Researchers at the University of Regina are using transcranial Doppler ultrasound to investigate the pathophysiology of concussion.

Concussions can lead to physical, pathophysiological, psychological and cognitive symptoms. Confusion and amnesia usually appear immediately following the concussion. Other immediate symptoms may also include nausea or vomiting, dizziness, fatigue, headaches, ringing in the ears and irritability, and sometimes (but not always) a loss of consciousness. It is important to note that loss of consciousness does not need to occur to have a concussion. Most people fully recover within two days to a month.

What's the difference between a concussion and brain injury?

Our knowledge of concussion has improved in the last decade. There has been a growing trend especially within the sports and medical fields to talk about sport-related concussion instead of mild traumatic brain injury, but often the terms are used interchangeably. It may be semantics, but a brain injury is most often defined by swelling, bruising and bleeding in the brain, which are clearly visible on an MRI or CT scan. When these same tests are done following a concussion the scans are almost always normal. This is why concussion is defined as a functional injury, rather than a structural injury.

(Some people who have been in the field for decades will still refer to a concussion as a mild brain injury, but the trend is to move away from that terminology.)

Prevalence of sport-related concussion in Canada

Athletes are more likely to experience a concussion if they participate in collision sports, such as ice hockey, football, rugby and wrestling. A 2006 study of concussions among Canadians found that more than half were sport-related. Males between the ages of 16 and 34 were overrepresented, with more than 85% of these related to sports. In another study of head injuries among Canadians, 28% of head injuries among children and youth requiring hospital admission were related to sports and recreational activities.

Short-term and long-term health risks

Within the first week of a concussion, most people exhibit difficulties with concentration, memory, and multitasking, and feel mentally foggy and tired. Headache is also a very common symptom. Fortunately, 80-90% resolve their symptoms within 7-10 days, and 95-97% fully recover by 3 months and regain their normal thinking skills. The other 3-5% continue to experience cognitive challenges, pain, anxiety or depression, although they have recovered from the concussion itself. Experts are unsure whether the continued symptoms are the result of psychological or chemical factors, or a combination of both.

Once an athlete has had one concussion, he or she has a greater risk for additional concussions. Some studies suggest that a history of three or more concussions may lead to permanent changes in brain chemistry, which in some cases can lead to cognitive deficits. Generally, the more concussions an athlete experiences, the more severe the symptoms and the longer the recovery.

Some recent studies looking at professional boxers and football players have suggested that players who have had repetitive concussions can potentially develop dementia, Alzheimer's disease (AD) or Parkinson's disease later in life. However, it remains unclear if the development of these neurological diseases is caused by multiple concussions or other factors, including other injuries or the athlete's lifestyle.

Postmortem studies that examined the brains of athletes who suffered numerous concussions during their careers suggest that they may have instead suffered from chronic traumatic encephalopathy (CTE), a progressive neurodegenerative disease associated with cognitive and personality changes. The dissections revealed the presence of tau, a protein that builds up in neurons and prevents them from forming normal connections with other nerve cells. Tau is also seen in Alzheimer's disease, but the pattern of accumulation is different in CTE than AD.

Experts say that athletes should not return to play on the day of the injury; they need physical and cognitive rest until all of their symptoms are gone. It is also suggested that the athlete needs to wait until all symptoms at rest are resolved before they're permitted to do light aerobic exercise such as walking, cycling or swimming, and only then may proceed to more intensive workouts, such as running and weight training, if their symptoms don't return. Football and hockey players can reengage in non-contact training drills and move on to full-contact practice and play if they remain symptom free.

Concussion prevention

Helmets can significantly reduce skull and brain injuries among cyclists, skiers, and snowboarders, but they do not necessarily protect the brain from concussions, since concussions result from a strong force shifting the brain within the skull. Experts say a combination of changes in sports behaviour, rules, and protective equipment will likely reduce the number of sport-related concussions.

The Féderation Internationale de Football Association (FIFA) found that one of the major causes of concussion during soccer games was due to players elbowing each other in the head. However, more research is needed in soccer as recent anecdotal reports suggest that continued heading the ball could lead to concussion-like symptoms. There have been a few reports recorded in amateur sports where concussions were related to heading the ball. This suggests that proper technique is imperative. FIFA changed its rulebook so that elbowing another player results in an automatic suspension for at least 2 matches.

For more information:

Willem Meeuwisse, University of Calgary, Calgary, AB

Stewart Longman, rehabilitation neuropsychologist, Foothills Medical Centre, Calgary, AB.

J. Patrick Neary, Exercise Physiologist, University of Regina, Regina

Len, T.K., **Neary, J.P**., Asmundson, G.J.G., Goodman, D., Bjornson, B., Bhambani, Y.N. (2011). Cerebrovascular reactivity impairment following sport-induced concussion. *Med Sci Sports Exerc*. 43(12), 2241–2248.

McCrory, P. *et al*. Consensus Statement on Concussion in Sport. 3rd International Conference on Concussion in Sport. Clin J Sport Med 2009;19:185–200.

Thinkfirst, non-profit organization focused on the prevention of brain and spinal cord injuries: www.thinkfirst.ca

Mayo Clinic: MayoClinic.com/health/concussion

Written by Natalie St-Denis for the Science Media Centre of Canada..