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#### Cerebral Concussions in Football

##### Should the football helmet do more?

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With the effects of multiple concussions having ended the NFL careers of players such as Roger Staubach, Al Toon and Merrill Hoge, people around the sport of football are beginning to understand the seriousness of this injury.

While it is debatable whether the rate concussions are occurring is increasing, present numbers already are of epidemic proportions, with approximately 250,000 occurring annually. More than 90 percent of athletics-related concussions are minor or Grade 1, involve no loss of consciousness; but rather a brief loss of mental function, i.e., being stunned, "seeing stars" for a few seconds or experiencing less than 30 minutes of post-traumatic amnesia. The more serious instances in which there is a more prolonged period of post-traumatic amnesia or loss of consciousness are relatively uncommon (less than 10 percent of athletics concussions).

Once an athlete has incurred a concussion, his chance of sustaining another is four times that of a colleague suffering a first. Whether this is primarily due to biological differences or the way the athlete plays the sport (e.g., by consistently leading with the head), remains unclear, but both are factors.

The major fear with concussion is second-impact syndrome (SIS), which can happen if the athlete is returned to competition before all cerebral symptoms have cleared. With SIS, the victim suffers a loss of autoregulation of blood flow, with vascular congestion within the brain leading to massively increased intracranial pressure. A person with this condition had a 50 percent chance of resultant death or vegetative state and an almost 100 percent chance of suffering permanent brain injury. Most but not all cases have come from football.

When NOCSAE standards for football helmets were proposed in 1973, they were designed to prevent the then-most-common cause of athletics death, the subdural hematoma, in the "average" athlete. This standard, a severity index of 1500, which the NOCSAE board has voted recently to be lowered even further to 1200 (thus making it stronger), has been successful in reducing the incidence of acute subdural hematoma by about 80 percent from the prestandard years.

Should equipment changes be made?

None of the football helmets on the market protects the neck, although three prototypes are under

investigation. None are specifically designed to prevent concussion. Although it may not be practical to devise a helmet that protects the neck and reduces concussion, given the commonality of such injuries, it is time to at least try.

Reduction in acceleration forces delivered to the brain could theoretically be achieved by increasing the padding thickness within the helmet or by transmitting forces delivered to the head to the shoulder pads. All three prototypes under development to prevent quadriplegia: an airbag system, a system of fixed helmet to a shoulder pad/flak jacket, and a system of locking the helmet to the shoulder pads only after forceful impact also would likely reduce the chance of concussion.

Acceleration forces necessary to produce concussion are known thanks to the work published in 1965 by Patrick, Lissner and Gurdjian, known as the Wayne State University (WSU) Cerebral Concussion Curve.

It is time to see if a football helmet can be made that will reduce dramatically or eliminate the chance of concussion. The increased padding will likely mean a larger outer shell and possibly more weight unless lighter "space age" materials are used that could add to cost. This additional padding would best be placed inside rather than outside the hard outer shell, since a helmet's smooth, elliptical surface maximizes the chance for a glancing blow, thus minimizing the acceleration forces being imparted to the brain.

In short, the "head hunting" in football must end, but rules alone will not make such injuries disappear; therefore, it is time to reassess head protection.

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