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High-tech helmets reveal new information about the impact of hard hits to the head

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In a game that spawned the term "slobber knocker," is there a limit to the amount of impact a football player's head can handle before the player suffers a concussion?

“The answer is yes ... and no, say researchers at the University of North Carolina at Chapel Hill. High-tech helmets worn by some University of North Carolina football players over the 2004 to 2006 seasons yielded new data that challenges conventional theories about these mild traumatic brain injuries.

The UNC study, in the December issue of *Neurosurgery*, shows that hits, and heads, are as individual as the players themselves, and researchers advise against establishing a one-size-fits-all rule for evaluating concussions.”

"People see massive hits and think, 'that's the one!' and ignore more trivial blows," said Kevin Guskiewicz, Ph.D., senior author on the papers and chair of the department of exercise and sport science in UNC's College of Arts & Sciences. "Now we know that these trivial hits may be just as serious as the harder ones."

This new information could lead to better guidelines for evaluating head injuries and deciding a player's playing status, Guskiewicz said. It might also lead to a better understanding of brain injuries from other trauma, or perhaps of diseases such as mild cognitive impairment and Alzheimer's which have been linked to recurrent concussion in

professional players.

Using special accelerometers embedded in helmets, researchers were able to measure in real time the amount of g-force players' heads experienced at impact, where on the head the players were hit and the directional force of the hits -- linear (straight) or rotational (twisted). The system is called HITS, or Head Impact Telemetry System.

G-force, a measure of acceleration against the earth's gravitational pull, is most often associated with fighter jets or roller coasters. In those scenarios, the body takes a maximum of about 4.5g, or four and a half times the force of gravity. In car crash tests at 25 mph, dummies hit windshields at 100g.

In football, a hit can easily jerk the head, for milliseconds, at 50g, and hits above 100g are common. One player in the study experienced 168g. It was previously suggested that a forces above 75g would likely result in a concussion, but these new results call into question that finding.

The UNC studies showed that some players suffered concussions at little more than 60g, while others sustained hits creating more than 90g and showed no signs of concussions; less than .35 percent (only one-third of one percent) of impacts greater than 80g resulted in concussions.

In one study, researchers collected data from 88 UNC players from fall 2004 through spring 2006 to determine a relationship between impact location and concussion. Eleven players sustained a concussion; one player had two concussions.

Players in the study were 6.5 times more likely to have sustained an impact greater than 80g to the top of the head rather than the sides, front or back. Six of the 13 concussions came from hits to the crown.

Another study, by graduate student Meghan McCaffrey, sought to compare differences in balance and cognition in players who did not self-report concussive symptoms within 24 hours of sustaining high-impact hits (90g) and low-impact hits (60g).

The study showed no statistically significant difference between the two groups.

"Our findings suggest that clinicians should not expect a single impact greater than 90g to necessarily result in immediate symptoms of a concussion," McCaffrey said.

Players in each of the studies represented various offensive and defensive positions, but the third study, by graduate student Jason Mihalik, looked for differences among playing positions and differences between practices and games in 72 players.

Offensive backs and wide receivers are more likely to take hits greater than 80g, and offensive players (backs, wide receivers and linemen) took more hits than defensive players (linemen, backs and linebackers).

Although most coaches regard helmets-only practices to pose the least risk, Mihalik found that more hard impacts were sustained in helmet-only and full-pad practices than in games.

All of the studies were accompanied by video, which led to an unintended outcome: preventing an injury. One player in Guskiewicz's study sustained two early season concussions, the first from a hit of 63.8g and, nine weeks later, one from an impact of 102g.

"We showed the coach the video and the HITS data , and he said, He's dropping his head!," Guskiewicz said.

The researchers and coaches showed the video to the player and coached him on proper technique. In the last game of the season this same player made a massive hit during a block on a kickoff return. This time, video clearly shows the player turning his head at the last second and leading with his shoulder.

The bottom line, Guskiewicz said, is that concussions are multifactorial.

"Football players receive concussions by impacts to the head that occur at a wide range of magnitudes, and clinical measures all appear to be largely independent of impact magnitude and location," Guskiewicz said.

"We need to replicate this study on a larger scale, with more players, but we believe this study is a first step toward better understanding the biomechanics of sport-related concussion and hope that it will assist athletic trainers and physicians in monitoring their players," he said.

A word about the technology

The helmets UNC used in these studies were embedded with the Head Impact Telemetry System, or HITS, from Simbex Inc. and incorporated with the Sideline Response System from Riddell.

The sensors recorded the hits in real time and sent the data to a sideline computer. When a hit was recorded it sent the data to the sideline response system, which listed the player's number and the magnitude of the impact. The computer can capture up to 126 impacts per game or practice.

ource: University of North Carolina at Chapel Hill