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Football Concussions Most Common in High School

The popularity of American football has raised awareness of the dangers of repetitive concussions in contact sports. In a highly publicized case in the National Football League, Ted Johnson of the New England Patriots suffered a series of concussions in 2002 from which he never fully recovered.

Johnson, who suffered an initial concussion in practice, alleges that he was returned to full-contact status far too early, a decision that led to more concussions, according to the Boston Globe. While he officially is listed as having had three or four concussions, he claims the real number is closer to 30. He has been medically diagnosed with post-concussive syndrome, which is characterized by chronic physical and psychological issues. He suffers from memory problems, chronic depression and amphetamine abuse.

Notwithstanding prominent cases such as Johnson's in professional football, concussions actually occur more often at the high school level. It is estimated that 6 percent of high school players sustain a concussion annually. These higher incidences in high school are related primarily to lower skill level and experience and to less-experienced coaching and training (Ref. 2, 4, 5).

WHEN CONCUSSIONS OCCUR

In the event of a concussion, it is critical to determine the severity of the injury. Diagnosis is based on physical and neurological examinations, the presence or duration of unconsciousness, and amnesia. The Colorado Concussion Grading System is commonly used (and discussed in the Q&A on page 2).

Minor head impacts after a concussion – even ones that normally would not cause a concussion – can result in fatal brain swelling.

It also is recommended that all players complete a battery of neuropsychological tests at the beginning of each season. These tests then can be conducted again after a head injury to assess the mental status of the injured player. This allows for a player-specific assessment of mental status and aids in monitoring the recovery of mental faculties over time.

However, a return to pre-injury test scores does not necessarily establish that the injury is completely healed and that the player is ready to play. This decision is difficult as concussion signs and symptoms typically resolve quickly, and physiological healing may lag the return of neuropsychological test scores.

With little objective data available, healthcare personnel traditionally have relied on subjective feedback from the athlete as a guide. This is problematic as many athletes underreport their symptoms so that they can return to full participation as quickly as possible. Most of the recent research recommends that a player who sustains a grade 1 concussion be asymptomatic for at least 15 to 20 minutes before a return to play. In the case of a loss of consciousness, current literature suggests that the player be held from playing for the remainder of that day.

Despite these recommendations, approximately 31 percent of all players who sustain a head injury return to participation the same day of the injury. This suggests that many concussed individuals are returning earlier than they should – and at greater risk of suffering second and third concussions and long-term damage. Minor head impacts after a concussion – even ones that normally would not cause a concussion – can result in fatal brain swelling.

With football season upon us, it is important to raise the overall awareness of how detrimental a concussion may be. It is critical to take steps to reduce the risk for sustaining such an injury, such as teaching proper techniques for tackling and using the most protective helmets. Once an athlete sustains a concussion, a comprehensive assessment of the severity of the injury must be undertaken. Cautiously observing the best return-to-sport guidelines is most important to help avoid long-term chronic problems.

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– Article by Joaquin Barrios

FOOTBALL HELMET (R)EVOLUTION

The best safeguard against football concussions is a helmet. The person often credited with inventing the football helmet is Joseph Reeves, who donned a moleskin version for Navy in an 1893 game against arch-rival Army. Until the 1940s, professional football helmets were optional and usually made out of leather. Facemasks debuted in the 1950s, when polymer materials replaced leather.

The science behind football helmets, however, advanced little from the 1950s until 2002. That is when manufacturer Riddell introduced its Revolution helmet. It was computer designed around the head's center of gravity, specifically to reduce the likelihood of a player sustaining a concussion. The helmet also features improved side and facial protection. More than 300,000 players across all competitive levels have switched to the Revolution helmet since its debut – and apparently with good reason.

A recent three-year study at the University of Pittsburgh Medical Center tested the Revolution against traditional helmets in more than 2,000 high school players. Players who wore the Revolution helmet were 31 percent less likely to sustain a concussion compared with players who wore a traditional helmet.

The researchers deduced that the Revolution helmet could reduce the number of concussions by 46,000 among the 1.5 million high school football players in America.

– Article by Joaquin Barrios

Q&A

Concussions

WHAT IS A CONCUSSION?

A concussion is an injury to the brain characterized by impairment of neural function resulting from mechanical trauma. Any head trauma or rapid deceleration of the head can cause a concussion. It is important to note that a direct blow to the head is not necessary to sustain a concussion. Neural impairment can take the form of changes in consciousness, disturbance of vision and speech, impaired judgment, headache, and loss of equilibrium and/or motor coordination. Symptoms may be apparent immediately or, in some cases, may not appear until some time after the initial trauma. Symptoms can last for days, weeks or even longer.

WHO'S AT RISK FOR A CONCUSSION?

Most often concussions occur as a result of auto accidents, falls or contact sports (most commonly football, hockey, soccer and wrestling). Individuals who have had a concussion in the past are more susceptible to sustaining subsequent concussions.

HOW IS A CONCUSSION DIAGNOSED?

On the field, concussions are assessed by a physician or a certified athletic trainer. This is done using neuropsychological tests, such as the Standardized Assessment of Concussions. Athletes are asked to orient themselves to person, place and time. Vision, hearing, balance and muscular coordination also are assessed. Any loss of consciousness or amnesia lasting longer than 15 minutes always should result in same-day assessment by a physician. The physician may order a computerized tomography (CT) scan. Only qualified medical personnel should make return-to-play (RTP) decisions for any concussion.

ARE THERE DEGREES OF CONCUSSIONS?

Yes. A common classification method, the Colorado system, is summarized as follows:

GRADE 1 (mild)	GRADE 2 (moderate)	GRADE 3 (severe)
Confusion without amnesia.	Confusion with amnesia. No loss of consciousness.	Loss of consciousness.

WHAT IS SECOND IMPACT SYNDROME?

This serious condition can occur when an individual with an unresolved concussion receives a second, sometimes even minor, blow to the head. Second impact syndrome is a life-threatening event resulting from cerebral edema followed by a rapid increase in intracranial pressure. This potential condition highlights the need for medical guidance when making any RTP decisions with athletes who have sustained a concussion.

HOW ARE CONCUSSIONS TREATED?

Recovery from a concussion cannot be rushed. Although rest is the best treatment for most concussions, the athlete's physician and certified athletic trainer should be closely involved in treatment and RTP decisions. In a recent consensus statement, the National Athletic Trainers' Association recommended that all athletes undergo pre-season baseline testing for cognition, balance and coordination. These recorded values can provide objective data for making objective RTP decisions.

ARE THERE SPECIAL CONSIDERATIONS FOR THE YOUNG ATHLETE VS. THE ADULT ATHLETE?

Yes. Because of a still-maturing brain, the young athlete recovers much more slowly from a concussion. In fact, almost all cases of second impact syndrome occur in athletes below the age of 18.

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– Article by Rich Willy

Photos: Pro Football Hall of Fame

CASE STUDY

Recovering From Concussion

PATIENT HISTORY

The patient was a 17-year-old football defensive end who was struck, helmet-to-helmet, while attempting to make a tackle. He did not lose consciousness and continued to play without telling anyone about the hit. His teammates noticed that he was unable to focus on the game, so they alerted the certified athletic trainer. The patient was removed from the game quickly.

During a thorough evaluation, he was noticeably irritable, impatient and frustrated that he could not appropriately respond to the questioning. He was unable to stand without assistance and experienced blurred and double vision. He was disoriented and photosensitive; he had retrograde and post-traumatic amnesia. His symptoms continued to deteriorate, and he was transported to the local hospital for further evaluation.

The hospital physician diagnosed him with a concussion and, for precautionary reasons, ordered a CT scan, which was negative. He was sent home with instructions to rest. His parents were advised to monitor him closely for signs of deteriorating symptoms and to schedule an appointment with his neurologist.

The patient had been administered a baseline neurocognitive test (ImPACT) four years earlier. This test is used to monitor symptoms of memory, object recognition, reaction time and motor speed. Although the patient had no medical history of head injury prior to this incident, it is not uncommon for a healthy teen-ager to have difficulty falling asleep and headaches at the time of baseline testing.

OBJECTIVE

The patient was instructed to stay home from school as active concentration increases blood flow to the brain and can be as harmful as physical activity. On Day 4, he experienced lethargy, headache and irritability, and he was advised to remain at home to rest.

He was administered the ImPACT test as a comparison to his baseline scores. He exhibited deficits in all categories and had a high symptoms score (see Table 1). It was determined that he needed more recovery time. He was held from all activities, including school, for the rest of the week.

On Day 10, another ImPACT test was given. The patient's score improved in all areas, especially reaction time and object recognition. With this progress, his physicians wanted to test his response to an increase in physical activity. However, after riding a stationary bike, he had a quick return of symptoms such as nausea, headache, dizziness and sensitivity to light. He was advised to rest for the next four days. On Day 14, he was stressed again on the bike with no return of symptoms.

The next ImPACT test was performed on Day 17. The results continued to improve when compared with his baseline test. But while his symptoms score improved, he was still forgetful and had a feeling of being slowed down. He was able to perform full sprints for 20-30 minutes without a return of symptoms. He was cleared to return to practice the next day but was restricted from any kind of physical contact.

On Day 24, the last ImPACT test was administered. His symptoms were significantly reduced, and his overall score had improved remarkably. He progressively increased his activity without any return of symptoms. Upon consultation with his physicians, he was cleared to engage in full practice.

In all, the patient missed two weeks of school, 25 days of practice and three games. He went on to have a successful season competing at a high level without further incident.

Table 1. **SYMPTOMS SCORE**

Rating scale of 0-6 (0 = no symptoms, 6 = most severe symptoms).

SYMPTOM	BASE-LINE	DAY 4	DAY 10	DAY 17	DAY 24
Headache	3	3	1	1	0
Nausea	1	1	0	0	0
Vomiting	0	0	0	0	0
Balance problems	0	1	0	0	0
Dizziness	1	2	1	1	0
Fatigue	1	4	1	2	1
Trouble falling asleep	5	0	0	0	0
Sleeping more than usual	0	5	2	1	1
Sleeping less than usual	0	0	0	0	0
Drowsiness	1	4	1	1	1
Sensitivity to light	0	3	0	0	0
Sensitivity to noise	1	2	1	0	0
Irritability	0	4	1	1	1
Sadness	0	1	0	0	0
Nervousness	0	1	0	0	0
Feeling more emotional	1	2	0	0	0
Numbness or tingling	1	1	0	0	0
Feeling slowed down	0	4	1	1	1
Feeling mentally foggy	1	3	1	1	0
Difficulty concentrating	2	5	3	1	1
Difficulty remembering	0	3	1	1	1
Visual problems	0	1	0	0	0
Total	**18**	**50**	**14**	**11**	**7**

Table 2. **IMPACT TEST**

MEASURED DATA	BASE-LINE	DAY 4	DAY 10	DAY 17	DAY 24
Verbal memory (%)	80	82	89	91	92
Object memory (%)	73	48	89	71	69
Visual motor speed (units/s)	31.03	32.65	39.18	42.20	42.45
Reaction time (s)	0-59	0.88	0.49	0.53	0.48
Symptom score	18	50	14	11	7

DISCUSSION

The goal in treating concussions is to allow the brain adequate time to heal. In the aforementioned case, this was best accomplished with rest. Preventing re-injury involved continual observation and specific return-to-play criteria. The patient's symptoms were monitored weekly by his physician and daily by his school's certified athletic trainer. Close communication among his neurologist, neuropsychologist and certified athletic trainer was necessary throughout his treatment and ultimately contributed to the successful outcome of this case.

– Article by Dan McAllister

RESEARCH ABSTRACT

Head Impacts in College and High School Football Players

Schnebel, B., Gwin, J., Anderson, S., Gatlin, R. "In vivo study of head impacts in football: a comparison of National Collegiate Athletic Association Division 1 vs. high school impacts." Neurosurgery, 60:490-496, 2007.

INTRODUCTION

Head injuries in sports are reaching epidemic levels, according to the Centers for Disease Control and Prevention. Considerable research has been conducted into the head impacts of automobile injuries. However, there is a lack of research into the frequency, magnitude and severity of impacts in football, as well as the concussion tolerance at different levels of play that result in a concussion.

The purpose of this research article was to compare biomechanical measures of head impacts between a National Collegiate Athletic Association Division 1 football team and a small high school team.

METHODS

Players who participated in the study represented a wide variety of positions, with starters given preference. Participants comprised 105 college players and 53 high school players, each of them monitored during all practices and games for the entire 2005 season.

Their helmets were outfitted with a head impact telemetry system. This system consisted of six accelerometers, one temperature sensor, one wireless transceiver and on-board memory capacity.

Player positions were divided into line players (linebacker, offensive and defensive linemen) and skill players (wide receiver, cornerback).

Two thresholds were used for determining high impacts.

The rate of concussions/impacts was much higher in the high school team compared with the college team.

The first was defined as hits greater than 60g, which represented the 90th percentile of all impacts. The highest impacts were defined as hits over 90g, of which 75 percent are believed to result in concussions.

RESULTS

There were 54,154 impacts for the college team, and 8,326 impacts for the high school team. Overall, 79 percent of the impacts were less than 30g. However, college players sustained more impacts greater than 60g than did high school players.

When the results were analyzed by position, skill position players had a higher percentage of the highest impacts than did linemen at either the college or high school level.

Skill players accounted for 24 percent of all impacts.

Both teams sustained three concussions during the season. All were classified as the highest of impacts, with hits measuring between 81-145g. However, the rate of concussions/impacts was much higher in the high school team (3/8,326) compared with the college team (3/54,154).

DISCUSSION

This is the first study of its kind comparing head impact accelerations between different levels of play and between different positions on a team. Although the college players had more high-impact hits, high school players still sustained a considerable number of hits (166) greater than 100g.

These results also show that although linemen experience less impact than skill players, they absorb more total hits per game. The effects of these repeated low impacts on the development of mild traumatic brain injury need further investigation. These results suggest that skill players may be at greater risk for high impacts and should be monitored closely for any signs and symptoms of concussion after a hard hit.

– Article by Brian Noehren