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Football Concussions: Effects, Evaluation and Prevention

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ABSTRACT

Football related concussions are a growing concern in society. Concussions can lead to a major brain disease called chronic traumatic encephalopathy. This disease leads to many degenerative qualities that affect physical, cognitive, and emotional aspects in football players. In this review, the effects, evaluation, and prevention of concussions in football are discussed. Concussion rates and brain damage can both be decreased through improving equipment such as helmet design as well as better head-on collision rules being developed, and better evaluation techniques for taking concussed players out of games. In the future, with the combination of advancements in evaluation and prevention, concussions can start to become less of a concern.

KEYWORDS: concussion, football, chronic traumatic encephalopathy, brain damage, concussion prevention.

INTRODUCTION

In football, concussions are a common occurrence. Football is a prime entrant for concussion research because it is a contact heavy sport with many head on collisions. Many football players' lives and their families are affected, so it is important to research concussions. Concussions are common understated injuries, however, concussions related to football have gained more attention from society recently. Football related concussions are described as a blow to the head that causes the brain to move suddenly in the skull. In the past, since concussions were not taken seriously, equipment such as helmets were not improved to prevent injury¹. Without advanced equipment, numerous players sustain injuries. In one study, almost 90% of the 202 players sampled had chronic traumatic encephalopathy (CTE)², which is a disease that degenerates the brain². The position with the most players diagnosed with CTE is lineman². This position has the most head to head collisions because they experience contact almost every play of a game, unlike a quarterback or punter who the linemen are instructed to protect from the opposing team's players. Researching football related concussions will lead to advancements in equipment, concussion tests and prevention. In this review, the many

effects of concussions, ways to evaluate concussions on the field, and how concussions can be prevented by football leagues are discussed.

EFFECTS

Physical

Post-concussion physical effects are researched through electrophysiological testing³ and neuroimaging testing such as magnetic resonance imaging⁴. Changes in the microstructure of brain tissue are found through a special, advanced technique in this field⁴. It has been found through magnetic resonance imaging that there are alterations in white matter in the brain⁴ as well as axonal damage⁵. Damage has also been found in players with post-concussion syndrome who had thalamic, temporal, and late frontal changes in their brains⁵. An immediate physical effect of concussions occurs when a football player loses consciousness after a direct collision to the head. Other physical symptoms football players may experience are headaches, dizziness, fatigue, visual disturbances, noise sensitivity, and light sensitivity⁶. Many football players ignore these physical effects and do not alert the proper medical personnel because they do not want to be removed from the game and miss future games, leading to further damage. With physical damage occurring to the brains of football players other deteriorations follow as result.

Cognitive

Alongside the physical effects, cognitive effects can ensue. A football player's risk of neurodegenerative disorders as they age is increased through multiple concussions⁷. Following concussions, players may have post-concussion syndrome. This syndrome is characterized by its ability to hinder the senses and brain function⁸. With these effects, it becomes hard to concentrate and behave normally. Examples of these effects are memory deficits, attention/concentration deficits, and executive function deficits⁶. These effects are not only hard on the player, but his family as well. If the damages are too detrimental, the player may act so uncharacteristically that his family might not recognize him. In one study, it was found that retired National Football League players' rate of dementia, Alzheimer's disease, or another memory-related disease was almost 2% higher in ages 30-49 and almost 5% higher in ages 50+ compared to men of the same age in the United States population⁹. This shows a significant correlation between repeated head injuries and brain diseases in football players.

Psychological

When a player's cognitive abilities begin to deteriorate, his emotional state may become affected as well. The player may become depressed, anxious, or irritable⁶. This can cause

the player to act irrationally and start to lose relationships with friends and family. A significant relationship between multiple concussions and diagnosis of lifetime depression was found in a study of 2552 retired National Football League players³. Multiple concussions affect football players later on in their lives, after their careers are over. In another study, it was found that retired National Football League players' rate in all of the following was almost 17% higher in ages 30-49 and 8% higher in ages 50+ compared to men of the same age in the United States population: most of the day you felt sad, empty or depressed, most of the day you were very discouraged about how things were going in your life, you lost interest in most things you usually enjoy like work, hobbies, and personal relationships, and most of the time you were very irritable, grumpy or in a bad mood⁹. NFL players had much higher rates than average American men. This strengthens the fact that multiple concussions have effects after the initial concussion period.

EVALUATION

There are tests implemented in football leagues for concussion evaluation on site. In collegiate football, one such test is the King-Devick test which assesses a potentially concussed player on their vision, speech ability, and attention in under two minutes¹⁰. This test has been proven to accurately assess players with concussions, leading to them being removed from play to preserve their health¹⁰. If the test is failed players are not allowed to return to the game, and their lives are potentially saved since repeated head injuries are what lead to CTE and other brain diseases. On site tests like the King-Devick are vital because concussions are not completely preventable at the current moment. While the King-Devick test was accurate in adolescents¹¹, not all tests are as accurate. This is why it is important to research all tests used by football leagues to assess concussions. In one study, a sideline assessment test called the Sport Concussion Assessment Tool-Third Edition (SCAT3) was found to be influenced by physical exertion during play¹². Therefore, more research should be conducted on sideline assessment tests so that only accurate tests are used for evaluation across all football leagues from youth to professional.

PREVENTION

Equipment

Football helmets are the most important piece of equipment when it comes to preventing players from obtaining concussions. Helmet designs are being modified and improved to further reduce risk of concussions. Earlier football helmets were only made out of leather, contemporary football uses more advanced materials in helmets including

metals, plastics, and rubber ¹³. While better materials are now used, they can still be improved. In collisions, more than half of impact sites are to the front and sides of the helmet ¹, so by modifying helmets in these areas of impact concussions can be reduced. In one study, it was concluded through computer simulation that face mask (front of helmet) design is significant to brain response during frontal impacts ¹⁴. There was almost a 40% drop in brain strain with an optimal helmet design compared to a base model ¹⁴. With this optimized helmet design, concussions can be reduced. If a previously concussed football player makes it through concussion protocol without detection and enters a game, chances of repeated injury are lowered through the advanced equipment.

Rules

There are rules set forth to prevent concussions at all levels of football. The “Crown of the helmet rule” is one used by National Football League ¹⁵. This rule penalizes players that use the top of their helmet to initiate contact intentionally, and it has been found to effectively reduce concussions in some players ¹⁵. Although rules such as these decrease risk of concussions, they increase the risk of damage to the lower body such as the knee or ankle ¹⁶. Since the rules penalize hits to head, players target the lower body when tackling. Further research should be conducted on producing rules where concussions can be reduced without increasing injuries to another region of the body. A study conducted on high school football showed that a rule limiting full contact practice reduced the incidences of concussions by half ¹⁷. This rule limited the amount of time a team could have full contact practice ¹⁷. By limiting contact, the chance of head-on collision is reduced. More research should be conducted in the future to further strengthen the validity of this study. By doing this, it would prompt other levels of football to adopt the same rule.

CONCLUSION

Concussions have many negatives effects. These effects include physical, cognitive, and psychological differences, all of which are detrimental to football players. Therefore, evaluation techniques like the King-Devick test must be consistent and accurate to make sure players are safe. There are measures put into place to prevent concussions from occurring in football, but no measure is completely effective. It is important to study concussions because many football players have repeated head injuries leading to CTE and the effects mentioned in this review (Table 1). To combat this, more research needs to be done in protective equipment, and how it can be improved. Also, more research should be conducted on how preventive concussion rule changes in football are not only beneficial, but also detrimental as the “Crown of the Helmet” rule is. Lastly, future

research should be done on tests such as the King-Devick so that not only football, but other sports leagues adopt similar techniques for assessing concussions.

Table 1. Concussion Effects, Evaluation Techniques, and Prevention.

Type of Effect	Effects	Evaluation Technique	Prevention Methods
Physical	Changes in the microstructure of brain tissue ⁴ Axonal damage ^{4,5} Thalamic, temporal and late frontal brain changes ⁵ Headaches ⁶ Dizziness ⁶ Fatigue ⁶ Visual disturbances ⁶ Noise sensitivity ⁶ Light sensitivity ⁶	Advanced magnetic resonance imaging ⁴ Physical examination Electrophysiological testing ³	Helmets/other protective equipment Head-on collision rules ¹⁵
Cognitive/Psychological	Memory deficits ⁶ Attention/concentration deficits ⁶ Executive function Deficits ⁶ Depression ⁶ Irritability ⁶ Anxiety ⁶	King-Devick Test ¹⁰ Sport Concussion Assessment Tool-Third Edition ¹²	Prohibition of reentering the game.

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