A REVIEW OF FOOTBALL RELATED CONCUSSIONS

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[1]Brigham Young University, Provo, UT, USA
E-mail: [redacted]

INTRODUCTION

The super bowl is one of the most widely viewed sporting events in the United States every year. One of the major draws towards the sport is the high impact collisions that occur regularly. However, the American family's appeal to the sport would drastically decline if the frequency of a concussion to star players dramatically increased (Levy, et. al. 2007). Researchers have studied the biomechanics of football and concussion related injury extensively. This abstract reviews how the following points are related to concussion, 1) Impact on biological tissues 2) Forces and 3) Innovations in helmet design.

IMPACTS ON BIOLOGICAL TISSUE

Forces from a hit during a football game act directly on the biological tissues of the body. Forces that cause concussions act primarily on the midbrain (Viano, et. al. 2007). The force from a hit to the head during a football game will cause strain on the midbrain, resulting in memory loss, nausea, and headaches as short term results and dementia, depression, and slurred speech as long term results (Jones, et. al. 2007). A linear force, like a hit from a football player, can result in an angular force by the rotation of the neck; therefore, the neck is also affected by the impact of a hit during a football game. The neck is only a conditionally affected area. The affect on the neck would decrease if the neck strength increased. As the strength of the neck increases, there is less rotation and less angular force applied on the head, thus the impact of the forces will decrease, possibly eliminating one factor that causes concussions. (Viano, et. al. 2007). Strain to the midbrain could also decrease with a well designed helmet that protects the more sensitive parts of the skull (Levy, et. al. 2004). While forces are an important aspect to concussions, the acceleration and momentum of the hit are essential factors for the development of a concussion.

FORCES

Football players are large and fast. This results in high momentum and high angular acceleration of the head. Many impacts in football are elastic collisions involving the head of one or more players. When elastic collisions occur momentum is transferred resulting in an increased velocity and acceleration of the head. In helmet to helmet collisions the player delivering the blow will transfer some of his momentum to the player receiving the blow. The receiving player's head will consequently experience an increase in momentum and angular acceleration, often causing a concussion. Scientists are now looking at the number of concussions in football and discovering how to reduce their frequency. Several studies have been conducted to find maximum head acceleration from NFL type collisions. Schnebel, et. al. 2007, observed that football players receive up to 98gs in force to the helmet. The NFL simulated 25 helmet impacts to see how angular acceleration was affected. They studied

impacts to the helmet both from the front as well as from the side. In frontal impacts peak translational acceleration was as high as 138 gs while peak rotational acceleration reached 9678 r/s². For side impacts peak accelerations were 135gs and 9590 r/s² respectively. Advances have been and are being made by football helmet producers to help reduce peak head acceleration as well as rotational acceleration to help reduce the number and magnitude of concussions. (Viano, et. al. 2007).

INNOVATIONS IN HELMET DESIGN

Since the 1890's, the football helmet has taken many forms. Early types were made of leather; metal alloys were added later for strength and protection. In the 1970's, biomechanical studies led to helmet reform (See Figure 1). Helmets were required to have an outer shell to protect the skull from impact. Modern helmets have modified protective inner suspension systems to allow for energy absorption and better fit. One system utilizes a combination of hollow plastic arches and gases to equalize pressure and create a contoured fit. Another type uses inflatable tubes within foam of different densities to allow for flexibility. A third style combines inflatable liners and special cuts of foam pads in precise locations around the skull for localized protection (Levy, et. al. 2004). A fourth design uses force sensors inside the helmet to record impact. The sensors transmit to a computer which allows a coach to monitor a player and prevent major head trauma by removing the player from the field when force readings are too high (Jones, et. al. 2007). Overall, biomechanical studies facilitate the ongoing improvement of the football helmet.

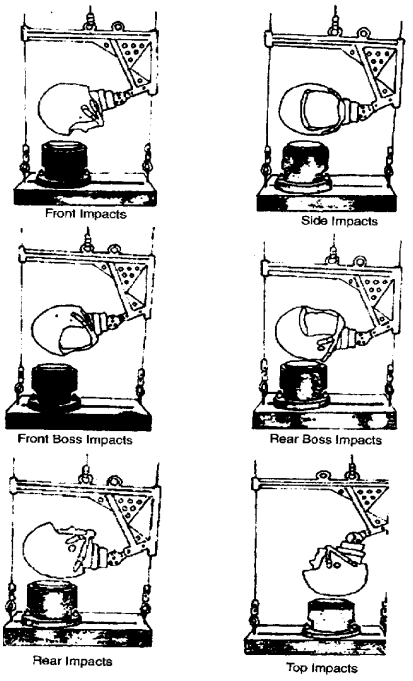

Figure 1: NOCSAE tests of impact and helmet integrity to create standards for helmet design (Levy, et. al. 2004).

SUMMARY

Football concussions are one of the most concerning injuries in the game. Impacts on biological tissue, forces and innovations in helmet design have all been evaluated. Research has shown that concussions result from high peak accelerations which directly affect the midbrain. Improvements in helmet design helps to isolate these forces, minimizing the trauma that can result.

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