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Head impact exposure in collegiate football players ☆

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ABSTRACT

In American football, impacts to the helmet and the resulting head accelerations are the primary cause of concussion injury and potentially chronic brain injury. The purpose of this study was to quantify exposures to impacts to the head (frequency, location and magnitude) for individual collegiate football players and to investigate differences in head impact exposure by player position. A total of 314 players were enrolled at three institutions and 286,636 head impacts were recorded over three seasons. The 95th percentile peak linear and rotational acceleration and HITsp (a composite severity measure) were 62.7 g, 4378 rad/s^2 and 32.6, respectively. These exposure measures as well as the frequency of impacts varied significantly by player position and by helmet impact location. Running backs (RB) and quarter backs (QB) received the greatest magnitude head impacts, while defensive line (DL), offensive line (OL) and line backers (LB) received the most frequent head impacts (more than twice as many than any other position). Impacts to the top of the helmet had the lowest peak rotational acceleration (2387 rad/s^2), but the greatest peak linear acceleration (72.4 g), and were the least frequent of all locations (13.7%) among all positions. OL and QB had the highest (49.2%) and the lowest (23.7%) frequency, respectively, of front impacts. QB received the greatest magnitude (70.8 g and 5428 rad/s^2) and the most frequent (44% and 38.9%) impacts to the back of the helmet. This study quantified head impact exposure in collegiate football, providing data that is critical to advancing the understanding of the biomechanics of concussive injuries and sub-concussive head impacts.

1. Introduction

Impacts to the head are commonly identified as the cause of concussion injury during athletic play (CDC, 1997; McCrory et al., 2009; Thurman et al., 1998) while repetitive head impacts, even those with no acute symptoms or signs, often referred to as sub-concussive impacts, have been suggested as a possible cause of chronic brain injury (Janda et al., 2002). At present, the relationships between head impacts and these brain injuries are not well understood. For example, studies utilizing surrogate reconstructions of documented concussive hits in the National Football League have proposed that the risk of concussion injury is associated with the peak linear acceleration of the head (Pellman et al., 2003b). Others have postulated that the threshold for concussive injury may be difficult to establish because of the varying magnitudes and locations of impacts resulting in concussion, as well as other factors such as the frequency of sub-concussive impacts and the number of prior concussions (Guskiewicz and Mihalik, 2011). This lack of consensus may be due in part to the challenges of measuring and analyzing head impacts. It also has been suggested that the location of the impact and the direction of the resulting head motion is a factor in the mechanism of concussion injury (Pellman et al., 2003a). Greenwald et al. (2008) determined that a weighted measure, HITsp that incorporates linear acceleration, rotational acceleration, impact duration and impact location, was more predictive of concussion diagnosis than any single biomechanical measure. Accordingly, head impact exposure is a risk factor for concussion

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