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Lecture

Comparison of head impact location during games and practices in Division III men's lacrosse players

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ABSTRACT

Background: Head impacts have been studied extensively in football, but little similar research has been conducted in men's lacrosse. It is important to understand the location and magnitude of head impacts during men's lacrosse to recognize the risk of head injury.
Methods: Descriptive epidemiology study set on collegiate lacrosse fields. Eleven men's lacrosse players (age = 20.9 ± 1.13 years, mass = 83.91 ± 9.04 kg, height = 179.88 ± 5.99 cm) volunteered to participate. We applied X2 sensors behind the right ear of participants for games and practices. Sensors recorded data on linear and rotational accelerations and the location of head impacts. We calculated incidence rates per 1000 exposures with 95% confidence intervals for impact locations and compared the effect of impact location on linear and rotational accelerations with Kruskal-Wallis tests.
Findings: We verified 167 head impacts (games = 112; practices = 55). During games, the incidence rate was 651.16 (95% confidence interval = 530.57–771.76). The high and low incidence rates for head impact locations during games were: side = 410.7 (95% confidence interval = 292.02–529.41) and top = 26.79 (95% confidence interval = 3.53–57.10). For games and practices combined, the impact locations did not significantly affect linear ($\chi^2_3 = 6.69$, $P = 0.08$) or rotational acceleration ($\chi^2_3 = 6.34$, $P = 0.10$).
Interpretation: We suggest further research into the location of head impacts during games and practices. We also suggest player and coach education on head impacts as well as behavior modification in men's lacrosse athletes to reduce the incidence of impacts to the side of the head in an effort to reduce potential injury.

1. Introduction

A mild traumatic brain injury, or concussion, is defined by the clinical signs and symptoms and changes at the cellular level of the brain (Broglio et al., 2014; Guskiewicz et al., 2007). Every year in the United States, there are a reported 1.6 to 3.8 million concussions in athletic settings (Kindschi, 2014). The incidence rate of concussions is most frequent in contact sports such as American football, ice hockey, soccer, and lacrosse (Kindschi, 2014). The two most common mechanisms of injury that can cause a concussion are head-contact injuries and head-movement injuries resulting from impacts to some other body part (Guskiewicz et al., 2007).

The location of head impacts is an important factor that should be studied due to associations with neuropsychological changes and injury risk. Pellman et al. (2003) examined head impact location in the National Football League (NFL) and found that football players acquire the most head impacts in the facemask (front) and back of the helmet (Pellman et al., 2003). However, head impacts to the back and side of the helmet resulted in the greatest rotational accelerations. Therefore, front and back locations are an area for concern because greater accelerations can lead to neuropsychological changes or concussion (Pellman et al., 2003). Mihalik et al. (2007) utilized the HIT system consisting of six uniaxial accelerometers embedded in the helmets of football players to measure linear and rotational accelerations and the location of impacts. A strong association between high-magnitude head impacts and the location of the head impacts (front & back) was observed. They also found that athletes received higher magnitude impacts during practices compared to games.

Previous research involving lacrosse and concussive injuries has examined video footage of high school boys' lacrosse games and studied the different mechanisms and helmet locations that resulted in a

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concussion (Lincoln et al., 2013). Researchers found that in 60% of concussive cases recorded in their study, the initial impact was to the side of the helmet (Lincoln et al., 2013). Research that has been conducted for men's lacrosse at the collegiate level has involved Division I athletes and has focused on head impacts and player position (Kindschi, 2014). Researchers found that face off specialists acquired the most head impacts to the front, sides, and back of the helmet in both games and practices (Kindschi, 2014).

The popularity of lacrosse is rapidly increasing. According to National Collegiate Athletic Association (NCAA) participation rates, from 2007 to 2008 to 2012–2013 across Division I (DI), Division II (DII), and Division III (DIII), football has added 29 programs (Irick, 2013; Kindschi, 2014). During this same time period, men's lacrosse has added 95 programs, with most of them being added at the DIII level (Irick, 2013). Men's lacrosse is a unique contact sport where the equipment and nature of play differ from both football and ice hockey. Due to this rapid growth in participation across the country, and the differences in head impact biomechanics with respect to football and ice hockey, it is necessary to further study the biomechanics of lacrosse in order to improve equipment designs, propose rule modifications, and suggest behavior modification to reduce potential risk for injury in the future. Therefore, the purpose of this study was to analyze practice and game footage of Division III men's lacrosse players to determine which location on the helmet received the highest frequency and highest magnitude of head impacts during games and practices. Specifically, we wanted to know if the linear and rotational accelerations of head impacts sustained by lacrosse athletes differed between helmet locations. We hypothesized that both accelerations would be different across helmet location. We also sought to determine the likelihood of receiving an impact to one location of the head compared to others. Impacts to the side of the head were expected to be the most frequent due to the nature of stick checking to dislodge the ball while it is cradled lateral to the head.

2. Methods

2.1. Participants

Eleven NCAA Division III men's lacrosse players (age = 20.9 (1.13) years, mass = 83.91 (9.04) kg, height = 179.88 (5.99) cm) from one institution participated in this study. We emailed athletes on the men's lacrosse team from all positions with information about the study and asked for their voluntary participation. We obtained at least one player from every position; the study included 1 goalie, 5 defenders, 2 midfielders, and 2 attack players. Participants had to be at least 18 years old or older, be a member of the active men's lacrosse roster, and not be concussed at the time of study enrollment.

2.2. Instrumentation

We used X2 Biosystems xPatch sensors (Seattle, WA), to measure the location of head impacts, as well as the linear and rotational accelerations of the impacts. The xPatch contains a triaxial accelerometer and a triaxial gyroscope to measure the six degrees of freedom necessary to calculate linear and rotational accelerations of the head (Nevens et al., 2015; Reynolds et al., 2016; Wu et al., 2015). The sampling rate for linear and angular accelerations was 1 kHz and 800 Hz respectively (Nevens et al., 2015). The head impact locations were calculated as 180° from the direction of motion at the peak linear acceleration and binned into the locations as detailed in Fig. 1. The xPatch has been found to be the most accurate head acceleration measurement device at recording impact location when compared to other head mounted and helmet mounted devices (Cummiskey et al., 2016). We used 15 g as our recording threshold for linear head impacts. We chose this threshold because linear accelerations from activities of daily living are typically under 15 g (Ng et al., 2006). The xPatch sensors overestimate linear and rotational accelerations (Wu et al., 2015), but have been found to be more accurate than other measurement tools for head accelerations (Cummiskey et al., 2016).

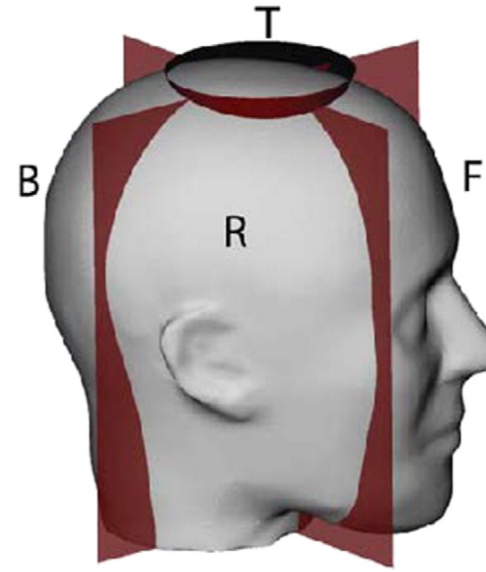

Fig. 1. xPatch sensor head impact locations. This is image is used with the courtesy of: Crisco JJ, Wilcox BJ, Machan JT, McAllister TW, Duhaime AC, Duma SM, Rowson S, Beckwith JG, Chu JJ, Greenwald RM. Magnitude if head impact exposures in individual collegiate football players. J Athl Train. 2010;45(6):549–559.

2.3. Procedures

The host institution was granted Institutional Review Board approval prior to participant recruitment. Before every practice and game, we applied the xPatch sensors over the right mastoid process of the participants after spraying 3M Cavilon No Sting Barrier Film Spray (3M Health Care, St. Paul, MN) to help prevent skin irritation. We activated the sensors, attached them to a small adhesive patch, and placed behind the right ear of the athlete over the mastoid process (Fig. 2). The

Fig. 2. X2 Biosystems xPatch sensor applied to an athlete. The application area was prepped with 3M Cavilon No Sting Barrier Film Spray (3M Health Care, St. Paul, MN). The sensor was then turned on using the X2Biosystems case and applied to the adhesive patch. The patch was then applied behind the right ear of the athlete with the arrow on the sensor pointing towards the ear.