Head Impact Exposure in Youth Hockey

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Introduction

An estimated 500,000 to 600,000 youth athletes participate in ice hockey in the United States each year, with rising popularity. Hockey has a high incidence of injury; estimated rates of concussion in hockey are similar to those of American football. Recent interest in sports-related concussion has motivated research to better understand the incidence of injury and sport-specific injury mechanisms. While the majority of hockey athletes compete at the youth level, exposure studies of pediatric populations are limited. This study quantified peak head kinematics and impact rates during one season of play, adding to existing knowledge of hockey head impact exposure.

Methods

This study enrolled male athletes (ages 12-14) participating in a local 14U hockey team. Each athlete was fit with a custom instrumented mouthguard featuring a tri-axial accelerometer and gyroscope embedded within a rigid retainer material bonded to a soft elastomer overlay, allowing for improved coupling and measurement of head impact kinematics.

On-ice impact data were collected during 58 sessions spanning 25 weeks. Acquisition was triggered when a mouthguard received an impact greater than 5g, and a total of 60 ms of data were recorded. This data was paired with time-synchronized video of each corresponding session to identify the contact scenarios associated with the mouthpiece-recorded event. Contact scenarios included: board checks, ice checks, falls, punches, unintentional collision with boards, and other head impacts. Contact scenarios were coded for head contact as either “yes”, “no”, or “unknown”.
True positive impacts were defined as mouthpiece-recorded events that occurred concurrently with a visually-verified contact scenario involving the instrumented athlete. Following data transformation, resultant time histories and summary statistics associated with peak resultant kinematics were calculated and compared by contact scenario.

**Results and Discussion**

A total of 682 contact scenarios were observed from video during the season. The most common contact scenarios observed were ice checks, board checks, and falls (n = 645). Unintentional collisions with the boards, punches, and other head impacts accounted for the remaining 5.7% of video-verified contact scenarios (n = 39). Of the 682 contact scenarios observed, 465 were classified as “true positive impacts”. Board checks (n = 113), falls (n = 152), and ice checks (n = 165) represented 92% of all true positive impacts. Of the 465 video-verified impacts, 119 included visible head contact. Impact rates were calculated based on the number of video-verified contact scenarios and ranged from 1.38 to 2.94 impacts per session per athlete; impact rates were higher in games than in practices; games also resulted in higher median peak linear acceleration (7.2g) and rotational velocity (7.4 rad/s) compared to practices (6.7g, 5.4 rad/s).

These data demonstrate that the majority of hockey impacts involve checking or falls. Impacts were greater in magnitude during games than practices. Only 25% of impacts involved head contact. As such, this data represents an important step towards understanding head impact exposure in the sport, and is the first youth study to the authors’ knowledge to collect kinematic data using an instrumented mouthpiece, which is associated with improved skull coupling as compared to other sensors.