The Effect of Shoulder Pad Design on Head Impact Severity during Shoulder Checks in Ice Hockey

Shane Virani1, Colin Russell1, Megan Bruschetta1, Kevin Hua1, Brigitte Potvin1, David Cox2, and Stephen Robinovitch1

1Department of Biomedical Physiology and Kinesiology, Simon Fraser University; 2Department of Psychology, Simon Fraser University.

Background / Purpose

Ice hockey accounts for 44% of sports-related brain injuries in Canadian youth.1 Over 40% of ice hockey concussions are caused by contact to the head by a player’s shoulder.2 Shoulder pads may influence the force delivered during a shoulder check.3

> Reducing stiffness of shoulder pads should decrease impact force for a given impact energy.
> Lower-stiffness pads may also cause players to adjust their “risk compensation” and deliver hits with higher impact energy.

The goal of this project is to determine how shoulder pad stiffness affects peak head accelerations during shoulder-to-head impacts in hockey.

Methods – Part 1

To address this goal, we developed a body checking “dummy” that allows players to deliver shoulder checks in a safe, realistic and controlled manner.

![Figure 1](image1.png)

Figure 1. Schematic of the body checking “dummy”. The head of the dummy was covered with a caged helmet, containing triaxial linear accelerometers (acquired at 20 kHz; Endevco 7264C) and angular velocity gyro (800 Hz; GForceTracker).

Methods – Part 2

![Figure 3](image3.png)

Figure 3. Players delivered the hardest shoulder check they were comfortable in delivering to the dummy. Participants delivered five impacts with each of the four shoulder pad combinations for a total of twenty impacts overall. The order of these shoulder pad combinations was randomized for each impact type separately.

For each trial, peak linear acceleration and peak angular velocity at initial impact were extracted from raw sensor data. High speed video (1200 Hz) for each trial was differentiated to estimate impact velocity.

Sensor Results

![Figure 4](image4.png)

Figure 4. When players delivered checks with foam-modified pads versus unmodified pads, there was a decrease of 27.7% in the average value of peak linear head acceleration of the dummy during (31.13 g versus 43.04 g; mean difference = 11.91 g (SE = 2.06); p < .0001).

![Figure 5](image5.png)

Figure 5. When players delivered checks with foam-modified pads versus unmodified pads, there was a decrease of 13.8% in the average value of peak rotational head velocity of the dummy (95.16 deg/s versus 1103.87 deg/s; mean difference = 152.31 deg/s (SE = 65.58); p = .025).

Discussion

Integration of 2 cm thick foam padding on top of common hockey shoulder pads did not cause players to increase their velocity when delivering shoulder checks to the head, and lowered indices of risk for concussion (peak values of linear acceleration and rotational velocity of the head).4

Further research should go into the optimal design of shoulder padding with regard to both geometry and materials in order to design equipment that is both protective to the checking player’s shoulder joint, as well as protective to the head of the player receiving the hit.

This will allow shoulder padding to work in tandem with other interventions such as improved helmet design, knowledge training, and rule changes, to reduce the number of brain injuries suffered by hockey players of all ages.

References and Acknowledgments


