THE EFFECT OF SHOULDER PAD DESIGN ON HEAD IMPACT SEVERITY DURING SHOULDER CHECKS IN ICE HOCKEY

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

I. Background on Head Injuries in Ice Hockey
II. Objectives of the Current Project
III. Methodology
IV. Results
V. Discussion
The Growing Concussion Epidemic

Concussion is the most common brain injury incurred by Canadian youth and young adults. (Browne, 2006)
A Word Associated With Career Ending Injuries and Hindered Daily Living

Canucks douse Flames, but lose Andrew Alberts with possible concussion
BY BRAD ZIEMER, VANCOUVER SUN  DECEMBER 30, 2013

Canucks' Andrew Alberts hoping for 'one day without headaches'
BY IAIN MACINTYRE, VANCOUVER SUN COLUMNIST  JUNE 2, 2014

DAN MURPHY  FEBRUARY 11, 2015, 11:06 PM
Andrew Alberts isn’t looking for sympathy. And the former Canucks defenceman is long past looking for an apology. All that he is looking forward to is feeling normal again.
A Word Seen On Multi-Million Dollar Lawsuits

NHL faces $13.5M legal bill in concussion case
By Rick Westhead

Steve Montador’s father takes up his dead son’s cause with lawsuit against NHL
By: Ken Campbell on December 8, 2015
Filed under: Anaheim Ducks, Boston Bruins, Buffalo Sabres, Calgary Flames, Chicago Blackhawks, Fighting, News, NHL

NHL concussions lawsuit: 12 more ex-players join
More than 100 now suing league for failing to protect them against brain injuries
By Michael Drapack, CBC Sports   Posted: Feb 03, 2016 2:27 PM ET   Last Updated: Feb 03, 2016 2:27 PM ET
Donald Trump Wants To Make Football Great Again With More Concussions

Donald Trump says NFL has 'gone soft' just like America

Republican candidate says there is too much emphasis on safety
What is a Concussion?

“Concussion is a brain injury and is defined as a complex pathophysiologival process affecting the brain, induced by biomechanical forces” (McCrorry et al., 2013).
Ice Hockey Accounts for 44% of Concussions in Youth

(Cusimano et al., 2013)
Is Modifying Shoulder Padding a Solution?

- 42% of concussions that occur are caused by direct contact to the head by the shoulder. (Hutchison et al., 2013)
- Suspected that shoulder pads can be used as offensive weapons to inflict head injuries. (Tator, 2012)
  - Negating the effects of protective equipment such as helmets.
- Foam has been shown to have effective force attenuation due to its highly elastic material properties. (Parkkari et al., 1995; Kannus, Parkkari & Poutala, 1999; A. McIntosh, 2004)
Risk Compensation

- Risk compensation suggests that individuals adjust their behavior in response to the perceived level of risk.
  - Becoming more careful when they sense greater risk and less careful if they feel more protected.
- Important to evaluate novel designs both biomechanically and behaviourally.
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Objectives of the Current Project

Aim 1: To determine how peak linear accelerations and peak rotational velocities of the head during shoulder-to-head collisions are affected by shoulder pad design - specifically by padding stiffness, modified by the addition of a 2cm thick foam overlayer.

Aim 2: To determine if shoulder pad design affects the aggressiveness of players in delivering shoulder checks to the head.
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Laboratory Instrumentation

- Outcome Measures:
- Peak linear head acceleration acquired at 20kHz via an Endevco 7624C tri-axial accelerometer setup.
- Peak Rotational Velocity acquired at 1kHz via G-Force Tracker Sensor.
- Trials recorded with a Nikon S2 highs speed camera at 1200 fps in order to differentiate shoulder impact velocity.
Experimental Protocol

• Participants (n=15) delivered the hardest shoulder check they were comfortable with to the dummy’s head with a 3m run-up.

• Were allowed to build up a speed of their choosing before impact.
Experimental Conditions

Total Impacts (n = 20)

- Pad A (n=5)
- Pad A w/ 2cm Foam (n=5)
- Pad B (n=5)
- Pad B w/ 2cm Foam (n=5)
The Experiment!
Data Analysis

- Each outcome was analyzed by conducting a two-factor (Presence of Foam, Shoulder Pad Type) repeated-measures ANOVA.
- Post-hoc paired t-tests were conducted to determine the differences between paired combinations of padding conditions.
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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 (31.13 g versus 43.04 g; mean difference = 11.91 g (SE = 2.06); p < .0001).
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 (951.56 deg/s versus 1103.87 deg/s; mean difference = 152.31 deg/s ($SE = 65.58$); $p = .025$).
When players delivered checks with foam-modified pads versus unmodified pads, there was no significant difference in average shoulder impact velocity (3.31 m/s versus 3.30 m/s; mean difference = 0.007 m/s ($SE = 0.06$); $p = .92$).
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What Does This Mean?

Concussion Risk Contours (Rowson, 2013)
Limitations

- Head and neck of the designed checking dummy made of foam rubber.
- Not double blinded.
- Participants only had a limited amount of time to become familiar with each shoulder pad condition.
- Subjects were running not skating.
Future Directions

- Rule change to add a specification for shoulder pads that already exists for elbow padding:
  All shoulder padding that does “not have a soft protective covering of sponge, rubber or a similar material at least 1.27 cm (1/2in.) thick shall be considered dangerous equipment”.
Future Directions

• Important to ensure that the amount of protection the shoulder pad offers the shoulder is not decreased to an amount that would cause an increased risk of incurring a shoulder injury.

• Ultimately further work needs to be done to find the optimal design that balances the protection of the checking player’s shoulder and the head of the player being checked.
Take Home Messages

- Integration of foam padding on top of plastic caps is warranted as a passive form of injury prevention:
  - Lowers peak linear accelerations and rotational velocities, two indices of risk for concussion.
  - Does not cause players to hit with an increased velocity.

- Shoulder padding can work in tandem with other interventions such as improved helmet design, knowledge training, and rule changes, to reduce the number of concussions suffered by hockey players of all ages.
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