Evaluation of Commercial Hockey Neck Guards via Novel Instrumented Test Surrogate

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Introduction: Ice hockey is a fast-paced physical sport, with frozen vulcanized pucks reaching speeds of over 100 mph at elite levels. Direct puck impacts occur frequently, and have been identified as one of the most common mechanisms for injury, with the head and upper body being the most frequently injured areas [1]. Hockey puck strikes can produce serious and/or fatal injuries when the neck is impacted, as has been reported in the news in recent years. Currently, neck guard standards (BNQ 9415-370) only require protection from lacerations via skate blades, leaving players potentially vulnerable to blunt impacts to the region. No known test surrogate exists that is capable of accurately assessing the protection provided by neck guards in response to direct puck impacts.

Objective: To develop an instrumented surrogate that accurately represents the stiffness of the neck and use it to evaluate commercial neck guards for their force attenuation under simulated hockey puck impacts.

Methodology: The surrogate was developed using a mannequin body with a spring installed within the neck. This was to replicate the stiffness of the human body while providing geometric accuracy (for mounting protective equipment) (Figure 1). The stiffness was obtained by simulating a hockey puck striking the THUMS human body model (Toyota Central R&D Labs, Inc., Nagakute, Japan) at the neck at 20.6 m/s (46 mph, 33 J) [2]. A PCB 200C20 force sensor was secured flush to the neck surface to measure transmitted force. Impacts at 33 J were applied using a pneumatic impacting apparatus and projectile mounted with a puck. Four conditions were tested: unprotected and equipped with three commercially available neck guards, with five trials each. Protection was quantified as the force reduction provided by each neck guard.

Results: Unpadded impacts resulted in a mean peak force of 8277 ± 186 N, demonstrating high surrogate repeatability (CV =2.3%). The Aegis Interceptor neck guard provided the greatest force reduction, with a peak force of 5049 N (39% reduction). The Bauer NLP7 and CCM NG600 provided minimal impact protection, reducing peak force to 7747 N (6.4% peak force reduction) and 7913 N (4.4% peak force reduction), respectively.

Conclusions: Of the three neck guards tested, only the Aegis Interceptor was designed to provide blunt impact protection via a unique foam insert as. Due to a lack of injury limits for the neck under blunt trauma, it is unknown if any of the products tested would reduce force below injurious levels. Upon availability of injury data, equipment effectiveness can be better assessed. Player comfort, also key in ensuring adoption, was not assessed in the present study. Development of a hockey-specific surrogate, and the testing of currently available neck guards, is an important first step towards establishing a test standard and guiding future neck guard design, minimizing the risk of catastrophic injury for players.

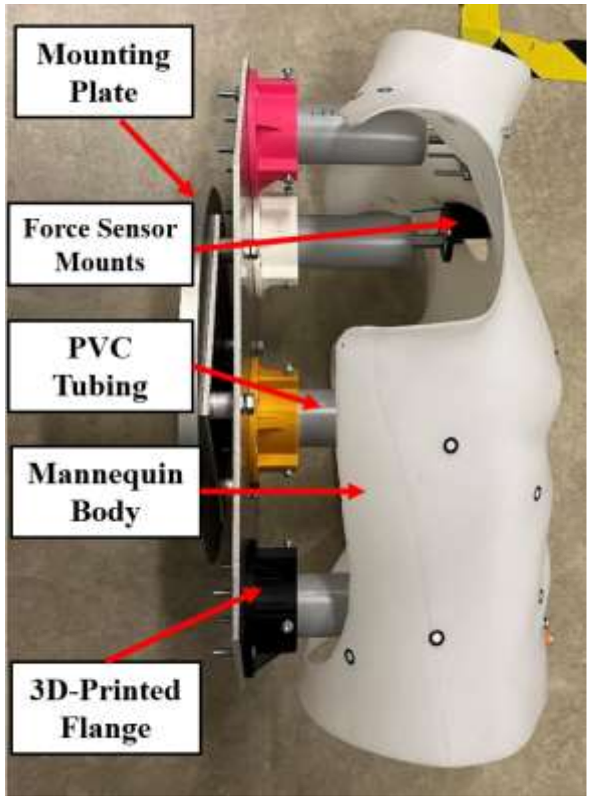

Figure 1: Side-view of fully assembled surrogate mounted to the attachment plate of the test rig.

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