EVALUATION OF HOCKEY HELMET PERFORMANCE BY FINITE ELEMENT MODELING

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INTRODUCTION: Since the advent of helmet use in ice hockey the incidence of traumatic brain injury (TBI) has decreased, however the prevalence of mild traumatic brain injury (mTBI) has not (Wennberg and Tator, 2003). Recently finite element modeling (FEM) has been used in an attempt to identify mTBI thresholds from an impact using shear stress strain (SSS) and other parameters to aid in reducing these injuries (Zhang et al., 2004). The following study employs the University College Dublin Brain Trauma Model (UCDBTM) to evaluate the ability of vinyl nitrile (VN) and expanded polypropolene (EPP) hockey helmets to reduce the risk of brain injury.

METHODS: A helmeted and unhelmeted hybrid III headform/neck, instrumented with a 3-2-2-2 accelerometer array, was impacted three times at 5.3 ± 0.05 m/s (Padgaonkar et al., 1975). The location of impact was front boss, with a negative azimuth, the weight of the impactor was 16.9kg. The results, in x, y and z components of linear and angular acceleration were inputted into the UCDBTM.

RESULTS AND DISCUSSION: The results indicated that while the general location of peak SSS did not change, its magnitude differed between the three conditions. The no helmet condition had a peak of 0.17 ± 0.001 mm/mm, the EPP helmet peak was 0.17 ± 0.002 mm/mm, and the VN helmet peak was 0.13 ± 0.005 mm/mm (Figure 1).

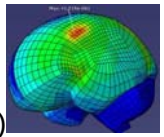
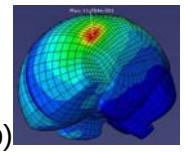
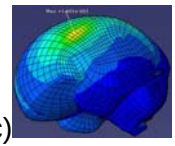
a)  b)  c) 

Figure 1: Impact to hybrid III headform for, a) no helmet, b) EPP helmet, and c) VN helmet.

While the SSS area was reduced between the no helmet and helmet condition, there was a reduction in peak SSS for the VN helmet where the EPP and no helmet remained the same. It should be noted that the peak linear and angular acceleration inputs into the model did not differ significantly, however, the slope of the curve to peak was steeper for the EPP helmet over the VN helmet. This would support the research that SSS is rate dependent (Zhang et al., 2004).

CONCLUSION: The UCDBTM was successful at showing how the use of a helmet can decrease the chance of brain strains. The results also suggest that there is a difference in how VN and EPP function in relation to actual brain injury, separate from peak acceleration values.

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