THE DETERMINATION OF NOVEL IMPACT CONDITIONS FOR THE ASSESMENT OF LINEAR AND ANGULAR HEADFORM ACCELERATIONS

Evan Stuart Walsh, Philippe Rousseau, Scott Foreman, and T. Blaine Hoshizaki

Neurotrauma Impact Science Laboratory, University of Ottawa, Ottawa, Canada

KEYWORDS: Neurotrauma, impact, injury, angular acceleration, sports helmets

INTRODUCTION: Sports helmets, albeit very effective at preventing traumatic brain injury, have not mitigated the risk of mild traumatic brain injury in sport (Flik, Lyman, & Marx, 2005). Current protocols utilized in sports helmet testing incorporate only impact vectors through the center of mass, eliciting primarily linear accelerations. Angular acceleration has been suggested to be a better predictor of diffuse head injury than linear acceleration (Holbourn, 1943); therefore, the objective of this study was to develop a protocol capable of producing and measuring both forms of acceleration for future implementation into sports helmet standards.

METHODS: A 13.8 kg linear impactor was used to produce impacts at 5.5 m/s to an instrumented Hybrid III headform. This velocity was selected to match existing protocols (NOCSAE). Five impact sites (Front, Front Boss, Side, Rear Boss, and Rear) were tested at four impact angles (Center of Gravity, Positive Azimuth, Negative Azimuth, and Positive Elevation). Resultant linear and angular headform accelerations were analyzed with respect to published injury thresholds (Zhang, Yang, & King, 2004).

RESULTS AND DISCUSSION:

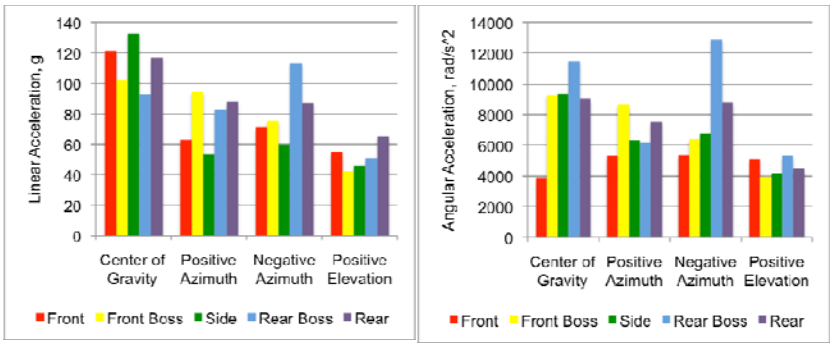

Figure 1: Peak linear and angular accelerations for multiple impact conditions at 5.5 m/s.

Three off-center impact conditions (Front Boss Positive Azimuth, Rear Boss Negative Azimuth, and Rear Negative Azimuth), along with the five center of gravity conditions, were determined to be above the published 80% injury risk prediction thresholds. A protocol using the above eight impact conditions could ameliorate mild traumatic brain injury prediction.

CONCLUSION: A new impact protocol employing both linear and angular accelerations for the prediction of mild traumatic brain injury was created. This protocol can be used towards the development of safer head protection for sport.

REFERENCES:

Flik, K., Lyman, S., & Marx, R.G. (2005). American collegiate men's ice hockey: an analysis of injuries. *The American Journal of Sports Medicine*, 33(2), 183-187.

Holbourn, A.H.S. (1943). Mechanics of Head Injury. *The Lancet*, ii, 438-441.

Zhang, L., Yang, K. H., & King, A. I (2004). A proposed injury threshold for mild traumatic brain injury. *Journal of Biomechanical Engineering*, 126(2), 226-236.

Acknowledgement

The authors would like to thank Xenith for supporting the Neurotrauma Impact Science Laboratory.