

THE EFFECT OF IMPACT CONDITION ON THE RELATIONSHIP BETWEEN LINEAR AND ANGULAR ACCELERATION

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INTRODUCTION: Helmets are mandatory in many contact sports and are designed to prevent traumatic brain injuries. When assessing their performance, angular acceleration is not measured, as it is generally assumed to be highly correlated with linear acceleration (Pellman et al., 2003). Although being common, this assumption is not supported by strong data. The aim of this study was to establish the relationship between linear and angular acceleration.

METHODS: A 13.8 kg linear impactor was used to produce impacts at $5.5 \text{ m}\cdot\text{s}^{-1}$ to an instrumented Hybrid III headform. 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).

RESULTS & DISCUSSION: Results show a moderate correlation between linear acceleration and angular acceleration ($R^2 = 0.401$). This is in part due to the front impacts through the centre of gravity, which clearly act as statistical outliers (Figure 1). Interestingly, this impact location is the most commonly used during helmet testing. This implies that adding the measurement of angular acceleration to current test protocols in order to predict mTBI is insufficient. New impact locations are necessary to characterize properly mTBI risk.

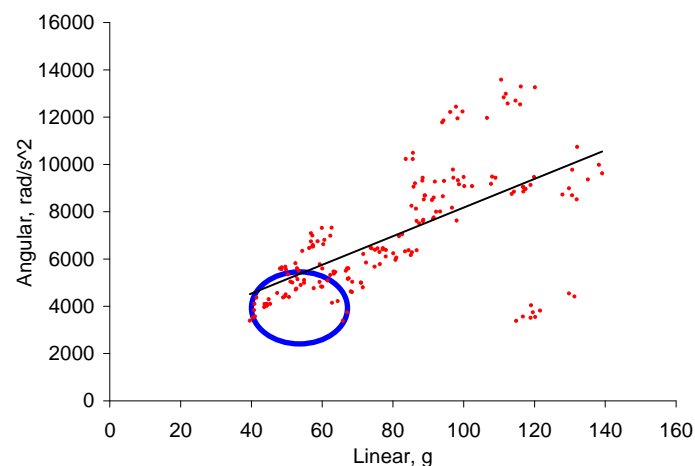


Figure 1: Relationship between linear acceleration and peak angular acceleration at 5.5 m/s. Front impacts through the centre of gravity are circled in blue.

CONCLUSION: The moderate correlation between linear and angular accelerations supports the inclusion of the latter in helmet performance tests. Doing so will allow for a better assessment of concussion protection in sport.

REFERENCES:

Pellman, E. J., Viano, D. C., Tucker, A. M., Casson, I. R., and Waeckerle, J. F. (2003). Concussion in professional football: reconstruction of game impacts and injuries. *Neurosurgery*, 53(4), 799-812.

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