

Title: Assessment of Thorax Response and Impact Location Dependence for Behind Armor Blunt Trauma

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Behind Armor Blunt Trauma (BABT) injuries can result from non-perforating ballistic impacts on thoracic armor. At present, the evaluation of soft armor performance involves subjecting it to various impacts, including shot-to-edge and shot-to-shot tests. Clay backing is utilized to measure the Back Face Deformation (BFD), where 44 mm is often used as a threshold. In a recent study, the correlation between BFDs and injuries was investigated using a computational human body model (HBM) to gain insights into injury tolerance, and to re-create real-world BABT cases that resulted in good, but conservative, injury predictions relative to the medical reports. It was noted that impacts occurred at various locations on protective body armour, but this was not considered in contemporary injury thresholds.

In this study, a thorax model, enhanced for high-rate deformation, was used to assess soft armor BABT for varying impact locations and BFDs. Twenty-four cases were simulated for three severities and applied to the thorax in a grid pattern covering low and high compliance regions spanning the sternum, ribs, and costal cartilage. Whole thoracic and locationally segregated injury risk curves (IRCs) were calculated for deformation- and kinetic-based metrics. Then the variability and prediction accuracy of the methods were evaluated using receiver-operating characteristic (ROC) area-under-the-curve (AUC) analysis.

The number of rib fractures, percent pulmonary contusion by volume, and corresponding injury rank, increased with increasing BFD. It was found that deformation-based IRCs generally had lesser variability and better accuracy than the kinetic-based IRCs. When impacts of like locations were grouped, it was found that location had a marked effect on the deformation-based IRCs, generally decreasing variability and increasing accuracy relative to the whole thorax IRC, suggesting that different regions of the thorax may have varying deformation tolerance levels.