Injury Models

Blast-induced Acceleration in a Shock Tube: Distinguishing Primary and Tertiary Blast Injury Mechanisms in Rat Traumatic Brain Injury (TBI)

Discerning biomechanical underpinnings is crucial for an understanding of the etiology and mitigation of blast-induced TBI. Scientists and engineers at the Walter Reed Army Institute of Research (WRAIR) are teaming with world renowned blast physics experts in examining the interplay of blast overpressure (BOP) and accelerative forces using an advanced blast simulator (ABS), which is capable of producing high fidelity improvised explosive device (IED)-like blast waveforms in the laboratory. This undertaking involves understanding the role that parameters such as areal density (the mass of an object divided by its projected two dimensional area), play in the scaling of acceleration and displacement (e.g., blast throw) resulting from blast shock waves. Experiments to date on spheres of varied mass indicate that trajectories for similar sized objects overlay each other when scaled by areal density.[1] However, trajectories do not scale across a range of sphere sizes and the entire mode of blast-induced acceleration changes with sphere diameter. For larger spheres the initial diffraction-phase loading dominates, and motion starts with a brief 'kickoff' velocity followed by immediate deceleration with the passage of the shock front. In contrast, for smaller diameter spheres acceleration was predominantly drag-dominated, with deceleration coinciding with the negative phase of the shock wave. The range of sphere sizes evaluated spanned the regime where acceleration was drag-dominated (for smaller spheres) to diffraction-dominated (for larger spheres) with a uniformly-applied shock wave profile having a strong decay with a six milliseconds positive phase duration. These characterizations are yielding great insight into scaling issues in laboratory experiments addressing human blast injuries as well as into the mechanisms that cause BOP TBI. By defining the scaled physical interactions of blast shock waves with test subjects, these findings when extended will provide valuable insights into biomechanical mechanisms underlying blast injuries in Service Members and associated mitigation measures.

1 VanAlbert, S. A., Ritzel, D. V., & Long, J. B. (2016). Blast Induced Motion from Diffraction-Phase Loading. Presented at the 24th International Symposium on Military Aspects of Blast and Shock (MABS24), Halifax NS, Canada.