Preclinical Models of Blast Injury

Blast-Induced Acceleration in a Shock Tube: Distinguishing Primary and Tertiary Blast Injury Mechanisms in Rat Traumatic Brain Injury

Discerning biomechanical underpinnings is crucial for an understanding of the etiology and mitigation of blast-induced traumatic brain injury (TBI). Scientists and engineers at the Walter Reed Army Institute of Research (Silver Spring, Maryland) are teaming with blast physics experts to examine the interplay of blast overpressure and accelerative forces using an Advanced Blast Simulator (ABS). The ABS is capable of producing high fidelity improvised explosive device-like blast waveforms in the laboratory. This undertaking involves understanding the role that parameters such as area density (the mass of an object divided by its projected two-dimensional area), play in the scaling of acceleration and displacement (i.e., 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. 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 (less than 150 microseconds) “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 shockwave. 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 shockwave profile having a strong decay with a six-millisecond 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 underlying blast overpressure TBI.

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