P79 Blast-Induced Motion and Scaling for Model Assessments of Blast Traumatic Brain Injury

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Abstract:

The air blast from improvised explosive devices (IEDs) has been speculated to inflict mild traumatic brain injury (mTBI) without overt signs of external wounding to the head. To properly investigate this matter, it is necessary to understand the biomechanics by which stress would be imparted to the brain; several mechanisms have been proposed including global acceleration of the head and skull flexure for example. The traditional use of animal models, especially rodents, for such injury assessments in neuroscience may be confounding outcomes and interpretations with respect to humans for several reasons including matters of scaling and the injury biomechanics. In this study blast-induced acceleration of objects is assessed using generic shapes as well as a rodent model in order to resolve scaling criterion. Experiments were conducted using Advanced Blast Simulators generating high-fidelity blast-wave conditions. Current semi-empirical methods for predicting blast-induced motion of objects show poor agreement with the experimental results, and it appears that when loading is dominated by the shock diffraction phase, as with most IED threats, a revised analysis is required which is discussed.

Further studies show that if the head is treated as a responding structure, such as a fluid-filled elastic shell rather than a rigid body, maximal internal stress conditions are imparted during the shock diffraction phase prior to onset of quasi-steady drag and detectable global motions. Therefore, apart from scaling tests for proper acceleration of models, the particular structural response dynamics of the skull/brain system appear critical to the injury outcome. Although preliminary, these results suggest animal models are unlikely to yield blast-induced brain stress conditions and consequent injuries directly analogous to that of humans. Despite such limitations animal models for blast TBI nevertheless remain indispensable for understanding relevant neurobiological phenomena and sensitivities to shock-wave exposures.

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