

Experimental and Computational approaches to explore the mechanisms of Blast-induced Brain injuries

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Warfighters and peacekeepers face continued blast threats from IEDs and landmines. Brain injuries resulting from blasts cause both short and long-term effects. The acute and chronic neurological, pathophysiological, and behavioral effects of single or repeated exposures to blasts are not known. We have combined an integrated approach of experiments and computations to answer these questions at New Jersey Institute of Technology. In the newly established Center for Injury Bio-Mechanics, Materials and Medicine we have developed experimental shock tubes that can produce field relevant shock loading conditions.

Different size shock tubes were carefully designed and built; the blast characteristics inside the tube are then validated against measurements in actual field blast testing. These validated primary blasts are then used to test on head forms, Post-Mortem Human Surrogates (cadavers), and a series of animal models (rodents and pigs). Precise stress measurements in PMHS and animal models show sharp pressure pulses in the front and diffuse pulses throughout the brain. Histological and immune-histo-chemical and proteomic measurements show blood-brain barrier damage and neuronal plasma permeability in different regions of brain. Based on mortality, a dose-response curve has been developed that relates peak overpressure (and hence different explosive strengths) to injury. Based on MRI/CT data on human beings and animal models, anatomically accurate geometric models as well as 3D finite element models have been built. The numerical model is then validated based on experimental data available in literature. Based on this integrated approach role of blasts in brain injury mechanisms and how best to protect against injury are explored.