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Multiscale Model of Blast Explosion Human Injury Biomechanics

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Abstract : Bomb blasts from Improvised Explosive Devices (IEDs) account for vast majority of terrorist attacks worldwide. Injuries caused by IEDs result from a combination of the primary blast wave, penetrating fragments, and human body accelerations and impacts. This paper presents a multiscale computational model of coupled blast physics, whole human body biodynamics and injury biomechanics of sensitive organs. The disparity of the involved space- and time-scales is used to conduct sequential modeling of an IED explosion event, CFD simulation of blast loads on the human body and FEM modeling of body biodynamics and injury biomechanics. The paper presents simulation results for blast-induced brain injury coupling macro-scale brain biomechanics and micro-scale response of sensitive neuro-axonal structures. Validation results on animal models and physical surrogates are discussed. Results of our model can be used to 'replicate' filed blast loadings in laboratory controlled experiments using animal models and in vitro neuro-cultures.

Keywords : blast waves, improvised explosive devices, injury biomechanics, mathematical models, traumatic brain injury
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