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NUMERICAL MODELS FOR INVESTIGATION OF BLAST WAVE TRAUMATIC BRAIN INJURY AND MODEL VALIDATIONS

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The modeling of human body biomechanics is very challenging because of the complex geometry and the substantial material heterogeneity in the human body. We developed a detailed human body finite element model (FEM) which represents both the geometry and the material realistically. The human body model was used to predict the biomechanical response when the blast wave impacts the human body ([1]). The blast loading on the external human body surface was generated from the simulated C4 explosions, via a novel combination of 1-D and 3-D computational fluid dynamics (CFD) formulations. The developed explicit solvers for both FEM and CFD systems are highly scalable and capable of solving large systems. The coupled gas dynamics and biomechanics solution approach has been validated against the recent shock tube testing data on the physical phantom and small animals ([2]). Under the same blast loading we show the difference in brain response when having different material properties for the skeleton, and the importance of inclusion of other body parts such as torso. To seek the long-term kinematic response of a human to the blast loading effectively, we also developed an anatomy-based articulated human model ([3,4]). The model was calibrated by comparing its response with those obtained from the post mortem human surrogates (PMHS) tests. The parametric study was carried out to find out effects of environmental obstacles, personal protective equipment (PPE), and fragment loading on the human body kinematic response. The implications of these results suggest that the developed virtual models could be used to predict the human biomechanical responses in the blast event, and help design the protection against the blast wave induced TBI.

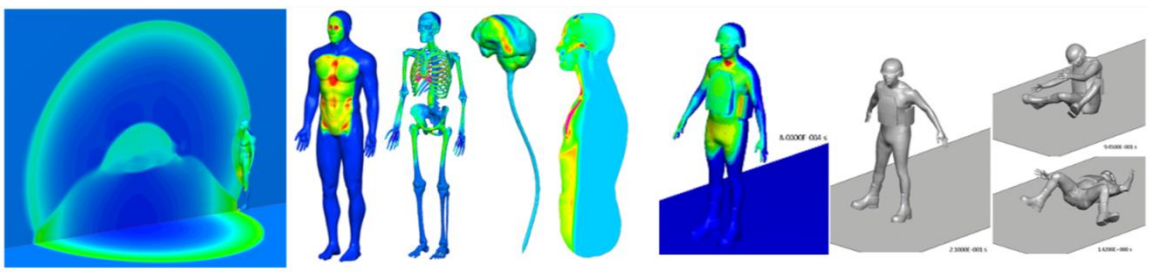

Figure 1. Left: Simulations of human body under C4 explosion and blast wave induced biomechanics ([1]); Right: Articulated human body dynamics of human body with PPE under blast and fragment loadings ([3,4]).

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