Modeling and Simulation of the High Strain-Rate Response of Brain Tissue for Traumatic Brain Injury Applications

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ABSTRACT

The prediction of traumatic brain injury (TBI) is of great importance for the development of protective systems and treatment approaches. This is an inherently multidisciplinary problem that requires accurate modeling and simulation of the loads, geometry and material response of the various components that make up the brain. The main goal of this work is to model and simulate the high strain-rate response of brain tissue. We propose a viscohyperelastic constitutive model for brain tissue, based on the data published in the literature for strain rates up to 3000% s^{-1}. This new constitutive model is able to accurately capture the response of brain tissue for strains up to 40%. A detailed anatomical representation of human head, including brain, skull and cerebrospinal fluid (CSF), is developed from MRI scans. Interactions between brain tissue, CSF and skull during injury conditions are defined and all this knowledge is combined to carry out a detailed finite element simulation using the commercial FEA solver LS DYNA. The response of the head to various conditions such as frontal and lateral impacts is studied. The talk will address current challenges and opportunities in TBI simulations, discuss details of the proposed viscohyperelastic material model, and present preliminary results from simulations.