Traumatic Brain Injury, and the Dynamics of the Live Human Brain

K.T. Ramesh

Decker Professor of Science & Engineering
Director, Hopkins Extreme Materials Institute
The Johns Hopkins University

ABSTRACT

This webinar provides an overview of the dynamics of the living human brain when subjected to impacts or accelerations, with a view to developing insight into traumatic brain injury. Our interest is in injuries arising from sports and defense environments, and in developing a model that is validated using live human brains.

We begin by discussing the anatomy of the human brain and the properties of human brain tissue (the latter is an area that is in need of high-quality experimental data). We then discuss a computational approach (the Hopkins Head) that integrates information on the events that cause TBI with high-fidelity models of the anatomy and physiology of the living human brain. We develop an anatomically accurate, subject-specific, three-dimensional (3D) computational model of the human brain, including detailed morphology using magnetic resonance imaging (MRI), some material properties using magnetic resonance elastography, and orientation of white matter fibers using diffusion tensor imaging (DTI).

Subject-specific full-field motions in live human brains are used to validate the models, with the data obtained through tagged MRI. A representative subject-specific head model is then used to simulate events that result in injury. The results suggest that the rotational dynamics of the brain has a specific timescale, and that some anatomical features of the human head are particularly important during some dynamic loading conditions.

K.T. Ramesh is the Alonzo G. Decker Jr. Professor of Science & Engineering at Johns Hopkins University. His research interests are in the physics of dynamic failure, impact biomechanics, and planetary scale impact problems. He received his doctorate from Brown University in 1987, and after a short stint as a postdoctoral fellow at the University of California, San Diego, he joined the Department of Mechanical Engineering at Johns Hopkins in 1988. He was Department Chair from 1999-2002 and became the founding Director of the Hopkins Extreme Materials Institute (HEMI) in 2012.