Imaging of Dynamic Brain Deformation *In Vivo* for Development and Evaluation of Brain Biomechanics Models

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ABSTRACT

Traumatic brain injury (TBI) is caused by the rapid deformation of brain tissue that occurs in response to head impact or acceleration. Mathematical modeling and numerical simulation of brain biomechanics promise to illuminate the mechanisms of TBI, and hasten the development of strategies for prevention or treatment. However, mathematical models are useful only if they satisfy two conditions. First, models must accurately represent both (a) the constitutive properties of brain tissue, and (b) the interactions of the brain with the skull. Second, the accuracy of mathematical models must be evaluated by direct comparison to experimental measurements relevant to injury, such as strains induced by head acceleration. Strains should ideally be measured with high resolution in the intact brain, *in vivo*, in order to reflect actual constitutive properties and interfacial interactions. Many brain biomechanics models have been evaluated by comparing predictions to sparse measurements of intracranial pressure (1) or displacement (2) in cadaver studies. More recently, emerging imaging technologies have provided improved, richer and more relevant data sets for evaluating the accuracy of brain biomechanics simulations. In particular magnetic resonance imaging (MRI) techniques, such as MR elastography (3) and tagged MRI (4), provide high-resolution, full-field, 3D displacement and strain measurements in the intact, living brain. In combination with appropriate image analysis tools and mathematical models, these imaging techniques promise to extend our understanding of brain biomechanics and improve our ability to study TBI *in silico*.

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