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Neuro-mechanics of hydrocephalus

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Hydrocephalus is a serious neurological disease caused by an interruption to the normal flow of the cerebrospinal fluid (CSF) inside the brain, resulting in an excessive accumulation of CSF in the brain's ventricles, brain compression and sometimes an increase in the intracranial pressure. The treatment is surgical in nature and continues to have poor outcomes. An important step in the design of better therapy protocols for hydrocephalus is the development of predictive mathematical models that better explain the fundamental science behind this clinical condition. In this talk, the author will review some mathematical models of brain neuro-mechanics and corresponding numerical solvers that the author and her collaborators developed for predicting the onset and evolution of hydrocephalus. More precisely, author will present the following results: 1). A quasi-linear viscoelastic constitutive law for brain tissue can predict treatment outcomes similar to reported clinical data; 2). A non-linear hyper-elastic constitutive law for the brain tissue indicates that once a threshold for the intracranial pressure is reached the natural pulsations of brain could contribute to the development of hydrocephalus; 3). A triphasic model of the brain tissue suggests that normal pressure hydrocephalus could be caused by an imbalance in the salt concentration in the absence of an elevated intracranial pressure; 4). A fluid-structure interaction approach using the immersed finite element method shows that the CSF viscosity could play an essential role in treatment outcomes.

Biography

Corina S Drapaca is an Assistant Professor in the Department of Engineering Science and Mechanics at Pennsylvania State University since fall 2007. She has received her PhD degree in Applied Mathematics from the University of Waterloo, Canada, in 2002 and held post-doctoral fellowships in the Department of Radiology, University of California, San Francisco, the Department of Applied Mathematics, University of Waterloo, and the Department of Physiology and Biomedical Engineering, Mayo Clinic, Rochester. She is a specialist in theoretical and computational mechanics, medical image analysis, and has particular interest in modeling brain diseases such as hydrocephalus, Chiari malformations, and brain tumors.

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