The Identification of the Constitutive Model Parameters of White Matter of Brain Tissue

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Abstract

As one of the most critical parts in the human's body, the brain tissue is easily damaged in accidents. An accurate description of the constitutive relationship of brain tissue is required to study the injury mechanism and develop effective protective approaches. Normally, Extensive researches only considered the hyper-elastic property of brain tissue, but ignored the viscoelastic property. And there is a big difference for the material parameter values in different literatures. Therefore, in order to determine the constitutive parameters of white matter of brain tissue, this paper presents a computational inverse technique based on unconfined uniaxial compression tests, which comprehensively consider the hyper-elastic and viscoelastic. Firstly, through the application of micro CT, the complex geometry of special specimens are scanned to establish Finite Element Model (FEM). Then, the unconfined uniaxial compression tests are performed under the given velocity to measure the force-time curve. Consequently, the constitutive model parameters can be identified by minimizing error functions of the compressive force curve measured in experiments and that computed in simulation. To determine the inverse objectives, sensitivity analysis is employed to evaluate the importance of constitutive model parameters. Finally, genetic algorithm (GA) as the inverse solver is applied to search the optimal solution. Meanwhile, by comparing with the experiment measurement of other specimen, the numerical computation with the identified parameters is obtained to validate the correct and reasonability of the inversed results for write matter of brain tissue.

Keywords: Brain tissue, White matter, Constitutive model parameter, Hyper-elastic and viscoelastic, Computational inverse technique, Unconfined compression test