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Dynamic Behavior of Brain Tissue under Transient Loading

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Abstract : In this paper, an analytical study is made for the dynamic behavior of human brain tissue under transient loading. In this analytical model the Mooney-Rivlin constitutive law is coupled with visco-elastic constitutive equations to take into account both the nonlinear and time-dependent mechanical behavior of brain tissue. Five ordinary differential equations representing the relationships of five main parameters (radial stress, circumferential stress, radial strain, circumferential strain, and particle velocity) are obtained by using the characteristic method to transform five partial differential equations (two continuity equations, one motion equation, and two constitutive equations). Analytical expressions of the attenuation properties for spherical wave in brain tissue are analytically derived. Numerical results are obtained based on the five ordinary differential equations. The mechanical responses (particle velocity and stress) of brain are compared at different radii including 5, 6, 10, 15 and 25 mm under four different input conditions. The results illustrate that loading curves types of the particle velocity significantly influences the stress in brain tissue. The understanding of the influence by the input loading cures can be used to reduce the potentially injury to brain under head impact by designing protective structures to control the loading curves types.

Keywords : analytical method, mechanical responses, spherical wave propagation, traumatic brain injury
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