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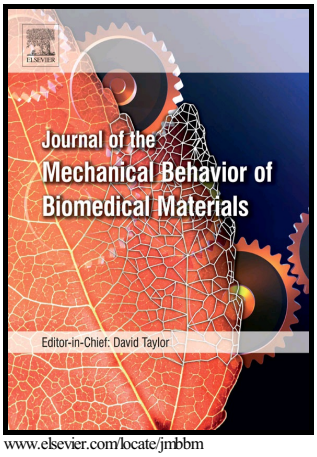

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Influence of strain rate on indentation response of porcine brain

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Abstract

Knowledge of brain tissue mechanical properties may be critical for formulating hypotheses about some specific diseases mechanisms and its accurate simulations such as traumatic brain injury (TBI) and tumor growth. Compared to traditional tests (e.g. tensile and compression), indentation shows superiority by virtue of its pinpoint and nondestructive/quasi-nondestructive. As a viscoelastic material, the properties of brain tissue depend on the strain rate by definition. However most efforts focus on the aspect of velocity in the field of brain indentation, rather than strain rate. The influence of strain rate on indentation response of brain tissue is taken little attention. Further, by comparing different results from literatures, it is also obvious that strain rate rather than velocity is more appropriate to characterize mechanical properties of brain. In this paper, to systematically characterize the influence of strain rate, a series of indentation-relaxation tests (n = 210) are performed on the cortex of porcine brain using a custom-designed indentation device. The mechanical response that correlates with indenter diameters, depths of indentation and velocities, is revealed for the indentation portion, and elastic behavior of brain tissue is analyzed as the function of strain rate. Similarly, a linear viscoelastic model with a Prony series is employed for the indentation-relaxation portion, wherein the brain tissue shows more viscous and responds more quickly with increasing strain rate. Understanding the effect of strain rate on mechanical properties of brain indentation may be far-reaching for brain injury biomechanics and accurate simulations, but be important for bridging between indentation results of different literatures.

Graphical abstract

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