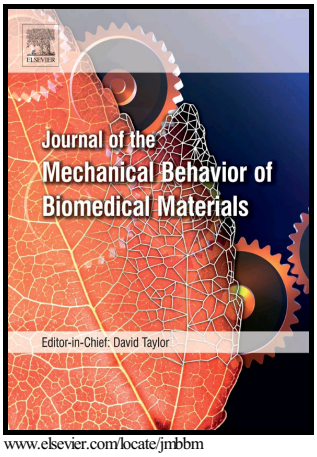
Experimental research of mechanical behavior of porcine brain tissue under rotational shear stress

Gang Li, Jianhua Zhang, Kan Wang, Mingyu Wang, Changqing Gao, Chao Ma



www.elsevier.com/locate/jmbbm

PII: S1751-6161(15)00464-6
DOI: http://dx.doi.org/10.1016/j.jmbbm.2015.12.002
Reference: JMBBM1714

To appear in: *Journal of the Mechanical Behavior of Biomedical Materials*

Received date: 3 June 2015
Revised date: 24 November 2015
Accepted date: 3 December 2015

Cite this article as: Gang Li, Jianhua Zhang, Kan Wang, Mingyu Wang, Changqing Gao and Chao Ma, Experimental research of mechanical behavior o porcine brain tissue under rotational shear stress, *Journal of the Mechanica Behavior of Biomedical Materials* http://dx.doi.org/10.1016/j.jmbbm.2015.12.002

Experimental research of mechanical behavior of porcine brain tissue under rotational shear stress

Gang Li, Jianhua Zhang*, Kan Wang, Mingyu Wang, Changqing Gao, Chao Ma

Key Laboratory of High Efficiency and Clean Mechanical Manufacture, Ministry of Education of China, School of Mechanical Engineering, Shandong University, Jinan, China

*Corresponding author. Tel.:+86 18854168635; fax: +86 0531 88392329; 17923 Jingshi Road, School of Mechanical Engineering, Shandong University, Jinan, 250061, China.

E-mail addresses: ligangsdu@foxmail.com (G. Li), jhzhang@sdu.edu.cn (J. Zhang), wangkan199109@163.com (K. Wang), mingyuwangsdu@hotmail.com (M. Wang), gaochangqing666@126.com (C. Gao), symachao10@163.com (C. Ma).

Abstract

The objective of this paper is to investigate mechanical behavior of porcine brain tissue with a series of rotational shear stress control experiments. To this end, several experiments including stress sweep tests, frequency sweep tests and quasi-static creep tests were designed and conducted with a standard rheometer (HAAKE RheoStress6000). The effects of the loading stress rates to mechanical properties of brain tissue were also studied in stress sweep tests. The results of stress sweep tests performed on the same brain showed that brain tissue had an obvious regional inhomogeneity and the mechanical damage occurred at the rotational shear stress of 10-15 Pa. The experimental data from three different loading stress rates demonstrated that the mechanical behavior of porcine brain tissue was loading stress rate dependent. With the decrease of loading stress rate, a stiffer mechanical characteristic of brain tissue was observed and the occurrence of mechanical damage can be delayed to a higher stress. From the results of frequency sweep tests we found that brain tissue had almost completely elastic properties at high frequency area. The nonlinear creep response under the rotational shear stress of 1, 3, 5, 7 and 9 Pa was shown in results of creep tests. A new nonlinear viscoelastic solid model was proposed for creep tests and matched well with the test data. Considering the regional differences, loading stress rates and test conditions effects, loss tangent tan δ in porcine brain tissue showed a high uniformity of 0.25-0.45.

Keywords: Brain tissue mechanics, rotational shear stress, loading stress rate, nonlinear viscoelasticity