MCB, vol.16, supplemental 1, pp.9-10, 2019

An Analytical Investigation of *in Vivo* Mechanical References for Mechanobiological Experiments of Vascular Cells

Shaoxiong Yang[1], Xiaobo Gong[1,*], Yingxin Qi[2] and Zonglai Jiang[2]

Abstract: Blood vessels interact with their mechanical environments in a comprehensive way. Local mechanical stimuli outside the biological range play important roles in various human cardiovascular diseases. Although many mechanobiological studies of endothelial cells (ECs) and vascular smooth muscle cells (VSMCs) *in vitro* have been reported in mimicking cellular dysfunctions, their quantitative correlations to the in vivo vascular conditions remain unclear. In order to interpret the stress-modulated dysfunctions of vascular cells and explore the key mechanical factors in vascular diseases, it is important to investigate the mechanical environments of vessel walls *in vivo* under various physiological conditions. Based on nonlinear continuum mechanics, we analyzed the variations of the mechanical stress, strain, and wall stiffness in human blood vessels at different blood pressures. We adopted nine middle-aged arteries located at different physiological sites for stress analysis including three aortas (ascending thoracic, descending thoracic, and abdominal), and five arterial branches (common iliac, femoropopliteal, subclavian, common carotid, and renal, and left anterior descending coronary artery). The femoropopliteal arteries aged from 11 years to 70 years were also adopted for investigating the aging effects. It is found that 1) the vascular cells experience various mechanical stimuli along the arterial tree; 2) the intima and adventitia exhibit distinct variations in stress and strain during the femoropopliteal artery aging; and 3) the magnitude of wall stiffness seems to depend on the arterial locations rather than aging. Although it is reported that stress concentration usually occurs in intima causing EC dysfunctions, our results suggest that the adventitia is more likely to bear high stresses in middle-aged aortas and aged femoropopliteal arteries, triggering the vascular inflammation. We conclude that the mechanical niches of vascular cells strongly depend on the physiological site and aging process. The present results contribute to a better understanding of the mechanical environments in vessel walls, which could serve as a reference for studying the vascular cell mechano-transduction.

Keywords: Mechanical stress and strain, wall stiffness, arterial location, aging, vascular mechanobiology.

[1] Key Laboratory of Hydrodynamics (Ministry of Education), Department of Engineering Mechanics, School of Naval Architecture, Ocean and Civil Engineering, Shanghai Jiao Tong University, Shanghai, 200240, China.

[2] Institute of Mechanobiology and Biomedical Engineering, School of Life Sciences and Biotechnology, Shanghai Jiao Tong University, Shanghai, 200240, China.

[*] Corresponding Author: Xiaobo Gong. Email: x.gong@sjtu.edu.cn.

Acknowledgement: This work was supported by the National Natural Science Foundation of China (Grants 11872040 and 11232010).

Dr. Xiaobo Gong is an Associate Professor and PhD supervisor in the Department of Engineering Mechanics of Shanghai Jiao Tong University. He is now serving as the board member of the Biomechanical Branch Committee of China National Society of Mechanics, Chief Board Member of the Shanghai Biophysical Society, and the Vice Dean of the Department of Engineering Mechanics of Shanghai Jiao Tong University. His research interests focus on the biofluid mechanics, microfluidics and cell mechanics. He was awarded with grant supports from National Natural Science Foundation, and National Key Research Program of China. He has published over 30 peer reviewed journal papers including PNAS, Journal of Fluid Mechanics, Journal of Computational Physics.