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Evaluating the effect of stenosis increase and pulsatile blood pressure on effective stress distribution in viscoelastic finite element model based on carotid artery ultrasound images

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Abstract

The aim of this study is to evaluate the changes of effective stress distribution in plaque by progressing to the stenosis throat and to assess the pulsatile pulse pressure effect on effective stress of a viscoelastic finite-element model of carotid arteries having less and more than 50% stenosis. In-vivo geometries of the arteries were reconstructed using consecutive transverse ultrasound images. Pulse pressure waveform exerted on the artery walls and Kelvin viscoelastic model parameters were extracted from consecutive longitudinal ultrasound image processing. According to the results of this study, the effective stress applied to the mild stenotic plaque decreases with progression to the throat and there after increases again. However, in more than 50% stenosis, thickness of the layer between the plaque component and artery lumen determines the trend of effective stress exerted on different sites of the plaque. Moreover, results showed that regardless of extremum effective stress locations in different cross-sections, maximum differences between the extremum effective stresses of different cross-sections accure in systole whilst in the beginning and end parts of the cardiac cycle differences are not considerable. It seems that this viscoelastic model can be used for accurate evaluation of stress distribution during the atherosclerotic stenosis progress.

Keywords: Ultrasounic horn, Microstreaming, Acoustic pressure, Measurment.

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