World Academy of Science, Engineering and Technology
International Journal of Bioengineering and Life Sciences
Vol:16, No:08, 2022

Geometrical Analysis of an Atheroma Plaque in Left Anterior Descending Coronary Artery

Authors : Sohrab Jafarpour, Hamed Farokhi, Mohammad Rahmati, Alireza Gholipour

Abstract : In the current study, a nonlinear fluid-structure interaction (FSI) biomechanical model of atherosclerosis in the left anterior descending (LAD) coronary artery is developed to perform a detailed sensitivity analysis of the geometrical features of an atheroma plaque. In the development of the numerical model, first, a 3D geometry of the diseased artery is developed based on patient-specific dimensions obtained from the experimental studies. The geometry includes four influential geometric characteristics: stenosis ratio, plaque shoulder-length, fibrous cap thickness, and eccentricity intensity. Then, a suitable strain energy density function (SEDF) is proposed based on the detailed material stability analysis to accurately model the hyperelasticity of the arterial walls. The time-varying inlet velocity and outlet pressure profiles are adopted from experimental measurements to incorporate the pulsatile nature of the blood flow. In addition, a computationally efficient type of structural boundary condition is imposed on the arterial walls. Finally, a non-Newtonian viscosity model is implemented to model the shear-thinning behaviour of the blood flow. According to the results, the structural responses in terms of the maximum principal stress (MPS) are affected more compared to the fluid responses in terms of wall shear stress (WSS) as the geometrical characteristics are varying. The extent of these changes is critical in the vulnerability assessment of an atheroma plaque.

Keywords : atherosclerosis, fluid-Structure interaction modeling, material stability analysis, and nonlinear biomechanics
Conference Title : ICBM 2022 : International Conference on Biomechanics and Modeling
Conference Location : Barcelona, Spain
Conference Dates : August 16-17, 2022