On the fluid-structure interaction modeling of atherosclerosis

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Abstract

Fluid-structure interaction (FSI) occurs when fluid flow causes deformation of the struc- ture. This deformation, in turn, changes the geometry of the fluid flow. In the first part of the study we investigate the effects of the interaction of blood flow with the arterial wall and atherosclerotic plaque. To model this we introduce the generalized Navier-Stokes equa- tions reformulated to describe the non-Newtonian blood behavior. Being a non standard formulation, we carry out a well posedness analysis, providing an existence result for the evolutionary case. Moreover blood flow interacts mechanically with the vessel wall. A FSI model where interactions between the fluid (blood) and structures (the arterial wall and atheromatous plaque) are governed by the Arbitrary Lagrangian Eulerian (ALE) method for the numerical simulations.
Monocytes play a significant role in the development of atherosclerosis. During the process of inflammation, monocytes that circulate in the blood stream are activated. Upon activation, they adhere to the endothelium and extravasate through the latter to migrate into the intima. In the second part, we investigate the interaction of one monocytic cell with the blood flow and with endothelial cells. A computational model using FSI is presented to investigate the physical motion of a recruited monocyte inside the artery.

Keywords: atherosclerosis, fluid-structure interaction, blood flow, monocytes.

References

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