Dokumenttyp: Zeitschriftenaufsatz


Titel des Beitrags: A Multiphysics Approach for Modeling Early Atherosclerosis

Abstract: This work is devoted to the development of a mathematical model of the early stages of atherosclerosis incorporating processes of all time scales of the disease and to show their interactions. The cardiovascular mechanics is modeled by a fluid-structure interaction approach coupling a non-Newtonian fluid to a hyperelastic solid undergoing anisotropic growth and a change of its constitutive equation. Additionally, the transport of low-density lipoproteins and its penetration through the endothelium is considered by a coupled set of advection-diffusion-reaction equations. Thereby, the permeability of the endothelium is wall-shear stress modulated resulting in a locally varying accumulation of foam cells triggering a novel growth and remodeling formulation. The model is calibrated and applied to a murinespecific case study and a qualitative validation of the computational results is performed. The model is utilized to further investigate the influence of the pulsatile blood flow and the compliance of the artery wall to the atherosclerotic process. The computational results imply that the pulsatile blood flow is crucial, whereas the compliance of the aorta has only a minor influence on atherosclerosis. Further, it is shown that the novel model is capable to produce a narrowing of the vessel lumen inducing an adaption of the