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MODELING OF PLAQUE PROGRESSION IN THE CORONARY ARTERIES

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Atherosclerosis is a progressive disease characterized by inflammation, monocyte-macrophage migration, and lipid accumulation in the vascular wall.
In this study we analysed group of 28 patients where we compared with CT our computer model of the plaque size for three groups of patients: de-novo, old-lesions and control patients. Boundary conditions for de-novo patients are zero plaque size at all location and starting simulation for corresponding time for follow-up. The 3D blood flow is governed by the Navier-Stokes equations, together with the continuity equation. Mass transfer within the blood lumen and through the arterial wall is coupled with the blood flow and is modeled by the convection-diffusion equation. LDL transport in lumen of the vessel is described by Kedem-Katchalsky equations. The inflammatory process is solved using three additional reaction-diffusion partial differential equations. We included in our 3D model fitting parameters with ODE and PDE system. For patients models we used ICAM for coronary arteries, LDL, Cholesterol/HDL, WSS [1-2].
It can be seen that computer simulated values for plaque area in the different cross-sections are close to the measurements with multi slice CT. Shear stress distributions for baseline and follow-up for these patients are given. Location of low WSS mostly denotes the plaque position. A good trend for plaque location and size can be found.
Determination of plaque location and progression in time for a specific patient shows a potential benefit for future prediction of this vascular decease using computer simulation.

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