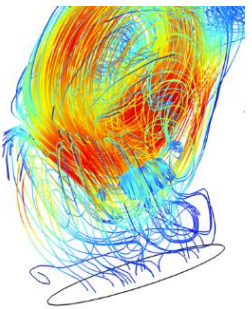
Comparison Of Newtonian And Non-Newtonian Blood Flow In Ascending Aortic Aneurysm

A Petuchova, A Maknickas

Vilnius Gediminas Technical University
Vilnius, Lithuania



Velocity streamlines in ascending aortic aneurysm during systole with non-Newtonian modeling

Aims: The aim of this work is to perform a numerical study of aortic hemodynamics and to evaluate the parameters of the ascending aortic aneurysm when blood is modeled as a non-Newtonian fluid and a Newtonian fluid using COMSOL software.

Methods: The ascending aorta model was constructed from a medical CT image. The finite element method laminar blood flow modelling of six cardiac cycles was performed at different blood parameters. Navier-Stokes equations for an incompressible fluid were used to simulate blood flow in the CFD tool.

The inflow boundary conditions were a flow waveform that approximates the systolic and diastolic phases. The outflow boundary conditions were set as pressure at each outlet that varies with time as a function. The first solution was calculated by considering blood as a Newtonian fluid, in the second solution, blood was assumed to be a non-Newtonian fluid using the Carreau model.

Results: The results showed that the highest blood flow velocities were 0.806 m/s in the aorta model with Newtonian fluid and 0.820 m/s in the non-Newtonian during systole. There were changes in the blood velocity streamlines during diastole. The distribution of the wall shear stress (WSS) plot on the aneurysm surface showed changes: In the non-Newtonian simulation, the systolic WSS values were 0.3 Pa, Newtonian values were 0.2 Pa. Highest time-average one cycle WSS values were 2 Pa for both non-Newtonian and Newtonian cases.

Conclusions: According to investigation of two types of fluids as Newtonian and non-Newtonian, the general conclusions were made: the average systolic velocities and diastolic velocities were 2% and 9% higher in the non-Newtonian fluid. The WSS values at the aneurysm surface were higher 30% in non-Newtonian simulation during systole and the average WSS at the surface of the artery in diastole was 20% higher in Newtonian fluid.