

Abstract: Time-dependent and three-dimensional flow of Newtonian fluid is studied in context of two biomechanical applications, flow in cerebral aneurysms and flow in stenotic valves.

In the first part of the thesis, the computational meshes obtained from the medical imaging techniques are used for the computation of hemodynamic parameters associated with the rupture potency of the cerebral aneurysms. The main result is the computation within twenty geometries of aneurysms. It is shown that the aneurysm size has more important role in wall shear stress distribution than the fact whether the aneurysm is ruptured or unruptured.

The second part of the thesis is addressed to the flow in stenotic valves. It is shown that the method currently used in medical practice is based on assumptions which are too restrictive to be apply to blood flow in the real case. The full continuum mechanics model is presented with physiologically relevant boundary conditions and it is shown that results are consistent with measured data obtained from literature.

Then we focus on the obtaining the pressure field from the velocity field. The presented method provides more accurate pressure approximation than commonly used Pressure Poisson Equation. The last chapter of the thesis is dedicated to Nitsche's method for treating slip boundary condition. The numerical results are presented in comparison to the flow with no-slip boundary condition and the differences are significant.