This thesis is motivated by a problem of cerebral aneurysms, which are abnormal bulges on the arteries which supply blood for our brain. These
aneurysms can rupture and cause death or permanent neurological deficits. To study the evolution of aneurysms and assess the risk of rupture,
mathematical modelling might be used to compute otherwise unobtainable information about blood flow inside the aneurysm. For this reason it is
essential to be able to model blood flow in sufficiently high resolution. A goal of this thesis was to implement standard projection method for the solution of
unsteady incompressible Navier-Stokes equations using the free finite element software FEniCS to create a working code adjusted to the need of
this particular application. The incremental pressure correction scheme was chosen. Various shortcomings of this method are described and a proper
choice of boundary conditions and other implementation issues are discussed. A comparison of computed important hemodynamic indicator wall shear stress using
new and previously used solution approach are compared. A test of the new code for parallel efficiency and performance on finer meshes for a real
medical case was conducted.