A computational study of the blood flow in cerebral aneurysms

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ABSTRACT

The scope of the present student thesis is the computational study of the blood flow in a cerebral aneurysm geometry, using the open-source software OpenFOAM. The developments in the field of computational mechanics at the end of the last century, together with the simultaneous rapid increase in computer power, led many engineers to study problems of medical interest, aiming to produce useful diagnostic tools and provide realistic solutions. This study aims to create a trustworthy tool for applications in aneurysms and in general, in geometries of the cardiovascular system, such as the carotid artery branches and arteriovenous malformations. A real aneurysm geometry was extracted from an electronic repository. In order to conduct a realistic study, pulsatile flow was introduced as an inlet boundary condition in the middle cerebral artery, based on bibliographic data. At the same time. laminar and non-newtonian flow is used, as it is recommended for arteries with small diameters, such as the cerebral ones. After a detailed analysis of OpenFOAM functionality and the selection of the appropriate parameters for the nature of our problem, a mesh independence study was carried out using the simpleFoam solver, to determine the appropriate mesh. The final results are obtained by performing the pisoFoam solver and thus we receive necessary hemodynamic quantities, such as velocity and pressure profiles and more importantly, the wall shear stress distribution. The wall shear stress is a critical parameter, as it is one of the mechanisms that contributes to the rupture of the aneurysm, and therefore can act as a predictor.

Key words

OpenFOAM, CFD, hemodynamics, aneurysm, WSS