INVESTIGATION OF THE FLOW FIELD IN AN ARTERY WITH DOUBLE STENOSIS

A. Romeos, A. Giannadakis, A. Vouros, N. Tsoni, Th. Panidis., K. Perrakis
Laboratory of Applied Thermodynamics, Mechanical Engineering & Aeronautics Department, University of Patras, Rio, Greece

Introduction

Blood flow dynamics play an important role in atherosclerosis initiation, plaque rupture and thrombosis, which consequently can lead to heart or brain stroke [Ku, 1997]. In the present study, experimental and numerical evidence of the steady and pulsating flow field of an artery with a double stenosis of 75% occlusions are reported. The influence of the stenoses on the formation of recirculation zones and the development of shear stresses in the artery is discussed.

Methods

A transparent Plexiglas test model of 24 mm diameter was used in the experiments (figure 1). Each stenosis was simulated by sinusoidal narrowed sections. The distance between the stenoses could also be adjusted. The working fluid was a water-glycerin mixture, seeded with ~50μm glass-sphere particles, which circulated through the pipe line by a pulsative pump. Measurements were conducted using 2D DPIV.
A computational model has been designed to simulate the blood flow through the artery, based on the open-source CFD (Computational Fluid Dynamics) code OpenFoam. Simulations are performed for steady and pulsating flow. Turbulent models and wall functions were evaluated, in order to reveal the flow separation and the formation of recirculation zones past the stenoses.

Results and Discussion

A view of the mean flow field and the velocity vectors through the first stenosis are presented in figure 2.

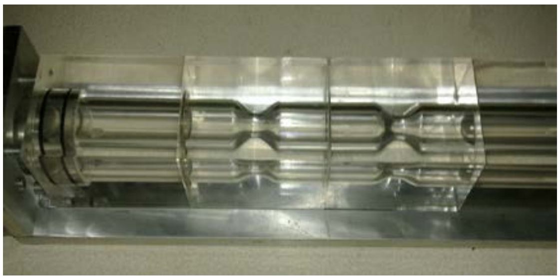

Figure 1: Artery test model

The smooth contraction results to the acceleration of the fluid and the formation of recirculation zones past the stenoses [Giannadakis, 2011]. The formation of these zones is responsible for the presence of stagnant flow regions, where lipids and additional substances deposit on the artery walls [Tarbell, 2003]. The mean flow field as it is predicted by the computational simulations for the steady flow is presented in figure 3.

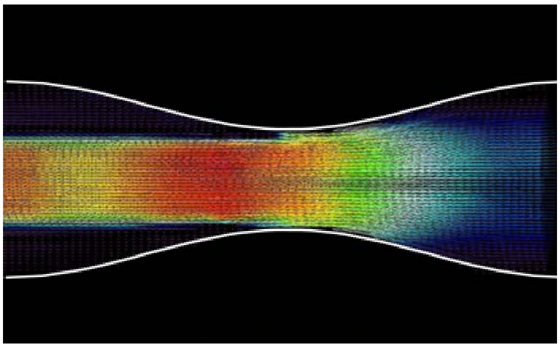

Figure 2: Vector map and mean axial velocity through the first stenosis.

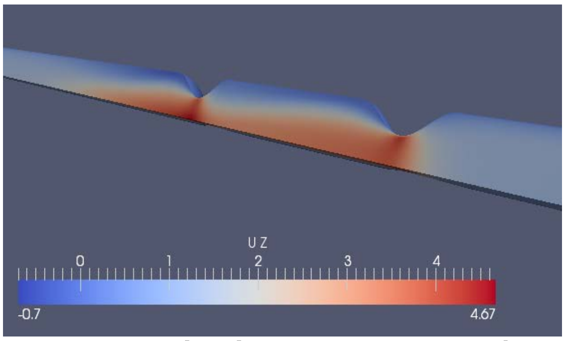

Figure 3: Predicted mean streamwise velocity contrours on the plane of symmetry.

Acknowledgment

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References

Ku D.N., Annu. Rev. Fluid Mech., 29:399–434, 1997
Tarbell J.M., Annu. Rev. Biomed. Eng., 5:79–118, 2003.
Giannadakis A. *et. al*., 10th IEEE International Workshop of Biomedical Engineering, 2011.