EXPERIMENTAL INVESTIGATION OF THE NON-NEWTONIAN FLOW INSIDE A STENTED CORONARY VESSEL

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Introduction

Inserting a stent structure into a coronary blood vessel nowadays is a standard procedure to open the blocked vessel and to cure a coronary thrombosis. However many patients suffer from a restenosis, a post operative closure of the vessel (Mitra 2006). Experimental studies have identified the importance of the wall shear stress as one critical parameter for the unwanted growth of the neointimal tissue (Malek 1999). Our investigation will clarify the role of the restructured flow inside the vessel after the stent implantation which alters the wall shear stress and subsequently increases the risk of a restenosis.

Method

A non-Newtonian flow with a refractive index matching fluid through a transparent 1:1 scale stent model was generated using a micro pump. The flow was seeded and observed through a Leica Microscope by a double frame interline CCD camera. The double images of the fluorescent seeding particles were evaluated using a particle tracking algorithm resulting in a 2D velocity vector field. To extend the range of tolerable particle displacements the measurements were repeated using multiple double frame separation times.

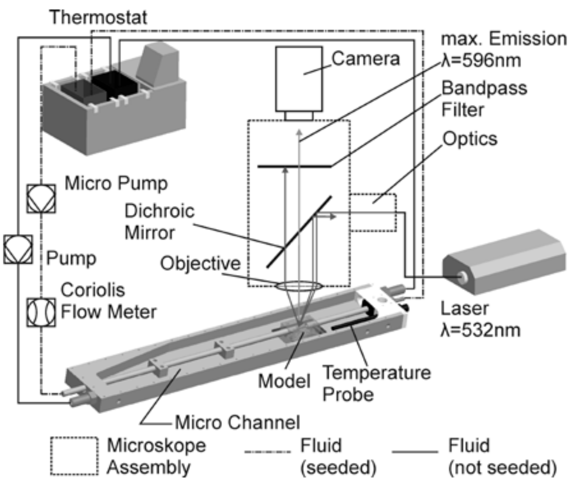

Figure 1: Experimental Setup for µPTV

Results & Discussion

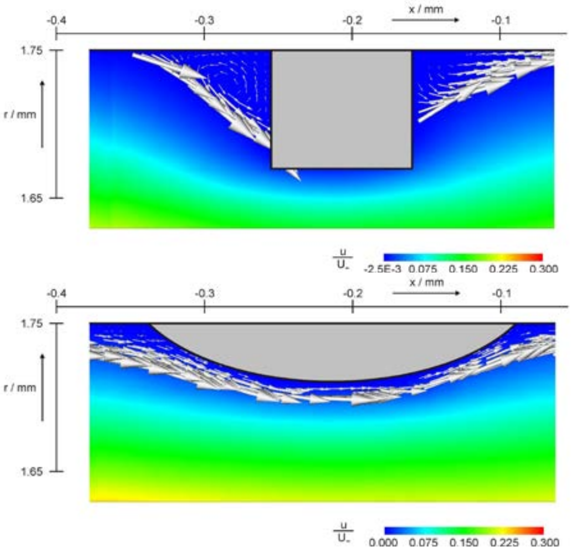

Figure 2: Velocity field (vectors), u-velocity magnitude (color) near two stent strut models

Depending on the size and the shape of the strut geometry recirculation zones are found up- and downstream of the struts (Fig. 2). The resulting wall shear stress (Fig. 3) shows either large areas of critically low values of 0.5 Pa and below for a flow with pronounced recirculation zones or small areas with critical wall shear stress for almost separation-free flow in the case of circular strut cross sections. In a future stent design, the shape of the struts will have to be selected accordingly to minimize the size of regions of critical wall shear stress to reduce the risk of an in stent restenosis.

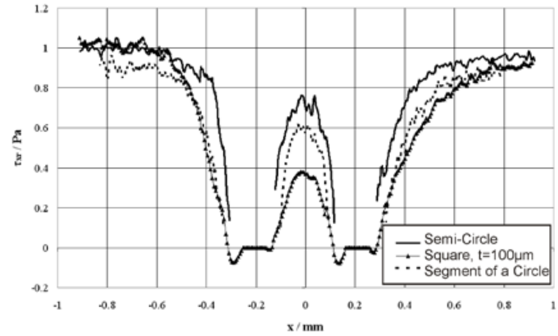

Figure 3: Wall shear stress around <u>two</u> struts at x=-0.2 and x=0.2mm, for three stent strut geometries

References

A.K. Mitra *et al.*, J. Clin Pathol, 59:232-239, 2006.

A.M. Malek *et al.*, JAMA, 282:2035-2042, 1999.