In-Vitro Velocity Mapping and Flow Simulations

Realistic in-vitro vascular phantoms in combination with MRI flow measurements offer the possibility to predict changes of hemodynamic effects due to vascular modifications. Further they allow the modeling of different stages of vascular diseases and their effect on blood flow dynamics. The aim of this work is to study heamodynamic effects of aortic coarctation with different stenosis grades using a realistic rapid prototyping model of the thoracic aorta. Additionally a flexible stenosis was integrated into the descending aorta of the vascular model. Realistic pulsatile flow waveforms were realized using a pneumatically driven VAD (ventricular assistant device) pump system attached to the ascending aorta (Fig.1). For this study the impact of different stenosis grades on local and global flow dynamics was evaluated for five different coarctations grades (Fig. 2).

Figure 1: Experimental set up of the flow circuit.

Figure 2: 3D Stream-lines for five different stenosis grades in two different time frames. White arrows indicate increased velocities in the stenotic and post-stenotic area. Additionally changes in flow patterns such as helical flow for higher grade stenosis in the post-stenotic descending aorta are evident.

References: [1] Canstein, C., et al. Time-resolved 3D MR Velocity Mapping in a Realistic Vascular Rapid-Prototyping Model of the Thoracic Aorta. Proceedings 14th Scientific Meeting ISMRM, Seattle, USA, 2006 [2] Canstein, C., et al. ID MR Flow Analysis in a Realistic Rapid-Prototyping Model System of the Thoracic Aorta: Comparison with In-Vivo Data and Computational Fluid Dynamics in Identical Vessel Geometries. Proceedings 15th Scientific Meeting ISMRM, Berlin, Germany, 2007 [3] Canstein, C., et al., 3D MR Flow Analysis in Realistic Rapid-Prototyping Model Systems of the Thoracic Aorta: Comparison with in-vivo Data and Computational Fluid Dynamics in Identical Vessel Geometries. MRM, 2007, in press.

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