Institut für Strömungslehre und Wärmeübertragung

Bachelorarbeit / Bachelor Thesis

Numerical simulation of the blood flow in the aorta

An aortic dissection is a serious condition caused by a tear in the inner layer of the aorta, the large blood vessel branching off the heart (Fig. 1). Due to the pulsation of the heart, blood surges through the tear, which causes the inner (intima) and middle (media) layers of the aorta to separate (dissect) (Fig. 2). Due to the pulsation of the heart, the newly created cavity, the so-called false lumen, grows around the aortic branch. If the blood-filled false lumen ruptures through the outer layer (adventitia) of the aortic wall, aortic dissection is most likely fatal.
The course of the disease depends on the local haemodynamics in the original vessel (true lumen) and the false lumen, for which one decisive factor is the shear stress imposed at the cell walls due to the blood flow.
Blood is a non-Newtonian fluid, which means that its response to deformation depends on the local flow field. Its viscosity depends on the rate of deformation (shear rate), and so does the shear stress.

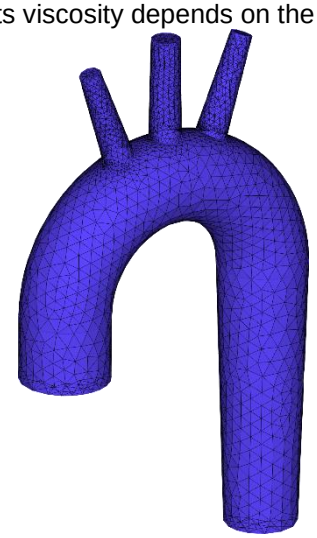

Fig. 1 Geometry of an idealized

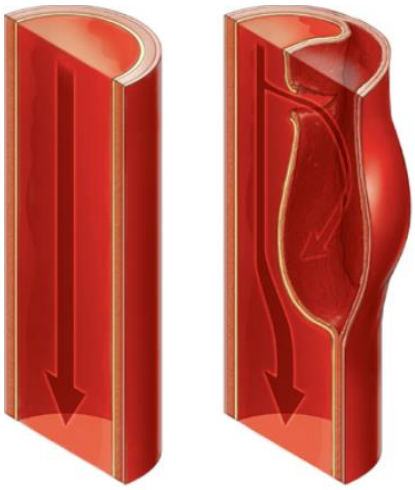

Fig. 2 Healthy aorta (left), dissected aorta (right) (Brunicardi, et al. (2015))

These quantities can be determined by numerically solving the equations of fluid dynamics, where the specification of boundary conditions for the flow field at the entrance of the aorta is crucial for the flow field in the domain. The question arises about the sensitivity of the quantities of interest (such as the maximum / time-averaged wall shear stress or the oscillatory shear index), if different entry velocity profiles are set.

Tasks

- Elaboration of different velocity profiles to be imposed at the inlet of the aorta
- Numerical simulations (OpenFOAM) with the elaborated velocity profiles for different physiological cases
- Elaboration and estimation of potential deviations of the flow field (and the quantities of interest) arising from the imposed velocity profiles

We offer

- Scientific supervision of high quality
- An international and dynamic working atmosphere
- Access to all required facilities of the Institute

The project will be accomplished at the Institute of Fluid Mechanics and Heat Transfer (Institut für Strömungslehre und Wärmeübertragung). The project can start at any time. If interested, please contact

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