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## **ASPECTS OF CREATING MATHEMATICAL MODELS FOR BLOOD FLOW IN THE AORTIC ROOT**

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Haemodynamic inside blood vessels is important for various vascular complications, such as atherosclerotic plaques in areas of low pressure on the vessel wall and dissection of the vessel walls at high pressure, which subsequently causes aneurysms. Both cases carry serious risks to human life, especially in cases with the aorta. In addition to the pressure exerted on the vessel walls, it is also important how the blood flows. Other than the properties of the blood vessel also the position and structure of the aortic valve plays a significant role in the blood flow and the pressure applied to the walls of the vessel by the blood. If the flow is laminar, it does not create excess stress for the walls of the blood vessel, since under normal conditions the blood in the blood vessel should have a laminar flow. In cases where laminar flow is impossible due to an obstacle, a turbulent flow is formed. As a result of the formation of a turbulent flow, as well as the effect of the shear rate caused by the blood flow, various blood elements such as cholesterol begin to accumulate in certain areas of the blood vessel. Also, the non-laminar flow exerts a different pressure on the vessel due to an uneven direction of blood flows.

To predict such complications, the best option is to create mathematical models. A common method for creating mathematical models is the finite element method.

For the creation of mathematical models, various initial data is required that affect haemodynamic to a varying degree. These are the different sizes of the aortic root and the leaflets of the aortic valve, as well as the position of the aortic valve relative to the outflow tract of the left ventricle and the angle between the axes of the ascending aorta and the outflow tract of the left ventricle. The fact that the aortic valve leaflets are unequal in size, and in some cases, instead of anatomically normal three, there may be only two of them, which leads to a number of different complications needs to be kept in mind. Another factor affecting haemodynamic inside the blood vessel, in addition to the size of the vessel, is the structure of the leaflet and vessel wall at the tissue level. Aortic valve leaflets exhibit a complex tri-layer striation: the fibrosa, which is located on the aortic side of the leaflet, is composed of numerous circumferentially aligned dense collagen bundles; the spongiosa is comprised primarily of glycosaminoglycans with a few loosely connected fibrous proteins; and the ventricularis, which contains a laminate of collagen and elastin. Collagen is the major stress-bearing component of the aortic valve and can transfer the load from the leaflets to the aortic wall when the valve is closed. Each of them makes up a different percentage of the wall this percentage varies depending on factors such as age, sex and different pathologies. These variations in the structure of the aortic wall and leaflets can be incorporated into the mathematical model with the use of the Young's modulus.

With the creation of accurate mathematical models of haemodynamic in blood vessels it becomes possible to predict the risks associated with the least favourable haemodynamic effects on the vessel wall. Which in turn would allow to foresee areas of possible ruptures of the vessel, aortic dissections as well as aneurysms by looking at the low and high pressure areas on the mathematical model.