Wydział Inżynierii Biomedycznej
Katedra Biomechatroniki

ROZPRAWA DOKTORSKA

Modelowanie i symulacja przepływu krwi przez środkową tętnicę mózgu

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Zabrze, 2022

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ABSTRACT OF DOCTORAL DISSERTATION

titled:

„Modeling and simulation of blood flow in the middle cerebral artery"

Cardiovascular disease is one of the leading causes of death worldwide. The most common diseases are the heart muscle, but a large proportion also affects brain aneurysms. The factors influencing the development of brain aneurysms are not fully known. For this reason, research into the causes of brain aneurysms is being conducted all over the world. Therefore, the doctoral dissertation investigates the phenomena of blood flow through the middle cerebral artery using computational fluid dynamics (CFD) and experimental tests on a laboratory stand. The combination of numerical and experimental methods is the most effective way to analyse hemodynamic factors such as wall shear stress (WSS) and pressure distribution across the artery wall. The use of these methods allows for the verification of the obtained results of numerical analyses and a better understanding of the processes taking place.

The aim of the study was to develop a model of blood flow through the middle cerebral artery using the CFD method, which enables the simulation and analysis of morphometric and hemodynamic parameters and their influence on the formation of aneurysms. The objective of the doctoral dissertation thus adopted was fully achieved by means of numerical simulations of blood flow through the developed MCA artery models obtained from DICOM images for physiological/actual boundary conditions. The scope of the performed tests included multivariate analyses of blood flow in the artery, including numerical analysis, and experimental tests at the PIV laboratory stand.

Conducted numerical simulations with the use of a parametric model made it possible to analyse hemodynamic parameters (WSS stress and pressure distribution) and morphometric parameters of arteries (division angle and radii) in terms of aneurysm formation. The retrospective analysis of blood flow through the arteries with the aneurysm and after its removal showed the highest values of WSS stress and pressure at the site of aneurysm formation. This is also confirmed by the results of experimental studies carried out using the proprietary laboratory stand for flow analysis using the PIV method. For this reason, the presented results of the doctoral dissertation supplement the knowledge of the factors/causes influencing the formation and development of aneurysms and may be helpful in planning the method of therapy/treatment of MCA cerebral artery aneurysms.