Development numerical model for fast and accurate prediction blood flow through artificial aortic valve

Marcin Nowak*, Ziemowit Ostrowski*, Adam Golda†, Wojciech Adamczyk*

* Biomedical Engineering Laboratory, Institute of Thermal Technology
Silesian University of Technology
44-100 Gliwice, Konarskiego 22, Poland
e-mail: wojciech.adamczyk@polsl.pl, web page: http://www.itc.polsl.pl/adamczyk

† Department of Cardiology, 4th Municipal Hospital in Gliwice
44-100 Gliwice, Kosciuszki 29, Poland

ABSTRACT

The cardiovascular system diseases (CVDs) are the leading cause of death in developed countries, where 31% of deaths are caused by CVDs. One cause of CVD is arteriosclerosis, causing among others myocardial infarction, heart failure, heart valve stenosis and stroke, and some other frequent affections, as valvular diseases. Nowadays, various diagnostic techniques are used, where each suffer from some imperfections. Generally, diagnostic procedures involve high examination costs, required qualified medical personnel and expensive equipment. Therefore there is a room for developing virtual diagnostic procedures, such as numerical modeling, which will provide a complex insight into a medical problem without any potential risk. This fact could reduce the patient's mortality and provide a tools improving the safety of the patient examination.

The aim of the presented work was to develop a fast and accurate numerical model for modelling the blood flow through the artificial aortic valve. The movement of the aortic valve leaflets was captured applying the fluid structure interactions approach [1]. To not incorporate to many complexities into the model, the blood flow is modelled using single phase model with surrogate model for prediction of the mechanical hemolysis process. Model is developed using empirical correlations [2] and using more sophisticated direct collisional model. Numerical model was validated against experimental data collected at in-house test-rig. Test rig is equipped with peristaltic pump (Harvard Apparatus) used to mimic the heart pulsation, aortic valve (Medtronic, Inc.) built in the transparent pipe, pressure transducer and PIV system to observe the flow field through the valve.

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