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ANALYSIS OF CARDIAC WORK AND SIMULATION OF AORTIC VALVE STENOSIS

Smiljana Tomasevic[1], Bogdan Milicevic[1], Igor Saveljic[2], Lazar Velicki[3], Nenad Filipovic[1]
[1]Faculty of Engineering, University of Kragujevac, Serbia; Bioengineering Research and Development Center, Kragujevac, Serbia
[2]Institute for Information Technologies, Kragujevac, Serbia; Bioengineering Research and Development Center, Kragujevac, Serbia
[3]Institute of Cardiovascular Diseases, Sremska Kamenica, Serbia; Faculty of Medicine, University of Novi Sad, Novi Sad, Serbia
smiljana@kg.ac.rs, bogdan.milicevic@uni.kg.ac.rs, isaveljic@kg.ac.rs, lvelicki@gmail.com, fica@kg.ac.rs

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Summary: The main aim of this work is to describe and analyze the basis of cardiac work and aortic root with stenosis, as well as to perform computational simulation of aortic stenosis employing patient-specific 3D analysis. In case of heart malformations, complex changes in left ventricular geometry are in most cases caused by continuous exposure to cardiovascular risk factors and/or hemodynamic conditions, which usually start as a physiological response. Cardiac work provides incremental information of left ventricle ejection fraction and strain which are sensitive to left ventricle afterload and related to non-invasive assessment of different types of cardiomyopathies. This is related to biomechanical alternations in case of aortic stenosis, a narrowing of the orifice of the aortic valve that causes an increased resistance to blood flow from the ventricle into the systemic circulation. Altered cardiac work, associated with aortic stenosis is commonly related with significant morbidity, mortality and healthcare costs. The presented study gives the insight into the model-based simulation of cardiac work and aortic stenosis, employing the in-house finite element PAK software and aims to propose an advanced approach for the assessment of work indices and biomechanical characteristics (stresses, pressures, displacements) based on computational modelling. PAK is a high-performance finite element (FE) software for solving complex coupled multi-physics/multi-scale problems, with main application in cardiovascular domain. It also can interact with different computational solutions and solvers. The computational modelling based on FE analysis could offer solutions to some of the problems in current healthcare practice, while its ability to run simulations and be predictive could help to identify the likely outcomes for patients. The performed study is the first step in further investigation and development of more advanced and complex 3D models.