The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

EFFECTS OF UNCERTAINTIES OF IMAGE-BASED MATERIAL PROPERTIES OF GREAT VESSELS ON VASCULAR DEFORMATION

B.M. Fanni[1], M.N. Antonuccio[1], G. Santoro[2], A. Mariotti[3], M.V. Salvetti[3] and S.Celi[1]

[1] BioCardioLab - Bioengineering Unit, Ospedale del Cuore, Fondazione CNR - Regione Toscana G. Monasterio, Via Aurelia Sud, 54100 Massa, Italy
bmfanni@ftgm.it, mnantonuccio@ftgm.it, s.celi@ftgm.it

[2] Pediatric Cardiology Unit, Ospedale del Cuore, Fondazione CNR - Regione Toscana G. Monasterio, Via Aurelia Sud, 54100 Massa, Italy, gsantoro@ftgm.it

[3] Department of Civil and Industrial Engineering, University of Pisa, Via G. Caruso 8, 56122, Pisa, Italy, alessandro.mariotti@unipi.it, maria.vittoria.salvetti@unipi.it

Keywords: *imaging, material properties, UQ, FSI, cardiovascular, aorta*

Patient-specific computational models represent a powerful tool for the planning of cardiovascular interventions. In this context, the patient-specific material properties are considered as one of the biggest source of uncertainty [1].
In this work, we investigated the effect of the uncertainty of the elastic module (E), as computed from a recent image-based methodology [2], on a fluid-structure interaction (FSI) model of a patient-specific aorta. The Uncertainty Quantification (UQ) was carried out using the generalized Polynomial Chaos (gPC) method. Four deterministic simulations were run based on the four quadrature points [3], computed considering a deviation of $\pm 20\%$ on the estimation of the E value of the vessel wall from patient's imaging [2].
The UQ of the E parameter was evaluated on the area and flow variations among cardiac cycle extracted from five cross-sections of the aortic FSI model. Results from gPC analysis showed a not significant variation of the area and flow quantities during the whole cardiac period, thus demonstrating the effectiveness of the used image-based methodology in the inferring of the E parameter, despite its intrinsic errors due to model definition.
This study highlights the importance of imaging to retrieve useful data in an indirect and non-invasive way, to enhance the reliability of in-silico models in the clinical practice.

REFERENCES

[1] W. Huberts et al., *What is needed to make cardiovascular models suitable for clinical decision support? A viewpoint paper*. J Computational Science, 24:68-84, 2018.

[2] B.M. Fanni et al., *A Proof of Concept of a Non-Invasive Image-Based Material Characterization Method for Enhanced Patient-Specific Computational Modeling*. Cardiovasc Eng Technol, 11(5):532-543, 2020.

[3] M.N. Antonuccio et al., *Effects of Uncertainty of Outlet Boundary Conditions in a Patient-Specific Case of Aortic Coarctation*. Ann Biomed Eng, 2021.