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

A Fluid-Structure Interaction Study of Hemodynamics in Arterial Bypass-Graft Anastomoses

Georgios Bletsos*[1], Lars Radtke[2], Alexander Düster[2] and Thomas Rung[1]

[1] Hamburg University of Technology, Institute for Fluid Dynamics and Ship Theory, Am Schwarzenberg-Campus 4, 21073 Hamburg, Germany, george.bletsos@tuhh.de

[2] Hamburg University of Technology, Institute for Numerical Structural Analysis with Application in Ship Technology, Am Schwarzenberg-Campus 4, 21073 Hamburg, Germany, lars.radtke@tuhh.de

Keywords: *Blood Flow, Fluid-Structure Interaction, Hemolysis, Bypass-Graft*

Bypass-grafts are oftentimes used in surgical procedures to divert blood around narrowed or clogged parts of an artery. The resulting diverted blood flow is crucial to the success of the operation as it may lead to undesirable peculiarities that can damage the graft or the blood itself. However, an a priori prediction of damaging hemodynamics factors due to the unnatural flow is significantly difficult to make in vitro or in vivo conditions. To this extent, a large amount of computational studies have been conducted to investigate the potential success of graft implementation depending on a variety of parameters such as the shape of the connecting cuff, the boundary flow conditions and the elasticity of the walls, see e.g. [1]. As regards the latter, it has been shown that between a flow simulation through rigid material and a coupled fluid-structure interaction (FSI) simulation, differences of up to 50% of the wall shear-stress (WSS) magnitude may occur [2].

This work presents numerical results on grafts with different cuff sizes for a variety of physiological boundary flow conditions. Results of WSS, oscillating shear index (OSI) and hemolysis are obtained for both rigid walls, through classical CFD simulations, and elastic walls, through FSI ones. Special interest is given to the prediction of hemolysis induction [3], as it is often neglected in similar studies. The influence of cuff shape and boundary conditions is investigated and discussed in the context of elastic or rigid walls to enhance our understanding of their overall effect in the surgical procedure.

REFERENCES

[1] L. Radtke, A. Larena-Avellaneda, E.S. Debus and A. Düster, Simulation der Fluid-Struktur-Interaktion in arteriellen Bypässen, *Gefässchirurgie*, Vol. **22(6)**, pp. 400-406, 2017.

[2] Y. Bazilevs, M.-C. Hsu, D.J. Benson et al., Computational fluid–structure interaction: methods and application to a total cavopulmonary connection. *Comput. Mech.*, Vol. **45**, pp. 77-89, 2009.

[3] H. Yu, S. Engel, G. Janiga and D. Thévenin, A Review of Hemolysis Prediction Models for Computational Fluid Dynamics. *Artif. Organs*, Vol. **41**, pp. 603-621, 2017.