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D. Drzisga, T. Köppl, U. Pohl, R. Helmig, B.
Wohlmuth



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Numerical modeling of compensation mechanisms for peripheral arterial stenoses

D. Drzisga^{a,*}, T. Köppl^{b,*}, U. Pohl^{c,1,2}, R. Helmig^b, B. Wohlmuth^a

^a*Institute for Numerical Mathematics, Technische Universität München, Boltzmannstr. 3, D-85748 Garching b. München, Germany.*

^b*Department of Hydromechanics and Modelling of Hydrosystems, University of Stuttgart, Pfaffenwaldring 61, D-70569 Stuttgart, Germany.*

^c*Walter-Brendel-Centre of Exp. Medicine, Ludwig-Maximilians-Universität, Marchionistr. 27, D-81377 München, Germany*

Abstract

The goal of this paper is to develop a numerical model for physiological mechanisms that help to compensate reduced blood flow caused by a peripheral arterial stenosis. Thereby we restrict ourselves to the following compensation mechanisms: Metabolic regulation and arteriogenesis, i.e., growth of pre-existing collateral arteries. Our model is based on dimensionally reduced differential equations to simulate large time periods with low computational cost. As a test scenario, we consider a stenosis located in the right posterior tibial artery of a human. We study its impact on blood supply for different narrowing degrees by the help of numerical simulations. Moreover, the efficiency of the above compensation mechanisms is examined. Our results reveal that even a complete occlusion of this artery exhibiting a cross-section area of 0.442 cm^2 can be compensated at rest, if metabolic regulation is combined with collateral arteries whose total cross-section area accounts for 8.14 % of the occluded artery.

Keywords: reduced model, peripheral stenosis, arteriogenesis, metabolic regulation

*Corresponding authors

Email addresses: drzisga@ma.tum.de (D. Drzisga), tobias.koepl@iws.uni-stuttgart.de (T. Köppl), upohl@lmu.de (U. Pohl), rainer.helmig@iws.uni-stuttgart.de (R. Helmig), wohlmuth@ma.tum.de (B. Wohlmuth)

¹DZHK (German Centre of Cardiovascular Research), partner site Munich Heart Alliance

²Munich Cluster for Systems Neurology (SyNergY)

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