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1D-0D-3D coupled models for simulating blood flow and transport processes in breast tissue

Tobias Koeppl[1], Andreas Wagner[2], Marvin Fritz[3], Barbara Wohlmuth[4] and Chengyue Wu[5]

[1,2,3,4] Department of Mathematics, Technical University of Munich, Boltzmannstrasse 3 85748 Garching, koepplto@ma.tum.de, wagneran@ma.tum.de, fritz@ma.tum.de, wohlmuth@ma.tum.de, http://www-m2.ma.tum.de

[5] Oden Institute for Computational Engineering and Sciences, The University of Texas at Austin, POB 2.128, USA, cw35926@utexas.edu, https://cco.oden.utexas

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In this talk, we present mixed dimensional models for simulating blood flow and transport processes in breast tissue and the vascular tree supplying it [1]. These processes are considered starting from the aortic inlet to the capillaries and tissue of the breast. Depending on the vessel and flow properties, appropriate flow models are chosen and assigned to the corresponding vessel types. In total, we consider four different model types. The first one is given by a system of 1D nonlinear hyperbolic PDEs to simulate blood flow in larger arteries with highly elastic vessel walls. Moreover, we assign 1D linearized hyperbolic PDEs to the smaller arteries with stiffer vessel walls. The third model type consists of ODE systems (0D models). It is used for the arterioles and peripheral circulation. Finally, homogenized 3D porous media models are considered to simulate flow and transport in capillaries and tissue within the breast volume [2]. Sink terms are used to account for the influence of the venous and lymphatic system. Combining the four model types, we obtain two different 1D-0D-3D coupled models for simulating blood flow and transport processes. The first one covers the whole path from the aorta to the breast, while the second one is a sub-model of the first one restricted to the breast vasculature and tissue. The motivation to consider besides the first model also a sub-model for the breast is due to the fact that by means of the less complex sub-model, the computational effort in terms of patient specific breast networks can be reduced, significantly. We show, how parts of the first model can be used to determine boundary conditions for the sub-model. Both models are compared to each other as well as to data from medical textbooks.

REFERENCES

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