Towards a mathematical and computational framework for red blood and circulating tumor cells in blood flows

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Metastasis is the way cancer spreads in a living organism. It involves the transport of tumor cells from their primary tumor through the vascular system. The influence of the hemodynamics on the arrest and adhesion of the tumor cells is not well studied. In [1], our biologists co-authors showed extensively this influence in the caudal vasculature of zebrafish embryos. Arrests areas depend on the hemodynamics which was controlled by drugs. We proposed a preliminary model based on a synthetic geometry and compared with the in-vivo experiments. The results were encouraging and more recently, in [2], we provided several improvements: (i) 2D and 3D realistic geometrical models reconstructed from the confocal images (ii) better modeling of the blood based on Carreau-Yasuda (iii) better modeling of the tissue constraint surrounding the vessels and (iv) red blood cells (RBC) in flow in the 2D realistic geometry. In this contribution, we propose the latest advances to our mathematical and computational framework as well as new numerical experiments: (i) 3D model and simulation of RBC and a preliminary model for circulatory tumor cells based on the level-set method (ii) an efficient FSI-ALE framework for the fluid-vessel interaction and (iii) new experiments to compare with the in-vivo data and quantify the hydrodynamic forces at play with the cells in flow. This work is a joint collaboration with Jacky Goetz, Sebastien Harlepp and Gautier Follain from the Tumor Biomechanics Lab (INSERM UMR S1109).

Références

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