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Simulation of red blood cells flowing over wall-bound cells AMIR H.G. ISFAHANI, University of Illinois at Urbana-Champaign, HONG ZHAO, Stanford University, JONATHAN B. FREUND, University of Illinois at Urbana-Champaign — Inter-cellular dynamics play a critical role in the phenomenology of the microcirculation. We present a quantitative investigation of the forces exerted by red cells on protrusions on a microvessel of diameter around 12 μm, which is 1.5 times the longest dimension of a red cell at rest. This configuration serves as a model for white blood cells (leukocytes), which can bind nearly statically to the endothelial cells as part of the inflammation response. The simulation tools are based on an $O(N \log N)$ boundary integral formulation. It permits the cells to both be realistically flexible and to approach to very close separation distances. The red blood cells are modeled as finite-deformation elastic membranes with strong resistance to surface dilatation and relatively small but finite resistance to bending. The no-slip condition is applied on the protrusion as well as the vessel walls. Simulation results show that these forces are significantly augmented by the particulate character of blood. For a tube hematocrit of 30% and a hemispherical protrusion with a height to tube diameter ratio of 0.4, the average forces are increased by about 50% and the local forces by more than two folds relative to forces from an effective viscosity homogenized blood. Different flow configurations are considered and analyzed.

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