Towards a computational model of leukocyte adhesion cascade: Leukocyte rolling DAMIR KHISMATULLIN, GEORGE TRUSKEY, Department of Biomedical Engineering, Duke University — Recruitment of leukocytes into sites of acute and chronic inflammation is a vital component of the innate immune response in humans and plays an important role in cardiovascular diseases, such as ischemia-reperfusion injury and atherosclerosis. Leukocytes extravasate into the inflamed tissue through a multi-step process called leukocyte adhesion cascade, which involves initial contact of a leukocyte with activated endothelium (tethering), leukocyte rolling, firm adhesion, and transendothelial migration. Recently we developed a fully three-dimensional CFD model of receptor-mediated leukocyte adhesion to endothelium in a parallel-plate flow chamber. The model treats the leukocyte as a viscoelastic cell with the nucleus located in the intracellular space and cylindrical microvilli distributed over the cell membrane. Leukocyte-endothelial adhesion is assumed to be mediated by adhesion molecules expressed on the tips of cell microvilli and on endothelium. We show that the model can predict both shape changes and velocities of rolling leukocytes under physiological flow conditions. Results of this study also indicate that viscosity of the cytoplasm is a critical parameter of leukocyte adhesion, affecting the cell's ability to roll on endothelium. This work is supported by NIH Grant HL- 57446 and NCSA Grant BCS040006 and utilized the NCSA IBM p690.

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