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Numerical analysis of cell adhesion in capillary flow[1] NAOKI TAKEISHI, Kyoto University, YOHSUKE IMAI, SHUNICHI ISHIDA, TOSHIHIRO OMORI, Tohoku University, ROGER KAMM, Massachusetts Institute of Technology, TAKUJI ISHIKAWA, Tohoku University — Numerical simulation of cell adhesion was performed for capillaries whose diameter is comparable to or smaller than that of the cell. Despite a lot of works about leukocyte and tumor cell rolling, cell motion in capillaries has remained unclear. The solid and fluid mechanics of a cell in flow was coupled with a slip bond model of ligand-receptor interactions. When the size of a capillary was reduced, the cell always transitioned to bullet-like motion, with a consequent decrease in the velocity of the cell. A state diagram is obtained for various values of capillary diameter and receptor density. According to our numerical results, bullet motion enables firm adhesion of a cell to the capillary wall even for a weak ligand-receptor binding. We also quantified effects of various parameters, including the dissociation rate constant, the spring constant, and the reactive compliance on the characteristics of cell motion. Our results suggest that even under the interaction between PSGL-1 and P-selectin, which is mainly responsible for leukocyte rolling, a cell is able to show firm adhesion in a small capillary. These findings may help in understanding such phenomena as leukocyte plugging and cancer metastasis.

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