Lateral migration of cells in the blood

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【はじめに】

Cells in the blood undergo migration perpendicular to the direction of flow while they flow along the direction of the surrounding flow. This process is referred to as lateral migration. Understanding the lateral migration of deformable bodies is necessary for fields as diverse as the development of microfluidic devices, such as those that sort cells, to the understanding of phenomena that occur within the body such as immune system functioning and coagulation. However, the physical and biological factors in play in the lateral migration of blood cells is still unclear. In this study we examine the hydrodynamic forces behind the lateral migration of a single blood cell using numerical simulation.

【結果と考察】

Using the boundary integral method, we break down the components acting on the lateral migration of the cell into those induced by the wall and by the curvature of an applied Poiseuille flow. By simulating a cell suspended in an infinite Poiseuille flow and a near-wall Poiseuille flow, we show that the effect of the wall is dominant even when the cell is placed far from the wall. Thus, the effect of the wall can be estimated by the analytical solution for a deformable particle in a near-wall simple shear flow (1), even when the cell is suspended in a non-linear flow. The lateral velocity of the cell in an infinite Poiseuille flow is found to be proportional to the shear gradient. Thus, using these relations, we can estimate the relative effects of the wall and the applied flow curvature on the cell lateral migration. Then, we imagine that the cell is suspended in a slit flow in which the opposing wall is sufficiently far such that its effect on the cell lateral migration can be neglected. Then, the ratio of the effect of the flow curvature to the wall can be rewritten in terms of two variables: the non-dimensional distance between the wall and cell, and the non-dimensional radius of the channel (2). In other words, the relative effect of the hydrodynamic factors acting on the lateral migration of the cell is independent of the external flow profile.

【参考文献】

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