Mixing of red blood cells in a micro-channel flow under high hematocrit conditions

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In a small artery, the blood is no longer assumed as a homogeneous fluid, because the size of blood cells cannot be neglected compared to the generated flow field. (The diameter of a red blood cell (RBC) is about 8μm.) In such a case, we need to treat the blood as a multi-phase fluid, and investigate the motion of individual cells in discussing the flow field. Blood may be modelled as a suspension of red blood cells (RBCs) in plasma, because about 99% of volume fraction of blood cells is RBCs. The interaction between RBCs generates micron-scale mixing in the blood flow, which has a significant effect on the diffusion of platelets and large molecules.

In order to measure a blood flow experimentally, various methods have been employed. However, most of conventional techniques are difficult to observe RBCs' behaviour inside of the high hematocrit (Hct) blood flow because of the less optical transparency of the RBCs even when the flow speed is low. To overcome this problem, we use confocal micro-PIV (Particle Image Velocimetry) system. This system enables us to visualize the individual RBCs even in the high Hct blood by exciting the labeled RBCs by the laser.

In this study, we investigate the motion of RBCs by using confocal micro-PIV system. We measure individual trajectories of RBCs in a straight tube and in a micro-channel with stenosis under high Hct conditions (up to 35%), where the interaction between RBCs becomes significant (see Fig.1). Our results clearly demonstrate that the mixing of RBCs strongly depends on the hematocrit, the RBC property and the position in the micro-channel. This information is important for a better understanding of mass transport in the microcirculation.

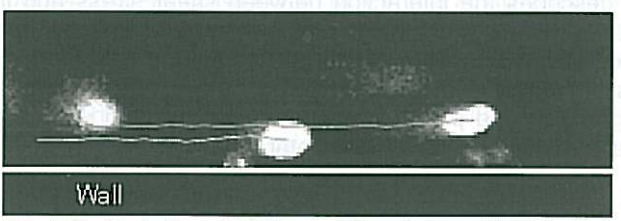

Fig.1 Trajectories of RBCs in 50μm tube with 23% Hct