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Diffusion of Fluid Particles in High Hematocrit Blood Flow in a
Capillary Tube
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In microrcirculation, the random-like transverse rotation and motion of
RBCs in shear flow is believed to play an important role in transport
phenomena. Although many studies have been performed on the
behavior of RBCs flowing through glass capillaries, the role of RBCs in the
mass transport of platelets and large molecules is still not completely
understood.

In this study, we experimentally investigated the self-diffusion of RBCs
in high hematocrit blood flow in a capillary tube. To better understanding of mass transport in blood flow in microrcirculation
and biomedical micro devices, in the present study, we examined the role of RBCs in the diffusion of fluid particles. Therefore we measured the radial
dispersion coefficient (D_r) of tracer particles using a confocal micro particle
tracking velocimetry (PTV) system. The experiments were performed in the
50 μm glass capillary at Reynolds number – 0.004 for three kinds of
working fluid: dextran40, dextran40 with 10% human RBCs and dextran40
with 20% human RBCs. Each fluid was seeded with 0.1% (by volume) 1μm
diameter fluorescent particles. From recorded images at the central plane of
glass capillary, hundreds of fluorescent particles were tracked successfully
with Image J software, using the manual tracking Mtrackj plug-in to find the
radial dispersion coefficient. The results clearly demonstrate that the
tracer particles in blood flow exhibited higher erratic radial displacement
comparing with those in dextran40 solution. It was found that the averaged
dispersion coefficient increased from 0.4 x 10^-6 cm^2/sec at 10% Hct.
the dependency of D_r on radial position in dextran40 was not high, because
the fluid is homogeneous. However, in 10% Hct blood, the D_r near the wall
was the lowest, mainly because of the tendency of RBCs to migrate to the
tube axis and formation of plasma layer near the wall, the number of RBCs
in this section is low. To investigate the effect of hematocrit, we increased
the hematocrit of blood to 20%, the dispersion coefficient of tracer particles
were increased to 1.6 X 10^-6 cm^2/sec.

In higher Hct, the smaller plasma layer and the increase in the local RBCs
density surrounding the particles may be the main causes of the enhanced
radial dispersion coefficient. These results indicate that effect of movement
of RBCs at the microscopic level on the motions of platelets as well as
chemical substances in the plasma is considerable. These findings are
important for better understanding of mass transport phenomena in micro
vascular blood flow.

WCB-A00964-01661
A Numerical Study on the Behavior of Cells in Micro-scale Blood Flows
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Migration to vessel wall is an important process for a variety of cells flowing
in blood, such as platelets, white blood cells, and cancer cells. Platelets
adhere to damaged vessel wall and form a primary thrombus to restore
the vessel wall. In the case of white blood cells, they adhere to the vessel
wall, and then invade local tissues to get the site of inflammation. Cancer
cells also adhere to the vessel wall and invade healthy tissues to grow and
divide there. While red blood cells are well known that they show axial
migration and generate cell free layer near the wall, it is not clear why
those cells migrate to the vessel wall, even though their physical property,
such as size and deformability, is varied. In this study, we numerically
investigate the mechanism of the cell migration in micro-scale blood flows.
In general, a cell is a capsule consisting of an internal medium enclosed
by a thin membrane. The internal medium contains cytoplasm, nucleus,
cytoskeletons, and various subcellular organelles. Here, we simply model the
cell as a spherical capsule that consists of a Newtonian liquid and
elastic membrane to simply compare the effect of the deformability on the
cell migration. Red blood cells are also modeled as simple capsules those
shapes are initially biconcave disk. We must solve complex hydrodynamic
interactions between red blood cells and other suspended cells. In order to
simulate this problem, a particle based method is employed. We discuss the
effect of capsule size, membrane stiffness, and capsule shape on the
behavior of the cell.

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Red Blood Cell dispersion in 100 μm glass capillaries: the temperature
effect
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The rheological behaviour of the red blood cells (RBCs) flowing in
microvessels and microchannels depend on several effects, such as
hematocrit (Hct), geometry, and temperature. Previous in vitro studies have
measured the Hct effect on the radial dispersion (D_y) at both diluted and
concentrated suspensions of RBCs. However, according to our knowledge
the effect of the temperature on RBC D_y was never studied. Hence,
the main purpose of the present work is to investigate the effect of the
temperature on the RBC D_y. In vitro human blood was pumped through a
100 μm glass capillary and by using a confocal micro-PTV system the RBC
D_y was calculated at two different temperatures, i.e., 25°C and 37°C.

WCB-A00985-01731
Flow of physiological fluids in microchannels: the sedimentation
effect
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Microfluidic devices are becoming one of the most promising new tools
for diagnostic applications and treatment of several chronic diseases.
Hence, it is increasingly important to investigate the rheological behaviour
of physiological fluids in microchannels. The main purpose of the present
experimental work is to investigate the flow of two different physiological
fluids frequently used in microfluidic devices.

The working fluids were physiological saline (PS) and dextran 40 (Dx40)
containing about 6% of sheep red blood cells (RBCs), respectively. The
capillaries were placed horizontally on a slide glass and the flow rate of
the working fluids was kept constant by using a syringe pump. By means of
a camera the images were taken and transferred to the computer to be
analysed. Generally, the results show that PS and Dx40 have different flow
behaviour due to the sedimentation of the RBCs.