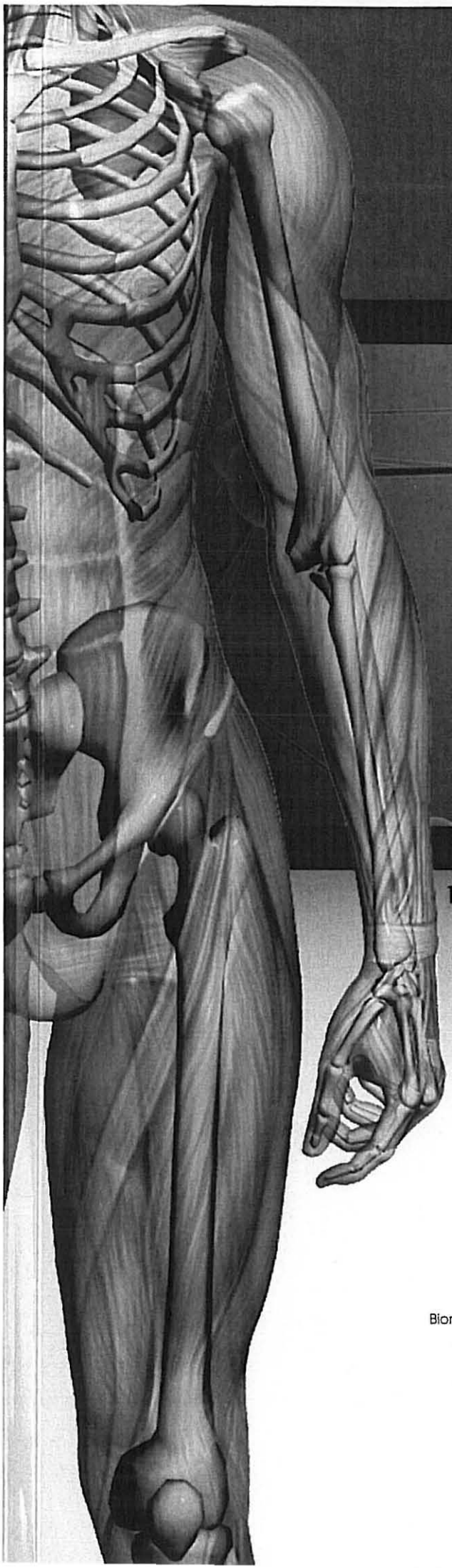

6th World Congress of Biomechanics

Abstracts

In conjunction with

14th International Conference on Biomedical Engineering (ICBME)

&

5th Asian Pacific Conference on Biomechanics (APBiomech)

1 - 6 August 2010

Singapore Suntec Convention Centre

Jointly Organised by

BES SINGAPORE

Biomedical Engineering Society (Singapore)

Global Enterprise for Micromechanics and Molecular Medicine

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ABOUT 6th WORLD CONGRESS OF BIOMECHANICS

The 6th World Congress of Biomechanics is hosted by Biomedical Engineering Society of Singapore (BES) together with the Global Enterprise for Micromechanics and Molecular Medicine (GEM4) and the National University of Singapore (NUS), in conjunction with the 14th International Conference on Biomechanical Engineering (ICBME) and the 5th Asian Pacific Conference on Biomechanics (APBiomech). With over 2,000 delegates from all over the World, especially from the Asia Pacific region, to attend this congress, this Biomechanics conference explores a wide field such as organ mechanics, tissue mechanics, cell mechanics to molecular mechanics.

At the 6th World Congress of Biomechanics, authors would be presenting the largest experimental studies, technologies and equipment. Special emphasis will be placed on state-of-the-art technology and medical applications, for example in areas of sports medicine and crash injuries.

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Diffusion of Fluid Particles in High Hematocrit Blood Flow in a Capillary Tube

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In microcirculation, the random-like transverse motion and rotation 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. Most of these studies were performed in dilute suspensions while the hematocrits that exit in microvessels are around 10-26%. It is believed that the interaction of RBCs in the concentrated regime generates microscale mixing in the blood flow, which has a significant effect on the diffusion of platelets and proteins. However, a few studies have been done in concentrated suspensions, because of difficulty in the experiments. In our former 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 microcirculation and biomedical micro devices, in the present study, we examined the roll of RBCs in the diffusion of fluid particles. Therefore we measured the radial dispersion coefficient (D_{rr}) 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 compared with those in dextran40 solution. It was found that the averaged dispersion coefficient increased from 0.4 X 10^{-8} cm^2/secat 10%Hct. The dependency of D_{rr} on radial position in dextran40 was not high, because the fluid is homogeneous. However, in 10%Hct blood, the D_{rr} 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^{-8} 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.

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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 ìm 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 (Dyy) at both diluted and concentrated suspensions of RBCs. However, according to our knowledge the effect of the temperature on RBC Dyy was never studied. Hence, the main purpose of the present work is to investigate the effect of the temperature on the RBC Dyy. In vitro human blood was pumped through a 100 ìm glass capillary and by using a confocal micro-PTV system the RBC Dyy was calculated at two different temperatures, i.e., 25°C and 37°C.

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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.