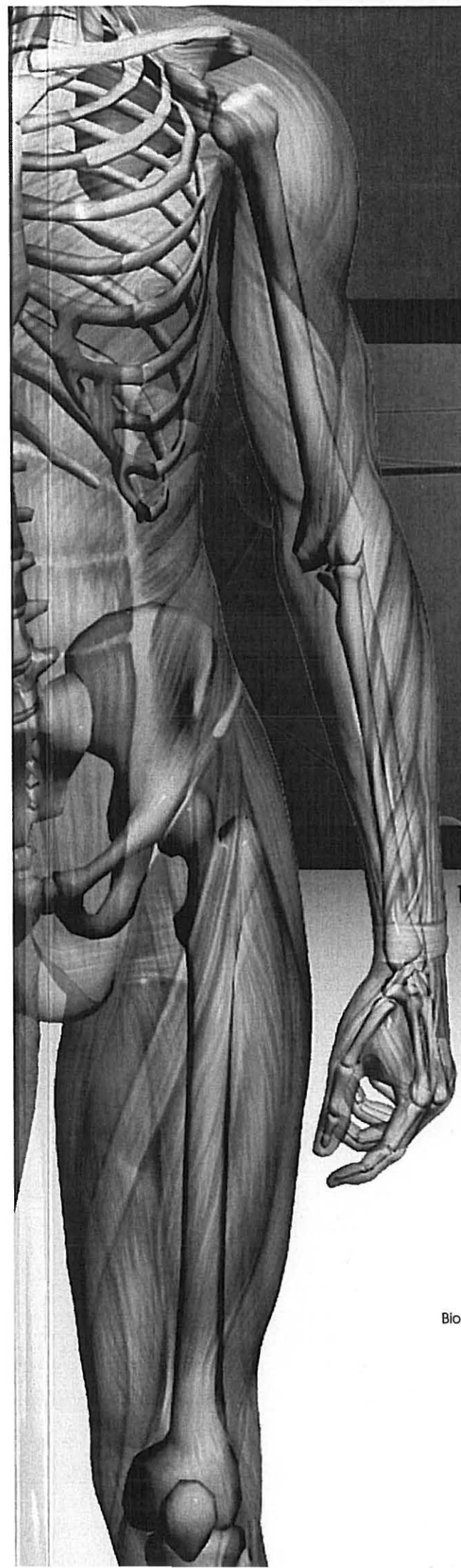

6th World Congress of Biomechanics

Abstracts

In conjunction with

14th International Conference on Biomedical Engineering (ICBME)

&

5th Asian Pacific Conference on Biomechanics (APBiomech)

1 - 6 August 2010

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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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In vitro Blood Flow in Circular PDMS Microchannels: Effect of the Flow Rate and Hematocrit

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Recently, Lima et al. [1] has performed confocal micro-PIV measurements on the blood flow through straight PDMS microchannel. In that study they have observed that the formation of the cell free layer is enhanced as the cross section ratio increases. However, the cross section ratio is not the only parameter that contributes for the creation of the cell-free layer. Hence, several other physical and hemorheological factors (such as flow rate, hematocrit, viscosity and cell deformability) need to be investigated in order to make use on the physics of microfluidics to either develop new lab-on-chip devices or to optimize the design of the existent microfluidic chips. The main aim of the present study is to show the effect of both flow rate and hematrocit on the blood flow and cell behaviour. The circular polydimethylsiloxane (PDMS) microchannels were fabricated by using wire casting technique and the experiments were carried out by using dextran 40 containing different fractions of red blood cells (RBCs). The in vitro blood flow was measured by means of video microscopy and image analysis. Additionally, the pressure drop was also measured.

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Measuring the Cell-Free Layer in Circular Microchannels

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One of the most interesting hemodynamic phenomenon observed both in vivo and in vitro studies is known as Fahraeus-Lindqvist effect, in which the apparent blood viscosity decreases as the tube diameter is reduced, for narrow tubes (< 300 μm). The physical reason behind this phenomenon is the creation of a marginal cell-free layer at regions adjacent to the tube wall. Although intensively studied, the complex formation of the cell-free layer has not yet been convincingly described mainly due to multi-physical and hemorheological factors that affect this phenomenon. The main purpose of this experimental work is to study the effect of the hematocrit (Hct) and temperature on the thickness of the cell-free layer in both glass capillaries and circular polydimethylsiloxane (PDMS) microchannels using an optical technique. The internal diameter of the glass and PDMS microchannels are 100 μm and 73±2 μm, respectively. The microchannels were placed on the stage of the inverted microscope and the temperature of the stage was adjusted by means of a thermo plate controller. The flow rate of the working fluids was controlled using a syringe pump. The images were recorded using a confocal microscopy system and transferred to the computer to be evaluated in Image J (NIH) using different plug-ins (MTrackJ and FeatureJ). The recorded images show a clear formation of a cell-free layer of variable thickness depending on experimental conditions.

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Deformation Behavior of Multiple Red Blood Cell in a Capillary Vessel with Bifurcations

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The detailed deformation of multiple red blood cells in capillary flows is investigated computationally and hydrodynamics in the capillary flow accompanied with the deformation of red blood cells are analyzed. The membrane of red blood cell is modeled as a hyperelastic thin-shell and the immersed boundary method is used for the fluid-structure coupling in the present simulations. Numerical results show that the apparent viscosity in the capillary flow increases with the increase of the shear coefficient in the membrane of red blood cell, while this change for the viscosity is not obvious when the stiffness of the membrane changes. The distribution of multiple red blood cells in a capillary with branches is also simulated which shows that the apparent viscosity in the flow and the distribution of the cells affect each other interactively.

WCB-A01271-02217

Drift and Fluctuating Motion of Artificial Platelet during Adhesion Process Near the Wall

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INTRODUCTION: Development of platelet substitute is necessary to overcome platelet transfusion problems, the limitation of short-term storage and the risk of viral and bacterial infections. To overcome these problems, the development of platelet substitutes is necessary to achieve long-term storage and avoidance of viral infections. An important mechanical aspect of platelet adhesion to vessel wall is a microscopic motion. Especially, a lateral motion of platelet plays a key role of transportation and adhesion to injured vessel wall in hemostasis process. Previous studies reported that the presence of Near Wall Excess (NWE: concentration of platelet near wall region in blood flow) largely contributes to the adhesion of platelet. However, because of short trajectory of the particle, the previous studies based on fixed-point measurement could not reveal the mechanism of lateral transport. To obtain long trajectories including lateral motion, we built a travelling stage of microscope for tracking particles moving through flow channel and estimated the lateral motion which contributes to NWE and adhesion.

MATERIALS AND METHODS: We employed recombinant Glycoprotein Ib alpha conjugated latex beads (rGPIba-LB) as platelet substitute. These particles were observed at wall shear rate (WSR) of 200, 500, and 1000 /s with hematocrit of 0 and 40% of washed red blood cells in rectangular flow channel which had vWf surface. To observe long trajectories of the particles, the field of view of the microscope was moved from the entrance to the exit by travelling stage. We tracked the particle as Lagransian method and separated the trajectory of particle with drift and fluctuating motion, and investigated quantitatively the motion which contributes to NWE and adhesion to the wall surface.

RESULTS AND DISCUSSION: Trajectories of rGPIba-LB were tracked from obtained movies. Then lateral gradient which reflects a drift motion of the particle toward the wall and dispersion coefficient which reflects a fluctuating motion of the particle were calculated. The rGPIba-LB moved only along axial direction with 0% hematocrit. As hematocrit increases, rGPIba-LB moved toward near the wall (about 0.9R) and the position was similar to that of NWE in previous studies. The dispersion coefficient increased near the wall and as WSR and hematocrit increased. Although the lateral gradient showed that rGPIba-LB moved toward the center of the flow channel on the wall, high dispersion coefficient near the wall induced rGPIba-LB to interact with the wall surface. These results showed that fluctuating motion is enhanced with the presence of RBC and high shear, and the particle motion near the wall includes low drift motion and high fluctuating motion.

CONCLUSION: We concluded the particle which has drift motion with high fluctuating motion induced by the presence of RBC and high shear contributes to interact to the wall surface and adhesion from NWE region.

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Mechanics of Human Red Blood Cell and the Smallest Limiting Geometries it can Flow Through

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The exquisite deformability of the human red blood cell (RBC) is essential to its physiological function which requires continuous circulation through narrow capillaries and even narrower splenic slits during about 120 days. Numerous diseases are associated with marked shape and deformability alterations of the RBC. Induced either by mutations of RBC cytoskeleton proteins in inherited disorders such as hereditary spherocytosis, or by the malaria parasite *P. falciparum* (amongst others), these alterations impair the RBC ability to overcome size-limiting deformability constraints in the human microcirculation. Analytical, continuum-based and molecular-level modeling have been applied to study the relation between RBC shape/ deformability versus the critical conditions of capillaries and splenic slits (limiting dimensions, geometry, and pressure differentials). These findings have been cross-validated by biological experiments using filters, and ex-vivo perfusion of human spleens. This integrative bio-physical approach will be now applied to more precisely explore key determinants of RBC microcirculation in physiology and disease.