ROLE OF THE HEMATOCRIT ON THE RADIAL DISPERSION OF RED BLOOD CELLS IN GLASS CAPILLARIES

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Introduction

The flow properties of blood in the microcirculation depend strongly on the hematocrit (Hct), microvessel geometry, and cell properties. Previous *in vitro* studies have measured the radial displacement of red blood cells (RBCs) at concentrated suspensions using conventional microscopes. However, they have used transparent suspensions of ghost red cells, which may have different physical properties than normal RBCs [Goldsmith and Turitto 1986]. In this study, we have used a new approach (confocal micro-PTV) to obtain direct and quantitative detailed descriptions of the flow behaviour of RBCs in concentrated suspensions of normal RBCs. The experiments were performed in 100 µm glass capillaries at Reynolds numbers (Re) of 0.005 and Hcts from 3 to 35%. Emphasis was devoted to the radial dispersion of RBCs located in the middle plane.

Materials and Methods

Working fluids and microchannel: In this study we used dextran 40 (Dx40) containing Hcts from 2 to 35%. The RBCs were fluorescently labeled with a dye (CM-Dil,C-7000;Molecular Probes) previously described [Lima 2007]. The microchannel was a circular borosilicate glass (100 µm in diameter).

Experimental set-up: The microchannel was placed on the stage of the microscope, with a controlled temperature of about 37ºC, where the flow rate was kept constant by using a syringe pump. By using a confocal micro-PTV system [Lima et al. 2006, Lima et al. 2007] confocal images were captured at a rate of 100 frames/s and then evaluated in Image J (NIH) by using a manual tracking MTrackJ plugin [Lima 2007].

RBC radial dispersion: the motions of RBCs were analysed by using a radial dispersion coefficient (D_{yy}) given by :

$$D_{yy}(t) = \frac{1}{N}\sum_{i=1}^{N} \frac{\left\langle \left(R_{i,y}(t) - R_{i,y}(0) \right)^2 \right\rangle}{2t} \qquad (1)$$

where $R_{i,y}$ and t are the radial displacement and time respectively.

Results and Discussion

Figure 1 shows the radial displacement of two labeled RBCs for Hcts of 3% and ~20. These results show clearly the fluid-dynamic interaction effects on the motion of RBCs flowing in concentrated suspensions.

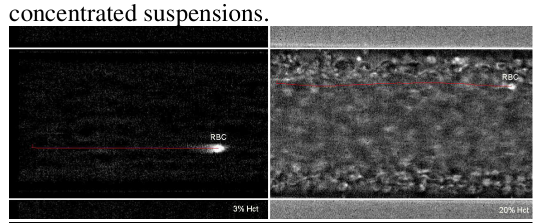

Figure 1: Radial displacement of labeled RBCs at 3%Hct (left side) and ~20%Hct (right side).

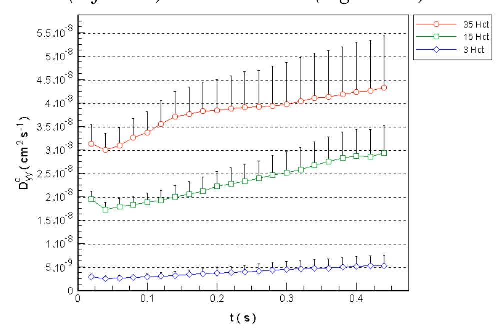

Figure 2: Radial displacement of labeled RBCs at 3%Hct (left side) and 35%Hct (right side).

The results from Figure 2 show that the radial dispersion coefficient (D_{yy}) increases with the Hct. In addition, the RBC D_{yy} for Hcts of ~35% have almost an order of magnitude greater than the D_{yy} for 3% Hct. These results clearly demonstrate that the RBCs at dense concentrations exhibit higher erratic radial displacement compared to dilute suspensions of RBCs.

References

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