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LEUKOCYTE AND ERYTHROCYTE VELOCITY IN ARTERIAL MICROVESSELS
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Introduction: Leukocyte adherence to vascular endothelium is an integral component of the inflammatory process and is often observed during histological visualization of the microvasculature. One of the phases of the adherence process is characterized by transient leukocyte sticking and subsequent rolling and/or sliding of the leukocyte along the vessel wall. Though limited data in the literature suggest that in vivo the speed with which the leukocytes roll (V_{xbo}) is directly related to the red blood cell velocity (V_{rbc}) to date no systematic study of this relationship has been carried out in arterial microvessels. The objective of the present work was to characterize the leukocyte dynamics in arterioles and determine the extent to which V_{xbo} is related to V_{rbc}.

Methods: Using the wing vasculature of the unanesthetized, little brown bat as an experimental model, V_{rbc} was determined in first order arterial branches (diameter range 32-65 microns) by timing their transit over an axial distance of 50 microns. Simultaneously, by continuous line measurement of center line V_{rbc} using a modified dual-slit method, the time averaged V_{rbc} during the transit of each leukocyte could be determined. All measurements were performed in unbranched vessel segments for a duration of 50 minutes. In each of the seven experiments a small region of the upper layer of epithelium covering the vessel segment was denuded 40 minutes prior to the start of data acquisition.

Results: Three classes of leukocyte dynamics were observed within the 50 micron axial zone. 1) most entered the zone by rolling along the wall and rolled throughout the length of the zone (V_{xbo} range 2-100 mu/sec) II) some entered rolling, but rolled for a distance of less than the full axial zone (V_{xbo} range 100-200 mu/sec) and III) zone were observable passing through the axial zone in the vessel wall and interface region but showed no obvious rolling (V_{xbo} range >2000 mu/sec). Whether analyzed on the basis of individual experiments or summarized over all data (1892 leukocytes) paired comparisons of V_{xbo} with the corresponding V_{rbc} (V_{rbc} range 0.5-5.7 mu/sec) showed correlations insignificantly different from zero when compared with and without class separation. However, when mean V_{xbo} and V_{rbc} were computed for each experiment a comparison made across experiments revealed a linear relationship (r = 0.9) between these two quantities.

Conclusions: Under the conditions of the present experiments the velocity of individual leukocytes was independent of simultaneously measured red blood cell velocities. Contrary to the mean values of these experiments, the presence of erythrocytes in the flowing stream of leukocytes indicated that the velocity of leukocytes was inversely related to the red blood cell velocity. The possibility of the interaction of leukocytes with each other and with the vessel wall is being investigated.

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IN VITRO DEMONSTRATION OF COLLATERAL BLOOD VISCOSITY: FLOW MEASUREMENT IN A MODEL OF VASCULAR NETWORK
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In vivo, blood behaves as an extremely non-Newtonian fluid, apparent fluidity variable between extremely high values at high, and extremely low (or even zero) values at low shear (CASSON-body behavior). The pronounced heterogeneity of microvascular perfusion in low flow states was explained as the biological consequence of these properties (1). The concept of "collateral blood viscidation" attributes localized flow retardation in close proximity to normally perfused vessels to an inhomogenous microvascular distribution of shear stresses. In capillaries and vessels positions in parallel to the main thoroughfare (2), a general drop in perfusion pressure was invoked to reduce shear stresses below a value necessary to maintain the fluidity of blood.

We tested this concept in vitro by producing capillary networks (1.D. 30 - 160 mu, 1/g 1/10) as shown schematically, capillaries are produced in transparent epoxy with the help of unsensitized nylon threads. Two of such threads are glued by formic acid and are fixed in the resin mass before polymerisation and removed subsequently after polymerisation by forming and coherent microvascular configuration. The channels are observed in a tilable microspectrophotometer and measured with a planimeter (Fig. 3). The channels are observed in a tilable microspectrophotometer and measured with a planimeter (Fig. 3).

In normal blood, (Ret. 5%) the fall of wall shear stress below 2 Pa is reversible in the longer capillary leads to reversible stagnation in this, not in the shorter tube; thus, a yield point of blood can be clearly demonstrated - while in a rotational micro rheometer, there is no indication of a yield point. At reduction of the material viscosity and/or tendency to aggregation (and thus non-Newtonian behavior) there is no indication of a yield point nor of collateral viscidation.

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