RATE OF MOVEMENT OF ERYTHROCYTES IN BLOOD VESSELS OF THE MESENTERIC MICROCIRCULATION OF ALBINO RATS

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The rate of movement of erythrocytes was studied by a rapid microfilming method in the vessels of the mesenteric microcirculation in albino rats. The mean rate of movement of erythrocytes in the arterioles was 6.3 ± 1.42 mm/sec, in the precapillary arterioles 2.39 ± 0.27 mm/sec, in the capillaries 0.5 ± 0.09 mm/sec, in the postcapillary venules 0.8 ± 0.12 mm/sec, and in the venules 3.0 ± 0.67 mm/sec.

The behavior and rate of movement of erythrocytes in the vessels of the microcirculation have previously been investigated [3-6], but no information is yet available on successive changes in the rate of blood flow in vessels with different functions within the same microcirculatory system.

EXPERIMENTAL METHOD AND RESULTS

In the investigation described below the rate of movement of erythrocytes was determined by rapid microfilming with a Type 16 Sp-m motion picture camera and Mku-2 apparatus. Intravital microscopy of the mesenteric vessels was carried out as described previously [1]. The speed of filming was 52 frames per second, the frame exposure $1/624$ per sec, and 16-mm reversible black and white motion picture film was used. By analysis of the frames on a decoder the linear displacement of the erythrocytes in the vessels per unit time was obtained.

The linear velocity of the erythrocytes (V_{lin}) in the capillaries was calculated by the equation

$$V_{lin} = \frac{\Delta l}{\Delta t_k}$$

where Δl is the linear displacement of the erythrocytes relative to a fixed point of the vessel on neighboring frames of the film. A fragment of one of the motion picture films from which the linear displacement of the erythrocytes between adjacent frames was measured is shown in Fig. 1.

To calculate the rate of movement of the erythrocytes in the arterioles and venules, the equation suggested by Lavrent'ev [2] for determining the linear stretching of a moving object on motion-picture frames photographed under a microscope was used.

$$\sigma = V_{lin} \cdot t,$$

where σ is the linear stretching of the moving object, which in the present case is equal to the difference between the size of the track left by the erythrocyte on the frame and the standard diameter of the erythrocyte; V_{lin} is the linear velocity, and t the time of exposure of the frame.

The rate of movement of the erythrocytes was measured in 20 arterioles, 35 precapillary arterioles, 37 capillaries, 14 postcapillary venules, and 15 venules.

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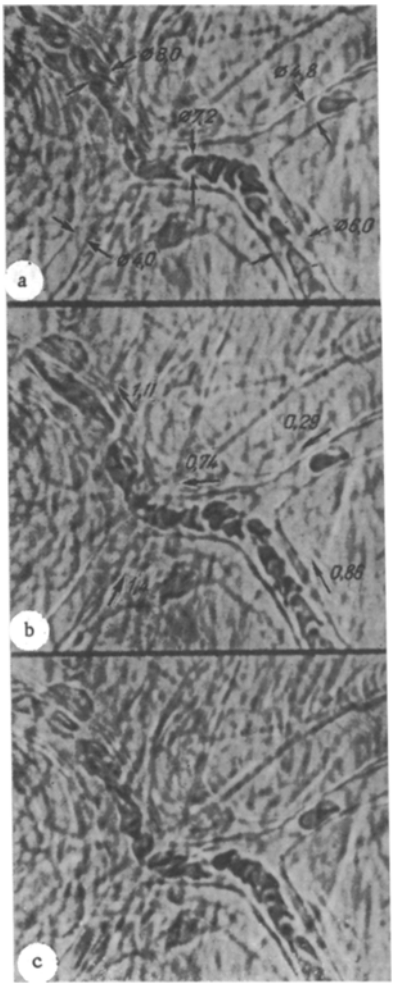

Fig. 1

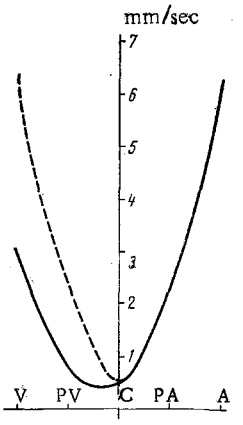

Fig. 2

Fig. 1. Fragment of motion-picture film of the capillary blood flow. Diameter of capillaries shown in microns, rate of flow in mm/sec. Arrow indicates direction of blood flow, 280×.

Fig. 2. Graph showing change in rate of movement of erythrocytes in blood vessels of microcirculatory system. Broken line denotes left branch of symmetrical parabola: A) arteriole; PA) precapillary arteriole; C) capillary; PV) postcapillary venule; V) venule. Ordinate, rate of movement of erythrocytes (in mm/sec).

The mean rate of movement of the erythrocytes in the arterioles was 6.3 ± 1.42 mm/sec, in the precapillary arterioles 2.39 ± 0.27 mm/sec, in the capillaries 0.5 ± 0.09 mm/sec, in the postcapillary venules 0.8 ± 0.12 mm/sec, and in the venules 3.0 ± 0.67 mm/sec.

The graph of the change in the rate of movement of the erythrocytes in blood vessels of the mesenteric microcirculatory system of the albino rat has the shape of an asymmetrical parabola (Fig. 2). The differences in the slope of the right and left branches of the parabola relative to the abscissa indicate that the intensity of the change in the blood flow velocity in the arterial and venous portions of the microcirculatory system is different.

Analysis of the results of intravital microfilming shows that the rate of movement of the erythrocytes in the vessels of the microcirculation is subject to considerable variation and depends not only on the struc-

tural parameters of the vascular network, but also on differences in the timing of the blood flow in neighboring vessels. In the capillaries, for example, it varies from 0.18 to 1.93 mm/sec. In about one-quarter of all capillaries the rate of movement of the erythrocytes was greater than 1 mm/sec, which is more than the mean rate of movement of the erythrocytes in the postcapillary venules.

Consequently, despite temporal variations in the capillary blood flow in a certain number of capillaries, the blood keeps a comparatively high reserve of kinetic energy which is utilized for maintenance of the normal passage of the blood along the vessels of the microcirculatory system as a whole.

LITERATURE CITED

1. V. I. Kozlov, Arkh. Anat., No. 5, 61 (1970).
2. V. I. Lavrent'ev and V. G. Pel'. High-Speed Motion-Picture Filming with the SKS-1 Camera [in Russina], Moscow (1963).
3. E. H. Bloch, Fed. Proc., 19, 89 (1960).
4. E. K. Greenwald, Microvasc. Res., 1, 410 (1969).
5. P. C. Johnson and H. Wayland, Am. J. Physiol., 212, 1405 (1967).
6. H. Wayland and P. C. Johnson, J. Appl. Physiol., 22, 333 (1967).