

## REDISTRIBUTION OF THE BLOOD IN THE BLOOD VESSELS OF LOWER MONKEYS

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The morphologic composition of the blood vessels is known to be different [2, 5, 6, 8, 9]. According to the data of the majority of investigators the number of leucocytes in the visceral blood vessels is lower than that in the blood vessels of fingers, ear lobe and skin. Such a migration of leucocytes within the body from one vascular area to another has received the name of "distribution leucocytosis."

At the same time some research workers deny the possibility of redistribution of blood in the organism [7]. In their view, if there is a difference in the values of blood indices from one vascular area to another it is connected not with redistribution of the blood but with a generally higher content of leucocytes in the skin as compared with large blood vessels and peripheral veins (since "peripheral blood" often implies capillary blood taken by puncturing the skin). However, this view requires a more thorough approach to its verification.

Literature references to the composition of the blood of internal blood vessels (veins and arteries) are limited chiefly to data on the total number of leucocytes, the question of the amount of hemoglobin and erythrocytes being covered inadequately.

The present investigation was carried out on lower monkeys of various species (Macacus rhesus, baboon Papio tramadryas, marmoset and gelada).

### EXPERIMENTAL METHODS

Ten adult males were used in the experiments. The monkeys were kept on similar diets and under identical conditions. Blood samples were taken twice a week at 8-9 a.m. before the animals were fed. Composition of the peripheral blood (erythrocytes, leucocytes, hemoglobin and differential leucocyte count) was determined in capillary blood from the right ear; composition of venous blood was determined on specimens taken from the right cubital vein. The venous blood was first mixed with sodium citrate (powdered); after 1 minute cell counts were made and the amount of hemoglobin determined (by the Sahli method). For the sake of convenience of presentation the hemoglobin indices are given as percentages. All specimens and the smear were treated in the usual manner. The elapsed time between the collection of blood from the ear and from the vein was no greater than 5-7 minutes. The blood was usually collected by the same persons under standard conditions of experimental environment over a period of 7-17 days.

### EXPERIMENTAL RESULTS

**Red cells.** The number of erythrocytes in 1 mm<sup>3</sup> blood taken from the vein is 20-50% lower (average) in monkeys than in blood taken from the peripheral blood vessels of the ear (see Table).

The Table shows that venous blood contains less hemoglobin than peripheral blood. The two show parallel changes in these indices.

### Average Values for Composition of Blood Obtained from the Ear and from a Vein in Lower Monkeys

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In the case of the monkey Bering, for example, the difference in the number of erythrocytes in venous blood and in capillary blood from the ear (average of 5 estimations) is 1,805,000 and the difference between the hemoglobin values in venous blood and in blood from the ear is 29.6%. In the case of the monkey Artam the former difference is 937,000, the latter 12.1%; in the case of Azon the differences are 390,000 and 2% respectively. The difference in hemoglobin content in different blood vessels is thus determined by the number of erythrocytes.

**White cells.** The number of leucocytes in venous blood is lower than in blood taken from the ear; this was found in all the monkeys examined (see Table). The difference in individual cases reached approximately 50-70%.

It must be noted that the number of leucocytes in peripheral blood of the monkeys was usually higher during the first few days than later on. Repeated examinations of the blood under identical experimental conditions lead to considerable lowering of the total number of leucocytes per 1 mm<sup>3</sup> of blood. Thus, in the case of the monkey Pion the average number of leucocytes determined in the first 5 analyses was 15,370 and 12,560 according to the last 5 analyses; in the case of Kipr the numbers were 12,560 and 8,760 respectively, in the case of Beglets 18,600 and 14,400 respectively. This phenomenon has been described by I. A. Utkin and M. I. Kuksova [3] and was regarded as extinction of reaction to experimental environment. This extinction phenomenon is also shown by the total number of leucocytes in venous blood. For example, in the case of the monkey Kipr the average number of leucocytes in venous blood was 9,040 according to the first 4 analyses and 7,360 according to the last five; in the case of Beglets the values were 10,100 and 9,300 respectively. This tendency was less pronounced in the monkeys Zher and Erdzhis.

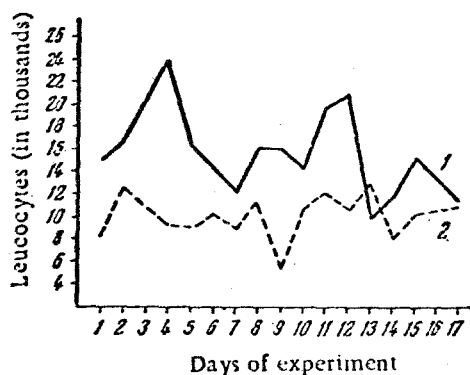


Fig. 1. Changes in the total number of leucocytes in venous blood and blood taken from ear capillary in the monkey Beglets during repeat examinations over a period of several days.

1) Number of leucocytes in the peripheral blood vessels of the ear; 2) number of leucocytes in the cubital vein.

The greatest difference between the total number of leucocytes in blood taken from the vein and from the capillary of the ear was observed during the first days of the investigation when the animal's reaction to experimental environment was more pronounced. This is expressed in increased leucocyte content predominantly in peripheral blood. On extinction of the reaction to environment the total leucocyte values in both cases tend to approach each other as the result of a definite drop in their number in the blood obtained from the ear (Figs. 1 and 2).

On some days the number of leucocytes in venous blood exceeds that of peripheral blood but, as a rule this difference is very slight and occurs after extinction of changes in peripheral blood elicited by reaction to the environment.

A differential leucocyte count (in absolute numbers) revealed that venous blood contained fewer lymphocytes, neutrophils, monocytes and eosinophils than peripheral blood.

The ratio of the main cells of the white series — lymphocytes and polymorphonuclear neutrophils, characteristic for each species of animal as determined from peripheral blood, is maintained also in venous blood (Fig. 3).

The material presented in this paper suggests that the dissimilar content of cellular elements of the blood and of hemoglobin in different blood vessels of the body is a consequence of redistribution over various areas of the vascular system. The differences in the composition of venous and peripheral blood are not qualitative but only quantitative in character.

The process of blood redistribution in the body is achieved by the neurohumoral route with participation of the higher sections of the central nervous system [1] and is related to "true" distribution of the blood associated with bone marrow activity.

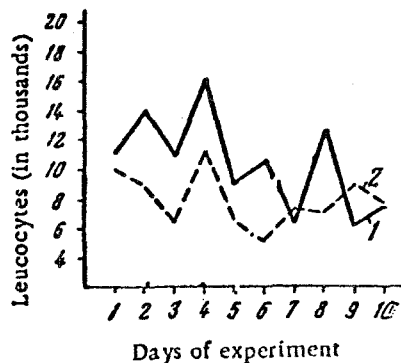


Fig. 2. Changes in the total number of leucocytes in the blood collected from the ear capillaries and a vein in the monkey Kipr during repeat examinations over a period of several days. Legend the same as in Fig. 1.

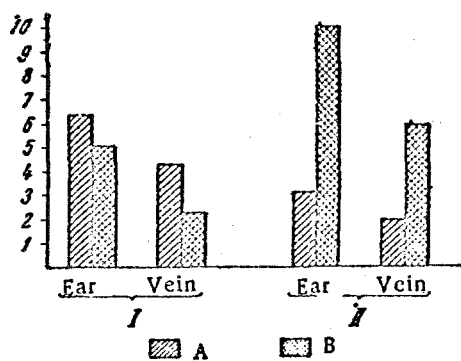


Fig. 3. Ratio of polymorphonuclear neutrophils (A) and lymphocytes (B) in ear capillaries and in a vein of the monkeys Pion (I) and Beglets (II).

In the light of our data it is tempting to consider the work of A. I. Chukavina [4] with respect to "local" and "general" leucocytosis. This author failed to obtain a significant difference in healthy subjects in the number of leucocytes obtained from the skin of various regions of the thorax ("local" leucocytosis) and from the finger ("general" leucocytosis). Nor were any differences in the numbers of leucocytes at the same sites noted after subcutaneous administration of atropine, pantopon and nitroglycerin. This should have been expected, since determination of "local" and "general" leucocytosis in the given case was carried out on peripheral areas of blood vessels. The skin of the fingers and of the chest or abdomen is essentially a peripheral part of the body and therefore regardless of the skin site of blood collection, the numbers of leucocytes found will, it seems to us, be relatively similar.

### SUMMARY

Experiments were performed on various species of monkeys. It was established there was a decreased number of erythrocytes, leucocytes (of the total number, as well as of their separate forms) and hemoglobin in the blood taken from the vein in comparison with the blood taken from capillaries of the ear lobe. The color index (which reflects the degree of saturation of a single erythrocyte by hemoglobin) and the ratio of the lymphocytes and neutrophils are the same in both specimens of the blood. The difference between the total number of leucocytes in the ear capillary and in the vein is greatest during the first few days when the animal is not yet used to the conditions in which the experiment is performed. With a decline of the reaction to the environmental conditions, the difference between the total number of leucocytes taken from the ear capillary and the vein becomes less pronounced due to the decrease of leucocytes in the blood taken from the ear. This demonstrates that uneven distribution of the cellular elements and hemoglobin in various vessels of the organism is the result of redistribution of the blood.

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