THE IMPORTANCE OF THE CAROTID SINUS REGIONS AND DEPRESSOR NERVES IN THE REGULATION OF HEMOPOIESIS

(A TRACER STUDY)

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There is data in the literature on the development of anemia in animals following resection or denervation of the carotid sinuses and section of the depressor nerves [5-7]. However, the influence of these reflexogenic regions on hemopoiesis was studied primarily by determination of the morphologic composition of the peripheral blood. Investigation of the deeper mechanisms of blood regeneration is also undoubtedly of interest.

In this work, in addition to determination of the morphologic composition of the blood in rabbits with removed or denervated carotid sinuses and sectioned depressor nerves, we also studied with the aid of tracer elements the assimilation of iron by the erythrocytes in their regeneration.

EXPERIMENTAL METHOD

The experiments were carried out on rabbits. Removal (23 animals) or denervation (20 animals) of the carotid sinuses was carried out in two stages: first on one side, and 8-14 days later on the other. After section of the depressor nerves the region of the carotid sinus was either removed or denervated by destruction of the carotid body, separation of the adventitia, and application of a 10% solution of carbolic acid to this region. The effectiveness of the operation was verified by determinations of the blood pressure, which was found to have increased in all operated-on rabbits.

For 1-3 weeks prior to operation blood pressure determinations (bloodless, on the ear) as well as determinations of the morphologic composition of the blood were carried out systematically.

The arterial pressure was 80-90 mm on the average, and its variation in the animal did not exceed 10-15 mm.

Variations in the hemoglobin, erythrocyte and reticulocyte contents were also insignificant, and were usually within normal limits (hemoglobin 5-8%, erythrocytes 400,000 - 600,000, reticulocytes 0.3-0.6%).

EXPERIMENTAL RESULTS

In the first days after operation there was noted a slight unilateral increase in blood pressure up to 100-115 mm, a decided tendency to a reduction in the quantity of hemoglobin and erythrocytes, and an increase in the reticulocytes (Fig. 1). After operation on the other side a more rapid increase in the arterial pressure was noted, up to 140-150 and even 160 mm. Simultaneously there was noted a progressive decrease in the quantity of hemoglobin (15-25% average) and erythrocytes (in individual cases 50-55%) and a significant reticulocytosis (up to 15-17%). Individual toxic erythrocytes were observed in the blood smear. The maximal increase in the changes in the blood picture was noted between the 8th and 20th days.

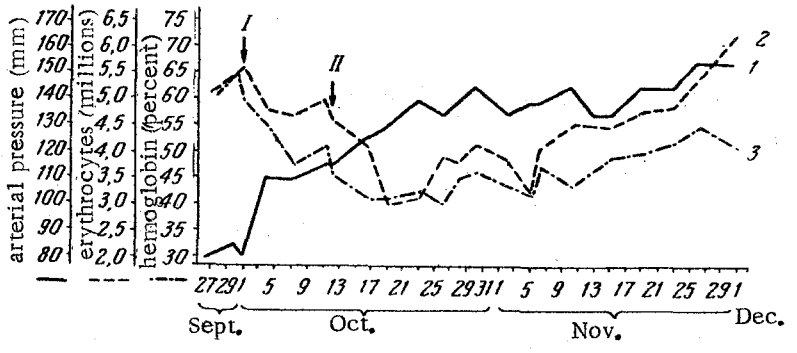

Figure 1. Changes in the arterial pressure (I) and morphologic composition of the blood after denervation of the sino-carotid regions and section of the depressor nerves; 2) erythrocytes; 3) hemoglobin
I – Operation on one side; II – Operation on the other side.

In 1 to $1\frac{1}{2}$ months the appearance of anemia slowly levelled off and the morphologic composition of the blood returned to normal (Fig. 1).

In individual animals we noted a further progessive increase in the quantity of hemoglobin and erythrocytes (up to 9-9.5 million/cc blood).

Thus, upon denervation of the carotid sinuses and section of the depressor nerves not only anemia but in individual cases polycythemia developed.

These data appear to be of vital importance because they coincide with observations on hypertensives in whom such phenomena as anemia and polycythemia were found [3, 4].

In this connection the investigation of M. L. Belenky and Yu. N. Stroykov [1] deserves attention, because they showed in a critical experiment that the appearance of erythrocytes following the introduction of cyanides into the blood of animals was dependent on a reflex action of the carotid sinus on the spleen.

It was important to investigate whether a relationship existed between the noted changes in the blood and the increase in blood pressure.

A comparison of the data showed no relationship between these phenomena. When an increase in hypertension was noted following denervation of the carotid sinuses and section of the depressor nerves, we also noted a progression of the anemia. However, on further observation, in spite of the fact that the blood pressure remained high, the morphologic indices of the constituents of the blood returned to normal. As a rule arterial tension remained high (155-160 mm), also with erythrocytosis.

Obviously changes in the blood following denervation of the carotid regions and section of the depressor nerves do not appear as simple consequences of the development of hypertension.

Experiments with intravenous administration of labelled iron (as Fe^{59} ascorbinate, 25-30 μ Cu) revealed peculiarities in its utilization by the animals submitted to operation. The radioactive iron content of the animal's blood was determined within 5 and 30 minutes, 1, 2, 3, 4, and 5 hours after its administration, and from that time daily for 1 to 1 $^1/_2$ months and still later (individual determinations).

In 1.5 to 2 hours, 25-30%, and in 5 hours or on the next day 15-17% of the administered iron remained in the blood of the control animals (6 rabbits – Fig. 2). In two days the quantity of iron in the blood began rising gradually, usually reaching 40-45% and in individual cases 60% of the original values.

Only 4-5% of iron remained after bloodletting (10 rabbits). Its further increase was sufficiently intense to reach 45-50% the first days, and it rose to 95-97% of the original value on the 8th to 10th days.

Analogous peculiarities were noted in the assimilation of iron in animals with removed or denervated carotid sinuses and those with sectioned depressors. The radioactive iron content of their blood reached 85-97% on the 8th to 9th days and remained for the duration of further observation at the higher figure (Fig. 2).

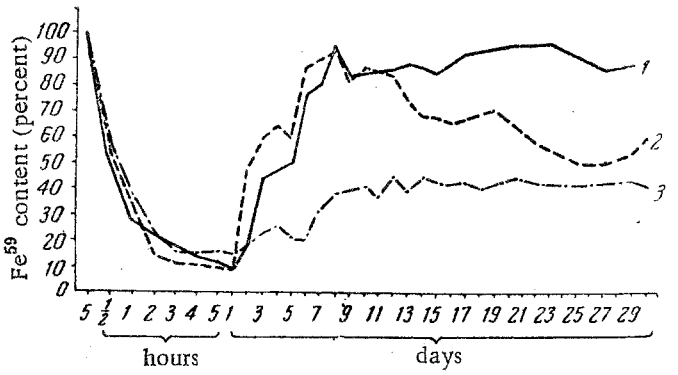

Figure 2. Dynamics of change of radioactive iron content in the blood. 1) After removal of the carotid sinuses and section of the depressor nerves; 2) after bloodletting; 3) control.

It is known that intravenously administered radioactive iron disappears in the first hours-days from the plasma, almost never to reappear there (we became convinced of this in our own experiments), and reappears in the blood as a constituent of the hemoglobin of newly formed erythrocytes, [2].

From the above it follows that the data obtained on the gross content of iron in the blood of experimental animals may serve as a measure of increased regeneration of blood. This conclusion corresponds to the results obtained in our morphologic studies of the blood: at the moment of the greatest increase in iron content in the blood there was noted an increase in the number of erythrocytes, reticulocytes and hemoglobin.

The fact that a speedier and more intensive iron assimilation was noted in some animals, not only during the anemia but also during the administration of iron 1 to 1 $^1/_2$ months after operation when the morphologic composition of the blood was returning to normal, deserves special attention.

This testifies to the fact that after normalization of the morphologic constituents of the peripheral blood following anemia, hemopoesis still remains disturbed. It is possible that the observed polycythemia in a number of cases is a result of this disturbance. Not only has this problem theoretical but also practical significance and needs further study.

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