CHANGES IN BLOOD ERYTHROCYTES AFTER PARTIAL DENERVATION OF THE KIDNEYS IN RABBITS

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Denervation of the blood vessels of various parts of the body and of the internal organs is accompanied by regular changes in the blood system [1-3, 5, 6]. At the same time the mechanism of development of the anemia observed in all cases of denervation cannot be regarded as completely explained. Reports in the literature indicate that the kidneys play a decisive role in erythropoietin formation [4, 7-12]. We have attempted to determine the relationship between the composition of the blood erythrocytes after denervation of the kidneys and the erythropoietic activity of the serum.

EXPERIMENTAL METHODS

The kidneys were denervated in rabbits by the usual method – division of the visible nerve filaments, stripping of the adventitia from the vessels and ureter and subsequent treatment of these structures with 10% phenol solution, and removal of the kidney capsule. In all the experimental animals the erythrocyte count, hemoglobin concentration and reticulocyte count in the blood were determined and the marrow examined before (for 1 month) and after (for 1-3 months) the operation. The erythropoietic activity of the serum was studied only after the operation, using the method of solid culture of marrow tissue. The nutrient medium consisted of rabbit's blood plasma from the animal whose marrow was cultivated. The test sera were added to the nutrient medium. Serum from healthy rabbits or Ringer's solution was added to the control cultures. After incubation for 24 h at 37° films were made from the culture and stained by the Giemsa-Romanowsky method. In each film 500 nucleated cells were counted. Thereafter, for convenience of comparison of the results of the various seedings, the numerical results were calculated in relation to the number of erythroblasts in the initial film of the cultivated marrow, which was always taken as 100%.

EXPERIMENTAL RESULTS

The kidneys of 18 rabbits were denervated. In contrast to the observations of E. L. Kan [2], who described the development of a persistent hypochromic anemia in cats after denervation of the kidneys, with restoration of the normal composition of the peripheral blood 2-7.5 months after the operation, the period of anemia was short in the rabbits and was not found in every case. The results, with their statistical analysis, are shown in Table 1.

A statistically significant fall in the erythrocyte count was observed in 15 animals and occurred during the first 3 weeks after operation (mainly during the first week). The degree of anemia was of short duration (1-3 weeks) and, in individual cases, was followed by a phase of erythrocytosis. In the remaining 3 animals an increase in the erythrocyte count was observed without any preliminary anemia. The hemoglobin concentration usually showed parallel changes to the erythrocyte count, while the number of reticulocytes rose after the operation in all the animals.

In the marrow ertythropoiesis was stimulated: the total number of erythroblasts increased by 50-200% on account of the younger forms (Table 2).

The reticulocytosis in the peripheral blood and the stimulation of erythropoiesis in the marrow, together with some delay in maturation, were observed constantly and for a long time (2-3 months) irrespective of the number of

TABLE 1. Changes in Erythrocyte Composition of the Blood in 18 Rabbits after Denervation of the Kidneys

Index	Character of changes	Time after operation (in weeks)		
		1	2	3
		number of animals		
Hemoglobin concentration	Lowered (by more than $\bar{x}^1 - 2\sigma)^2$	11	4	–
	Raised (by more than $\bar{x} + 2\sigma$)	–	2	1
Erythrocyte count	Increased (by more than $\bar{x} - 2\sigma$)	11	2	2
	Decreased (by more than $\bar{x} + 2\sigma$)	–	2	1
Reticulocyte count	Decreased (by more than $\bar{x} + 2\sigma$)	18	–	–

[1] $\bar{x}$ – arithmetical mean
[2] σ – standard deviation.

TABLE 2. Changes in Number of Erythroblasts (in % of initial value) after Denervation of the Kidneys

Rabbit No.	Day after operation		
	7-10th	12-14th	21-40th
1	152,63	242.1	
2	176 (anemia)	–	276
3	123,21	162.5	–
4	245,71	–	–
5	136,27 (polycythemia)	–	–
6	173 (anemia)	–	160
7	289,4 (anemia)	–	352,63 (anemia)
8	–	137.5	–
9	165,57 (anemia)	–	–
10	261,76	–	–

circulating erythrocytes. Hence the following variants of changes in the erythrocyte composition of the blood were observed after denervation of the kidneys in rabbits: 1) anemia followed by restoration of the normal ertythrocyte count (Fig. 1); 2) anemia followed by erythrocytosis (Fig. 2); and 3) the development of polycythemia without preliminary anemia.

The ertythropoietic properties of the serum were studied at different periods after operation. During the first 3 weeks the erythropoietic activity of the serum was more frequently lowered, but sometimes it was indistinguishable from that in the healthy animals (Table 3). In the later stages (1.5-2 months after operation) the erythropoietic activity of the serum was slightly raised (the number of erythroblasts in the marrow culture rose on the average by 50%).

TABLE 3. Effect of Serum of Healthy Rabbits (A) and Rabbits with Denervation of the Kidneys (B) on Erythroblastic Hemopoiesis in Marrow in Tissue Culture (as % of initial number of erythroblasts)

Rabbit No.	A	B				
		Day after operation				
		7-й	14-й	21-й	40-й	80-й
1	113,51	—	78,61	55,12 (anemia)	—	—
2	65	60,11 (anemia)	29,18 (anemia)	—	—	—
3	143,41	54,33	28,9	27,53 (anemia)	—	—
4	62,37	94,21	—	—	—	—
5	121	—	—	—	46,22 (Polycythemia)	—
6	77,61	—	—	—	—	152,86
7	69,66	—	—	—	—	155,2
8	74,56	—	—	—	152,6	—
9	196,18	—	—	138,66	—	—
10	121,62	—	—	—	164,33	—
11	—	—	112,71	—	—	—

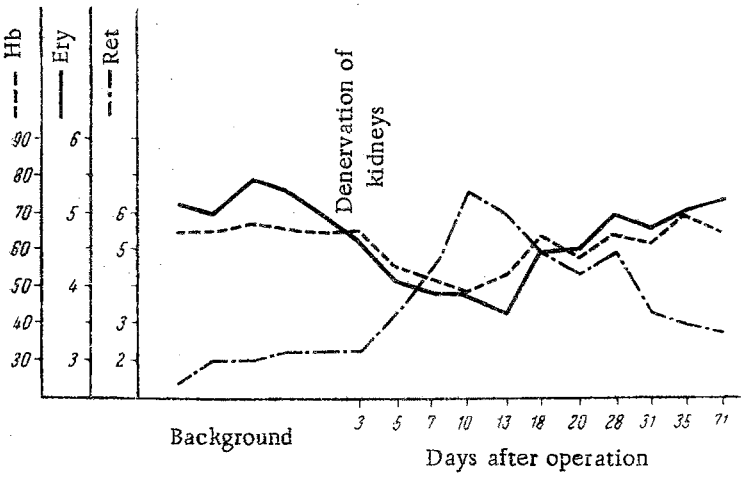

Fig. 1. Changes in the erythrocyte composition of the blood after partial denervation of the kidneys. Anemia followed by restoration of the initial erythrocyte count. Along the axis of ordinates: hemoglobin (in Sahli units), erythrocytes (millions), reticulocytes (in %).

A definite relationship was discovered between the erythropoietic activity and the number of erythrocytes in the blood. For instance, a fall in the erythropoietic activity of the serum was often combined with anemia, and in some cases it preceded anemia. At the same time, the number of erythroblasts in the marrow was increased the most in the animals in which the blood showed the presence of anemia and the erythropoietic activity of the serum was lowered. The impression was gained that some degree of correlation exists between medullary hemopoiesis and the eruthropoietic activity of the serum. Bilateral denervation of the kidneys is thus accompanied by regular changes in the erythrocyte composition of the blood, the erythroblastic activity of the marrow, and the erythropoietic activity of the serum.

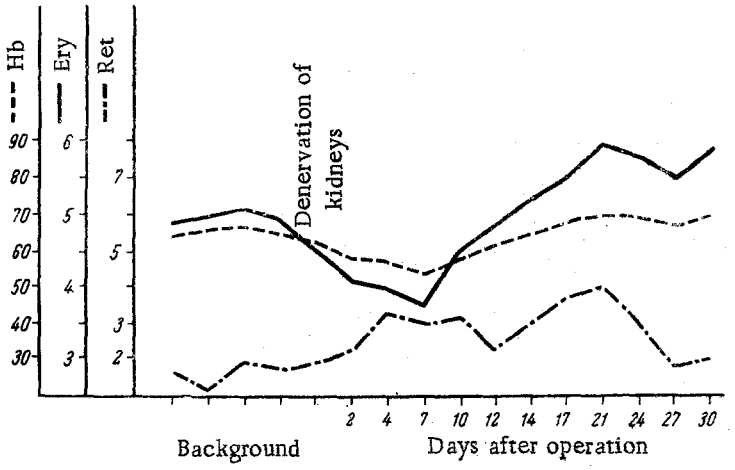

Fig. 2. Changes in the erythrocyte composition of the blood after partial denervation of the kidneys. Anemia followed by erythrocytosis. Legend as in Fig. 1.

SUMMARY

Bilateral partial denervation of the kidneys in rabbits stimulated bone marrow erythropoiesis, slowed erythroblast maturation and caused a rise of the blood reticulocyte count. A brief period of anemia set in during the first three weeks after the operation though the development of polycythaemin was a possible alternative.

At the time of anemia the serum erythropoietic activity was lowered.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.