THE EFFECT OF PANCREATIC DENERVATION ON THE BLOOD SYSTEM

V. I. Teterina

From the Department of Pathophysiology (Head – Prof. D. L. Goldberg), the Tomsk Medical Institute

(Received October 30, 1956. Presented by Prof. V. N. Chernigovsky, Active Member of the Academy of Medical Sciences, USSR)

The stimulation of different receptor fields or the exclusion of receptor zones leads to marked changes in the blood system.

Methods of denervating various internal organs were worked out in the laboratory of V. N. Chernigovsky. These methods made it possible to study the reaction of the blood system to the denervation of the carotid sinuses and the arch of the aorta [1,5,6,10,12], the spleen [2,3,4,9], the liver [7,8], and different sections of the stomach and intestines. Rather profound and lasting anemia was obtained in all of the experiments, which originated from erythropoiesis disturbance, with a disturbance of the erythroblastic maturing processes which developed long after the operation.

Therefore, the organs of the blood system are connected with the central nervous system by a bilateral nerve link. V. N. Chernigovsky and A. Ya. Yaroshevsky [11] advanced the possibility that there are two mechanisms regulating the activity of the blood system organs.

On the one hand, the activity of the blood system organs can be stimulated by impulses coming from the peripheral blood (in connection with the change in its chemical composition and physicochemical properties) into the central nervous system, from which place centrifugal impulses proceed to the executive organs - the blood system organs.

On the other hand, the activity of the blood system organs can also be stimulated reflexively, but the reflex originates from the receptor fields of the various organs sending impulses to the central nervous system, from which signals proceed to the blood system organs.

Therefore, on the basis of many factual data, many researchers have concluded that the exclusion of individual blood system organs and, also, of other receptor fields is reflected in the peripheral blood picture.

The effect of pancreatic denervation on the blood system has not yet been treated in the literature.

The purpose of our work was to trace the hematological changes occurring due to denervation of the pancreas.

EXPERIMENTAL METHODS

Seven healthy dogs with good hematological indices were used for the experiment. The pancreas was denervated in three of the dogs, and the other dogs were used as the control.

Denervation was done by carefully separating the organ from the surrounding tissues. The adventitia was carefully scraped from the main large 5-6 vascular trunks feeding the pancreas and were then coated with a 10% phenol solution over a section 1-1.5 cm long. The pancreatic ducts were processed in the same manner. The small vessels were ligated from two directions and transected.

For two weeks before the operation, the background blood composition was examined for hemoglobin content and number of erythrocytes, reticulocytes and leukocytes; myelograms and hemograms were examined, and the erythrocyte diameter and blood sugar content on an empty stomach were determined. After the operation, all the blood indices were examined after 3-4 days, and then every 7-10 days; every 15 days, a bone marrow punctate was studied, and the erythrocyte diameter was measured. The final stage was a microscopic study of the denervated pancreas.

EXPERIMENTAL RESULTS

After the operation, anemia developed in the dogs, with a maximal hemoglobin decrease of 13-20% by the 8th-24th day. After the 30th day, the hemoglobin content began to increase in all of the animals and, in Maryak, reached the original level on the 84th day, in Bars, on the 47th day and, in Laska, on the 66th day. Analogous changes were observed in the erythrocytes; the maximal decrease was 1,8-2,3 millions on the 8th-24th day of the experiment, then they began to gradually increase and reached their normal level on the 40th-66th day. The reticulocyte reaction was absent in all cases, and the white blood picture was essentially unchanged.

The study of bone marrow hematopoiesis showed that the principal changes in the myelogram concerned the polychromatophilic normoblasts, which increased 5-14% in number; the leuko-erythroblast ratio consequently decreased from 1,2-1,5 to 0,8-0,9. These changes indicated hyperplasia of the erythropoietic tissue and some disturbance of the maturing process of the cellular elements.

The average erythrocyte diameter was slightly changed; only in one dog was there an increase of some 0,25 micron. No shift of the peak in the Price-Jones curve was observed.

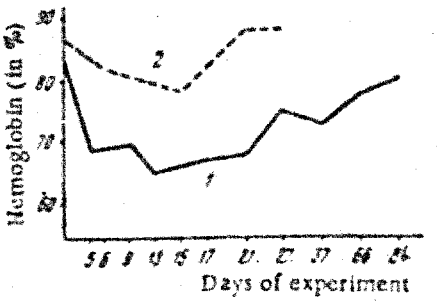

Fig. 1. Dynamics and time of Hemoglobin restoration in Maryak and Malchik.
1) pancreas denervated Maryak); 2) pancreatic ducts ligated (Malchik).

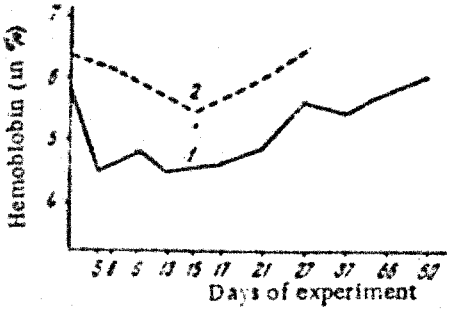

Fig. 2. Dynamics and time of erythrocyte quantity restoration in Maryak and Malchik. The symbols are the same as in Fig. 1.

At first, the blood sugar stayed within the limits of physiological fluctuations, but, after the 13th-27th day, there was a short period (10-14 days) in which its level decreased to 58-64 mg%, after which the sugar content returned to normal.

In the control group of dogs, the gland was totally resected (depancreatization), the pancreatic ducts were ligated or only laparotomy was done, with cauterization of the peritoneum by a 10% phenol solution.

Comparative analysis of the data obtained showed that the hematological indices were more quickly restored in the control than in the experimental group: maximal hemoblobin reduction was 8-20% on the 6th-15th day and maximal erythrocyte reduction, 0.8-1.5 million; the indices were restored on the 18th-21st day, but they were not restored in the experiment until the 47th-84th day (Fig. 1,2). In the control with the laparotomy, the reduction of the indices was extraordinarily weak (hemoglobin: 2-3%, erythrocytes: 0.2-0.3 million), and restoration was observed after only a week.

During the operation, the vessels were not carefully separated nor the adventitia scraped off in the dog Bars; it is interesting to note that the vessels were coated with phenol while still covered by cellular tissue. Restoration of the hematological indices occurred earlier in this dog (on the 47th day) than in the other two (on the 66th-84th day), but much later, however, than in the control animals (on the 18th-21st day) (Fig. 3,4 and Table).

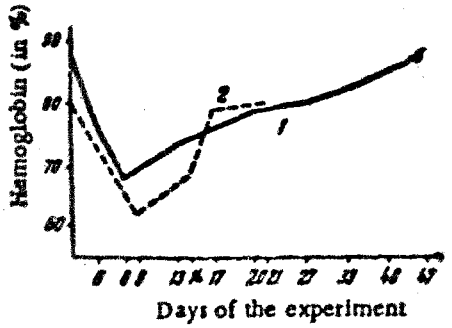

Fig. 3. Dynamics and time of hemoglobin restoration in Bars and Bobka.
1) pancrease denervation (Bars); 2) total resection of the gland (Bobka).

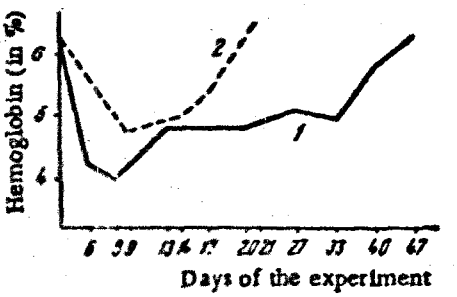

Fig. 4. Dynamics and time of erythrocyte restoration in Bars and Bobka.
The symbols are the same as in Fig. 3.

Time of Restoration of Blood Indices in Experimental and Control Groups

Name of dog	Kind of operation	Restoration time in days	
		hemoglobin	erythrocytes
Moryak	Pancreas denervated	84	40
Laska	The same	66	66
Bars	"	47	47
Malchik	Ligation of pancreatic ducts	21	27
Mishka	Total pancreatectomy	18	18
Bobka	Total resection of the gland	21	21
Zhuk	Laparotomy	7	7

The pathologico-histological picture of the pancreas after denervation was characterized by the congestion of the small and large veins with blood, their dilatation, and, in one case (the dog Maryak), by a sharp dilatation of the blood and lymph vessels, which suggested the relaxation of their walls. In the intrasecretory apparatus, the islands of Langerhans increased in size and capillary injection and minute grains in the cytoplasm of the cells were observed, which could indicate the hyperfunction of the given apparatus. The latter confirms the clinical data, as we observed temporary hypoglycemia in the clinic. The restoration of the sugar level to normal is probably connected with the supplementary action of compensatory mechanisms.

Therefore, a widespread trauma of the nervous system occurred in our experiments.

Regarding the development process of anemia and taking into account the data we obtained in other experimental series (extirpation of the organ, ligation of the ducts, artificial production of fistulae, alloxan diabetes), we concluded that the changes in erythropoiesis can occur due to the denervation of the pancreas, and not due to the disturbance of some specific hematopoietic function of this organ. Denervation, which disturbs the character of interoceptive impulses, regardless of where the actual operation is performed (carotid sinus, arch of the aorta, spleen, liver) affects the hematopoietic processes for a definite period of time.

The restoration of the normal blood picture after a long time interval perhaps indicates the development of compensating, protective adaptations of the body, which act under the influence of the central nervous system.

SUMMARY

It was shown that denervation of the pancreas in dogs caused anemia lasting from 47 to 84 days, with a 15-20% fall of hemoglobin and 1.8-2.8 million erythrocytes, hyperplasia of the erythroblastic tissue of the bone marrow, and inhibition of the maturation process. In controls (laparotomy, resection of the stomach, ligation of the pancreatic duct or removal of the pancreas) anemia was less pronounced, and of shorter duration. The author is of the opinion that anemia was not caused by some specific effect of the pancreas on the hemopoietic process, but was due to the exclusion of the interoceptive field of the pancreas.

LITERATURE CITED

[1] R. A. Durinyan, Experimental Analysis of Anemias Caused by Denervating Certain Internal Organs,* Avtoreferat Dissertation, Moscow, 1956.

[2] E. L. Kan, Data on the Study of the Nervous System's Influence on Blood Composition,* Avtoreferat Dissertation, Moscow, 1953.

[3] E. L. Kan, Byull. Eksptl. Biol. i Med., 1954, Vol. 37, No. 3, pp. 29-33.

[4] E. L. Kan, Byull. Eksptl. Biol. i Med., 1954, Vol. 38, No. 8, pp. 12-18.

[5] S. G. Kachanova, Byull. Eksptl. Biol. i Med., 1956, No. 1, pp. 11-13.

[6] K. A. Maslovskaya, Byull. Eksptl. Biol. i Med., 1953, Vol. 36, No. 4 (10), pp. 59-63.

[7] O. L. Moiseeva, On the Share of the Liver in the Regulation of Blood Composition,* (Clinical-experimental study), Leningrad, 1953.

[8] O. L. Moiseeva, Byull. Eksptl. Biol. i Med., 1954, Vol. 38, No. 8, pp. 23-32.

[9] N. S. Sozanova and E. A. Zhukova, in the book: Contemporary Problems of Hematology and Blood Transfusion,* Moscow, 1955, p. 85.

[10] A. M. Sarvanov, Change in Blood Composition after Denervation of the Carotid Sinuses and Ligation of the Depressor Nerves,* Avtoreferat Dissertation, Khabarovsk, 1955.

[11] V. N. Chernigovsky and A. Ya. Yaroslavsky, The Problem of the Nervous Regulation of the Blood System,* Moscow, 1953.

[12] A. Ya. Yaroshevsky, Arkh. Patol., 1951, No. 3, pp. 16-20.

* In Russian.