EFFECT OF BLOOD TRANSFUSION ON FUNCTION OF THE HYPOTHALAMO-HYPOPHYSEO-ADRENOCORTICAL SYSTEM

A. I. Abesadze, L. I. Akhmeteli, A. V. Khuchua, N. Kh. Borchkhadze, and Z. M. Robakidze

UDC 615.38.015.4:[612.432+612.453+612.826.4

Transfusion of 5-10 ml/kg blood stimulates hypothalamic neurosecretion on the day of the transfusion and depresses it on subsequent days. A more marked and prolonged activation is observed after transfusion of 20-40 ml/kg blood. Besides these changes, stimulation of the glucocorticoid function of the adrenal cortex is also observed.

According to existing evidence [1, 4-6], the hypothalamus plays an important role in the mechanism of action of blood transfusion. The adrenal cortex also participates in reactions of the body to blood transfusion [2-4, 7-10].

Histochemical changes in various parts of the hypothalamus, pituitary, and adrenals and the state of adrenal function after transfusion of various doses of blood were studied in the investigation described below.

EXPERIMENTAL METHOD

Experiments were carried out on 50 dogs. Blood was injected intravenously in doses of 5, 10, 20, and 35-40 ml/kg.

The hypothalamus and pituitary were fixed in Bouin's solution for 5 days. Sections were stained with hematoxylin-eosin, azure II-eosin, the PAS method, and with paraldehyde-fuchsin (by Gabe's method), and counterstained with Halmi's mixture.

The adrenals were fixed in Carnoy's solution and a 15% solution of neutral formalin. Sections were stained with hematoxylin-eosin and by histochemical methods: for ribonucleoproteins (RNP) by Andres's method, for ketosteroids by the Ashbel-Seligman method, for lipids with Sudan III, Sudan black, and Nile

TABLE 1. Changes in 17-HCS Concentration in Blood and Daily Urine after Transfusion of 40 ml/kg Blood

17-HCS	Background	After transfusion			
		2 h	2 days	3 days	5 days
In blood (μg)	5,8±0,5	8,6±1,5 $P>0,05$	9,2±1,2 $P<0,05$	9,4±1,4 $P<0,05$	8,1±0,8 $P<0,05$
Total 17-HCS in urine (mg)	2,5±0,2	—	3,4±0,12 $P<0,02$	2,6±0,18 $P>0,5$	2,5±0,1 no difference
Free 17-HCS	0,48±0,06	—	0,68±0,04 $P<0,05$	0,62±0,07 $P>0,5$	0,5±0,04 $P>0,5$

Experimental Laboratory and Biochemical Laboratory, Research Institute of Hematology and Blood Transfusion, Ministry of Health of the Georgian SSR, Tbilisi. (Presented by Academician of the Academy of Medical Sciences of the USSR N. A. Fedorov.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 70, No. 11, pp. 33-35, November, 1970. Original article submitted December 2, 1969.

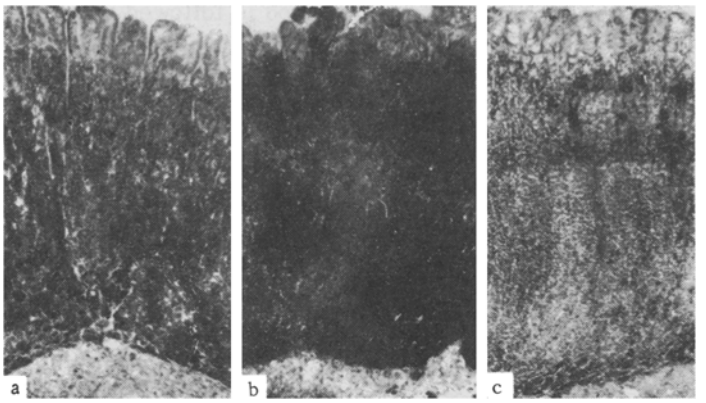

Fig. 1. Changes in content of sudanophilic lipids in adrenals after transfusion of 10 ml/kg blood: a) control; b) 2h after transfusion; c) 24 h after transfusion. Sudan III. 60×.

blue, and for polysaccharides by the PAS reaction. The isoelectric point of the ribonucleoproteins was determined by a method modified by A. L. Shabadash.

The state of adrenocortical function was assessed from changes in the concentration of 17-hydroxycorticosteroids (17-HCS) in the circulating blood, in blood flowing from the adrenals (by the method of Silber and Porter as modified by N. A. Yudaev and Yu. A. Pankov), and also in the urine (by the method of Silber and Porter, modified by M. A. Krekhova).

EXPERIMENTAL RESULTS

Accumulation of neurosecretion in the form of small and large diffuse granules was observed in the paraventricular and supraoptic nuclei of the hypothalamus 2 h after transfusion of 5-10 ml/kg blood. Neurosecretory granules were found also in the axons, and in some places aggregations of the granules, known as Herring's bodies, were formed. A few neurosecretory granules were present in the neurohypophysis. In the adrenal cortex the content of lipids and ketosteroids was increased (Fig. 1a, b). Hypertrophy of the cytoplasm and nuclei of neurons of the anterior hypothalamic nuclei was observed 24 h after transfusion of these doses of blood, and the nucleoli were enlarged and rich in ribonucleoproteins. Only a little neurosecretory material was present in the cytoplasm. The neurohypophysis, however, contained larger amounts of neurosecretory material. The content of lipids and ketosteroids in the adrenocortical cells was reduced (Fig. 1c).

Different phases of the secretory cycle were discovered 2 h after transfusion of 20-40 ml/kg blood in the anterior hypothalamic nuclei. Side by side with cells containing only a very small quantity of neurosecretory material or none whatever, other cells were found whose cytoplasm contained large amounts of neurosecretion. Axons and the neurohypophysis also contained large quantities of neurosecretion in the form of granules and Herring's bodies. The content of lipids and ketosteroids in cells of the adrenal cortex was considerably reduced. The anterior thalamic nuclei 24 h after transfusion contained a large quantity of neurosecretion, but the neurohypophysis contained only a small quantity. The content of lipids and ketosteroids in the adrenocortical cells was increased but not to its initial level.

Investigation of adrenocortical function showed a marked increase in the concentration of 17-HCS both in the circulating blood and in blood flowing from the adrenals after transfusion of 5-10 ml/kg blood. These changes were more marked and prolonged after transfusion of 10 ml/kg blood. The concentration of 17-HCS in the blood was also increased after transfusion of 20 ml/kg blood, and this increase reached a maximum after 10 min. The original 17-HCS concentration was restored after 24 h.

Almost identical changes in adrenocortical function took place after transfusion of 35-40 ml/kg blood, although in this case the stimulation had a stronger and more prolonged action (Table 1).

The concentration of total 17-HCS in the daily urine was increased only on the second day after transfusion, while the concentration of the free fraction was increased on the second and third days after transfusion, although the increase was statistically significant only on the second day (Table 1).

Consequently, transfusion of average doses of blood is followed by changes in hypothalamic neurosecretion in two opposite directions: it is activated on the day of transfusion but inhibited on the following day. A much more prolonged and persistent activation is observed after transfusion of large and, in particular, of massive doses of blood. Parallel with changes in hypothalamic neurosecretion, stimulation of the glucocorticoid function of the adrenal cortex is observed.

LITERATURE CITED

1. A. I. Abesadze, in: Collected Transactions of the G. M. Mukhadze Research Institute of Blood Transfusion [in Russian], Vol. 8, Tbilisi (1962), p. 389.
2. R. M. Glants, Vrach. Delo, No. 11, 983 (1953).
3. R. M. Glants, Vrach. Delo, No. 2, 111 (1955).
4. R. M. Glants, Pat. Fiziol., No. 5, 13 (1960).
5. I. I. Zaretskii, I. A. Mikhailova, and N. S. Rozanova, Probl. Gematol., No. 12, 34 (1959).
6. N. A. Fedorov, Abstracts of Proceedings of the 32nd Plenum of the Scientific Council of the Central Institute of Hematology and Blood Transfusion [in Russian], Moscow (1954), p. 3.
7. H. Mäller, Z. Ges. Inn. Med., 8, 948 (1953).
8. H. Mäller and W. Werdlang, Z. Ges. Inn. Med., 8, 339 (1953).
9. H. Mäller, Physiologie and Klinik der Bluttransfusion, Jena (1960).
10. H. Mäller et al., Z. Ges. Inn. Med., 12, 241 (1957).