PHYSIOLOGY

EFFECT OF REMOVING THE CORTEX OF THE CEREBRAL HEMISPHERES OF DOGS ON THE SALINE CONTENT OF THE BLOOD

V. S. Kulikova

From the Department of Physiology (Chairman: Corresponding member of the Academy of Sciences of the USSR E. A. Asratyan) of the II Moscow I. V. Stalin State Medical Institute (Director: S. I. Milovidov)

(Received December 16, 1955; Presented by Acting Member of the Academy of Medical Sciences of the USSR S. E. Severin)

The question of the regulatory effect of the nervous system on the chemistry of the blood arose long ago. However, up to the present the impression reigns in the literature of physiology that the mechanisms which regulate the dynamic constancy of the salt content of the blood lie below the cortex of the cerebral hemispheres [1, 2, 5, 6, 7].

Our work, forming part of the general investigation of the problem of the role of the cortex in unconditioned reflexes which is being worked out by the whole department, had as its aim to show the participation of the cortex of the cerebral hemispheres in the regulation of the constancy of the salt content of the plasma by their surgical elimination as proposed by E. A. Asratyan.

Eliminating the cortex of the cerebral hemispheres surgically, E. A. Asratyan found a basis for I. P. Pavlov's theoretical assumption that the cortex participates in unconditioned reflexes. He showed that the action of unconditioned reflexes becomes finer, more exact and more complete under the influence of the cerebral hemispheres.

Thus, the work of members of the department [3, 4] showed that the unconditioned reflex activity of the secretory mechanisms of the stomach, salivary glands, and liver, the regulation of the hematic system and of gaseous exchange changes considerably in dogs deprived of the cortex of the cerebral hemispheres. This regulation becomes cruder, inert and incomplete.

In our work, we observed the effect of removal of the cerebral cortex of dogs on the saline content of the blood.

EXPERIMENTAL METHODS

We used the time required for the calcium content of the plasma to level out after the intravenous loading of the animal's system with calcium, as the indicator of the regulation of the saline content of the blood.

The investigation was carried out in three series of experiments. At first we studied the potassium, calcium and inorganic phosphorus content of the blood plasma of normal dogs. Then we studied the same plasma components in dogs after the removal of the cortex of one cerebral hemisphere and, finally, after the removal of the cortex of the second cerebral hemisphere.

At all stages of the investigation of the dogs, tests were made by loading the animal's system with calcium salts.

After the salt content of normal blood plasma was studied, the cortex of one of the cerebral hemispheres was removed in all the experimental dogs. In approximately 7-10 days, the dogs were again used in the experiment to study the same indicators of the blood plasma.

EXPERIMENTAL RESULTS

Many tests convinced us that the potassium, calcium, and inorganic phosphorus content of the blood plasma of dogs deprived of the cortex of one hemisphere does not change. The absolute content of the electrolytes which we determined and the variations of their plasma content from experiment to experiment were the same as before the operation.

No deviations whatsoever from the normal content of the electrolytes under study were found in the blood serum of the experimental dogs even after greater periods of time after the operation (we tested two dogs in the course of a year after the operation for the removal of the cortex of one hemisphere).

In studying the potassium, calcium and inorganic phosphorus content of the blood plasma of the same dogs after the removal of the cortex of the second hemisphere, no obvious changes were observed in the content of the electrolytes under study neither in the first period after the operation nor at later times (Fig. 1). The experimental data for the dog Prokaznik at all stages of its investigation are shown in Figure 1.

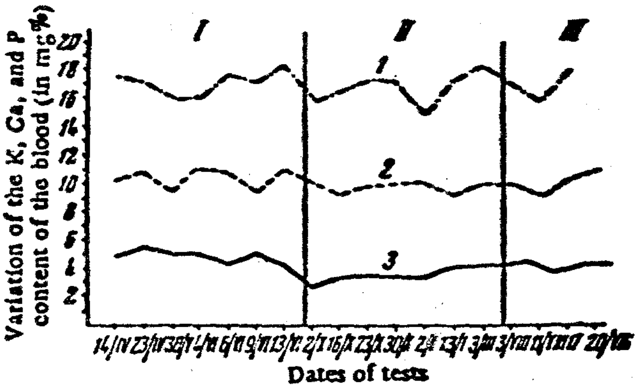

Fig. 1. Variations in the potassium (1), calcium (2) and phosphorus (3) content of the blood of the dog Prokaznik.
I) Prior to the operation; II) after removal of the cortex of one hemisphere; III) after removal of the cortex of both hemispheres.

Thus, the experiments which were set up to study the potassium, calcium and inorganic phosphorus content of the plasma of dogs deprived of the cortex of the cerebral hemispheres showed that the quantitative content of the electrolytes did not deviate from normal, neither in the first days after the operation or in later months.

As was observed above, the problem of the role of the cortex of the cerebral hemispheres in the regulation of the mineral content of the blood using calcium as an example was studied by us in experiments with loading. For this we selected a dose of calcium chloride and calcium gluconate which doubled the calcium content of the plasma.

Taking blood from the femoral artery of the dog in order to determine the initial calcium content of the plasma, we introduced calcium chloride or calcium gluconate intravenously, using 1.3 ml of a 10% solution per 1 kg of the animal's weight. Administration of this amount of calcium doubled its content in the blood. It increased from 10 to 20 mg% in the first 5 minutes after its administration. Therefore, blood was taken 5 minutes after the intravenous administration of calcium and then every hour until the calcium content of the blood returned to the original level. Such experiments were carried out on healthy dogs, as well as on dogs deprived of the cortex of one or two hemispheres.

In these experiments a difference was found in the return of the serum calcium to the original level between healthy dogs and operated ones. In the first hours, when the system is ridding itself of the huge excess of calcium in the blood, its elimination proceeded almost identically in normal and operated dogs. In the next hours, the nature of the elimination of a small excess of calcium differed considerably among normal dogs, dogs deprived of the cortex of one hemisphere, and, especially, of dogs operatively deprived of the cortex of both hemispheres. It is plainly visible in Fig. 2 that the calcium content of normal dogs returns to normal at the end of the 4th hour, the calcium content of dogs deprived of the cortex of one hemisphere returns to normal only at the end of the 5th hour, and of bilaterally decorticated dogs only at the end of the 7th hour. It should be observed that the elimination of the considerable excess of calcium in the blood of healthy and operated dogs occurs at approximately the same rate. But it leads to the complete re-establishment of the normal calcium level of the blood in the former, while in operated dogs (especially after the removal of the cortex of both hemispheres) the accuracy of the regulation is destroyed; an insignificant excess of blood calcium (2-3 mg%) remains for several hours.

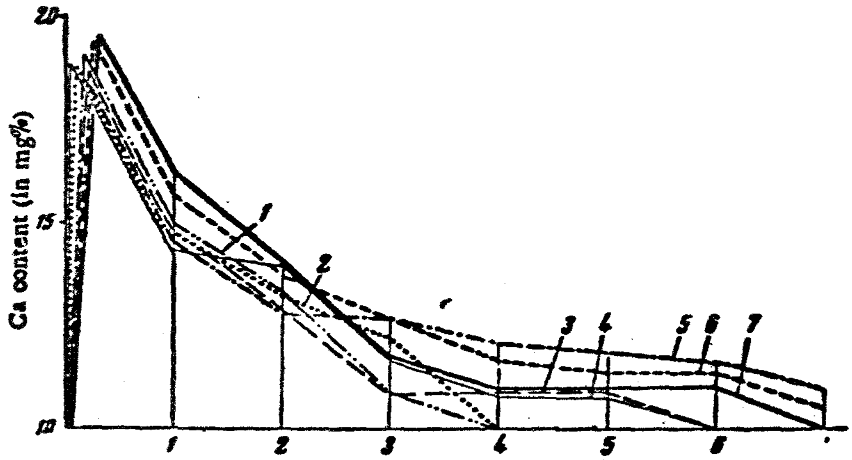

Fig. 2. Curves of the speed at which the calcium in the blood plasma returns to normal after intravenous loading of the dog's system with calcium gluconate. 1, 2) Before the operation; 3, 4) after removal of the cortex of one hemisphere; 5, 6, 7) after removal of the cortex of both hemispheres.

LITERATURE CITED

[1] K. S. Abduladze et al., Arkh. Biol. Nauk SSSR 38, 2, 407-411 (1935).

[2] N. P. Vashetko and V. S. Kozlovsky, Fiziol. Zhur. SSSR 40, 1, 76-81 (1954).

[3] A. A. Gubar and F. A. Oreshuk, Byull. Ekspt. Biol. i Med. 42, 9, 11-14 (1956)*

[4] I. K. Zhmakin, Effect of Removing the Cortex of the Cerebral Hemispheres on the Gaseous Exchange of Dogs, Author's abstract of dissertation** (Moscow, 1954).

[5] S. M. Leites, The Autonomic Nervous System and Internal Secretion** (Kharkov, 1927) fourth edition, pp. 111-117.

[6] N. F. Popov and E. M. Mikhailova, Sovremennoi Nevropatol., Psikhiat., i Psikhogig. 11, 4, 24-28 (1933).

[7] P. Yankovskaya, Izvest. Nauch. Inst. Lesgafta (Leningrad) 21, 1-2, 87-94 (1938).

* Russian pagination. See C. B. Translation.

** In Russian.