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FUNCTIONAL DISTURBANCES FOLLOWING MASSIVE INFUSIONS OF PHYSIOLOGICAL SALINE

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The sensitivity of the organism to loss of blood is not dependent solely on the amount of blood lost, or on the rate at which it is lost. Experiments carried out in I. R. Petrov's laboratory [3] have shown that over-heating, trauma, starvation, and other factors greatly aggravate the consequences of hemorrhage. Loss of blood leads more quickly to hemorrhagic collapse in anesthetized [1] or shocked [2] subjects. Replacement therapy, involving transfusion of blood or blood extenders, is most effective during the early stages of collapse. Infusions of blood or physiological saline are given after loss of blood in order to avert collapse. Saline is sometimes infused in very large amounts, with the intention of providing the organism with the largest possible reserves of fluid.

Arterial pressure is not significantly affected by slow intravenous infusion of even very large amounts of physiological saline. On this basis it has been thought that massive infusions of physiological saline are quite safe, and are therefore not only permissible, but even desirable in cases in which there is a risk of hemorrhage. It should not, however, be overlooked that intravenous infusion of physiological saline is not without effect on the reaction of the organism to loss of blood.

We have investigated the reaction of the organism to loss of blood following intravenous infusion of large volumes of physiological saline.

* In Russian.

EXPERIMENTAL METHODS*

Our experiments were performed on dogs. Subcutaneous injections of morphine, in doses of 0.5 ml of 1% solution per kg of body weight, were given 30-45 minutes before the experiment. The dogs were tied down, and the common carotid artery, trachea, external jugular vein, and iliac artery were exposed. Recordings of arterial pressure and respiration were made during the experiments. A glass cannula was inserted into the jugular vein, and connected by rubber tubing with a graduated vessel containing physiological saline at 37-39°. After recording the initial arterial pressure and the respiration, the physiological saline was infused into the vein, at a rate of 10-15 ml per minute, until the total volume infused amounted to 1-2 times the volume of circulating blood (this volume was computed from I. R. Petrov's table). Immediately after completion of the transfusion,blood was withdrawn through a cannula inserted into the iliac artery.

EXPERIMENTAL RESULTS

Since slow infusion of large amounts of saline had no significanct effect on arterial blood pressure, blood letting began at the pressure level shown in Table 1. The animals were in a state of profound hemorrhagic collapse. Arterial pressure fell to 10-40 mm Hg after the loss of 29-69% of the circulating blood.

The results are presented in the Table.

TABLE 1

Effect of Saline Infusions on the Sensitivity of the Organism to Subsequent Exsanguination

Weight of dog, Kg	Initial arterial pressure, mm Hg	Amount of physiological saline infused, ml	Arterial pressure after infusion, mm Hg	Amount of blood removed, ml	Percentage of total volume of blood removed	Arterial pressure after exsanguination, mm Hg
7.3	124	1 100	104	184	35.3	30
7.1	150	570	150	150	29.4	24
6.2	150	600	150	230	51.9	40
7.4	140	700	150	300	50.7	25
7.0	120	600	126	300	60.0	10
8.0	160	1 100	164	375	65.6	30
8.9	150	900	160	440	69.1	25
5.3	160	700	150	200	65.1	16
11.7	175	900	200	700	66.6	24
20	150	2 000	160	1 000	64.6	30
			Average		56.6	

As is evident from the Table, massive infusion of physiological saline not only did not raise resistance to exsanguination, but in fact lowered it. Profound shock followed the loss of about half the circulating volume of the blood.

It appears that the nature of the reaction of the arterial pressure to loss of blood changes after saline infusions. Arterial pressure remained steady for a certain time after blood-letting had begun, in the control animals (Figure 1). Fall in arterial blood pressure began as soon as bleeding of previously infused animals was commenced. This is evidence of weakening of compensatory reflex reactions, which usually appear in response to loss of blood. The alterations in arterial pressure recorded during exsanguination of an animal previously loaded with saline are shown in Figure 2.

It thus appears that although slow, massive infusion of physiological saline does not give rise to any visible stable changes in arterial pressure it nevertheless affects the reactivity of the organism.

* The Third-Year students Novikova and Ryzhkova took part in these experiments.

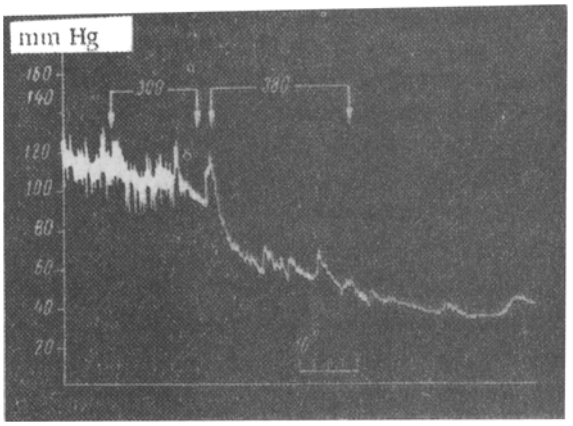

Fig. 1. Alterations arterial pressure of a healthy dog during exsanguination (weight of dog 11 kg).

The absence of pressure changes during slow infusion is evidence of the rapid deployment of reflex adaptive mechanisms, tending towards maintenance of the normal level of arterial pressure. The more prolonged the infusion, the greater is, in all probability, the increase in sensitivity of the vasomotor center, and the more active and adequate is the corresponding compensatory reaction.

It might have been expected that at higher rates of infusion of saline the compensatory reaction would also be accelerated, and hence that there would be a steadily rising intensification of stimulation of the vasomotor center. The possibility thus emerges of development of inhibition of the center, presumably of a parabiotic nature, with the danger of fall in arterial pressure.

The following experiments* were performed on a group 12 dogs, in order to verify this possibility. The animals were treated as in the preceding group, except that intravenous infusion of saline took place at a rate of not less than 50 ml per minute; as before, pressure was registered in the common carotid artery.

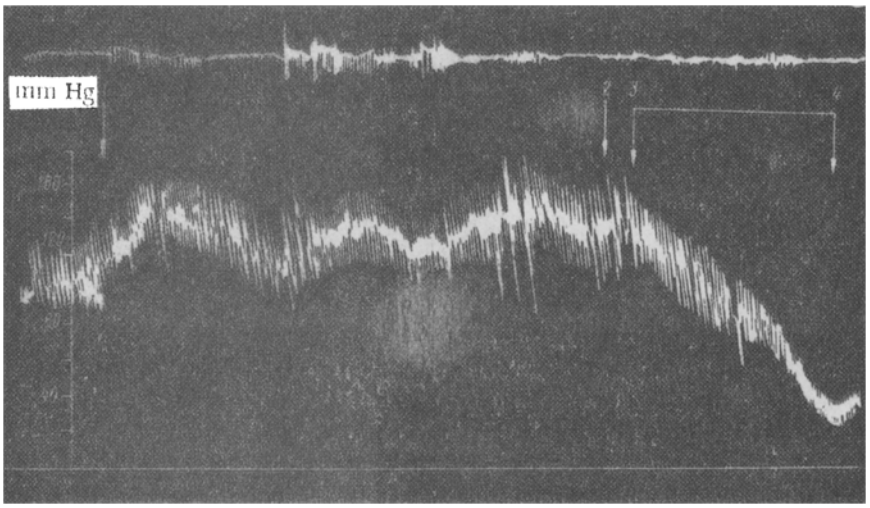

Fig. 2. Reaction to exsanguination of a dog previously infused with physiological saline (weight of dog 6.2 kg). 1) Beginning of infusion; 2) end of infusion; 3) beginning of blood-letting; 4) end of blood-letting. 500 ml of physiological saline was infused, and 230 ml of blood removed. Explanation of curves (from above down): respiration, arterial pressure.

The reaction elicited in response to acute overloading with saline, in particular that part of it manifested by alterations in arterial pressure, was not uniform for all the animals. In two cases arterial pressure at first rose steeply, and then fell abruptly, leading to the death of the animal (Figure 3).

A considerable fall in arterial pressure was seen in 7 dogs soon after beginning the infusion. The dogs did not die, however, and the pressure even rose slightly as infusion was continued. Death ensued as a result of pulmonary edema when the volume of fluid infused was equal to 2-3 times the volume of circulating blood. Pulmonary edema supervened in 3 dogs without previous fall in arterial pressure.

* The Third Year students Chaika, Rudneva, and Lizogubenko took part in these experiments.

It thus appears that rapid infusion of physiological saline caused a pronounced fall in arterial pressure in 9 out of 12 dogs, followed by their death, i.e., collapse ensued from acute overloading of the organism with physiological saline.

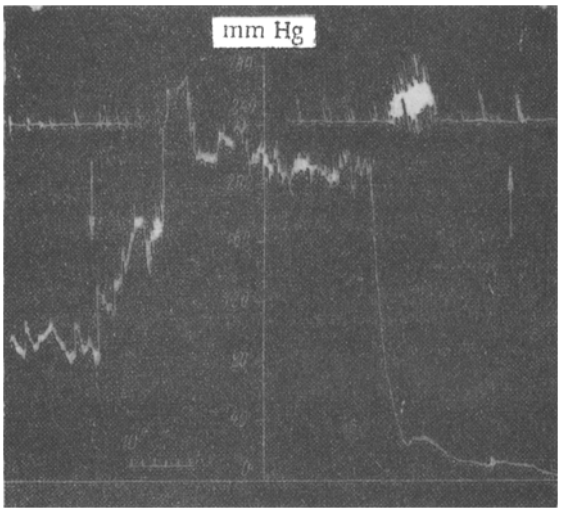

Fig. 3. Reaction to rapid infusion of physiological saline (650 ml infused; weight of dog 6 kg). ↓ beginning of infusion; ↑ end of infusion. Explanation of curves as in Figure 2.

The most common cause of death from acute overloading with physiological saline was pulmonary edema. Arrest of the heart took place at relatively high arterial pressures (80 mm Hg). After opening the iliac artery pressure fell gradually and smoothly to zero. This is evidence of the disturbance in normal hemodynamics caused by overloading with physiological saline.

Histological examination of the organs of the animals of this group, performed in collaboration with the Chair of Pathological Anatomy, revealed certain characteristic changes in the tissues' structure, apart from the generalized edematous condition. The argyrophilic substance of the lung tissues was disintegrated, and the pulmonary blood vessels contained protein floccules, suggesting that the plasma proteins had undergone profound alterations.

Our experiments show that significant changes take place in the organism following rapid infusion of large amounts of physiological saline.

Stimulation of the vasomotor center associated with slow infusion of physiological saline aggravates the outcome of subsequent blood-letting.

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RATE OF ELIMINATION OF CONGO RED FROM THE BLOOD STREAM OF DECEREBRATE DOGS

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Ablation of the cerebral hemispheres of dogs causes alterations in the vegetative and somatic functions of the organism, such as the nature of gastric secretion, the activity of the salivary glands, etc. There are also changes in the response of the organism to certain factors: they become more responsive to introduction of hormones [1], and they give a more intense leukocytic reaction to parenterally introduced proteins [2].

There can be no doubt that the reticuloendothelial system (RES) takes part in these reactions.

The present paper is devoted to a study of RES function in dogs before and after decerebration.

* In Russian.