PRINCIPLES GOVERNING CHANGES IN OSMOTIC CONCENTRATION OF THE BLOOD DURING EXPOSURE TO EXTREME CONDITIONS

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Ether anesthesia and surgical operations lowered the serum osmotic pressure in rats. If the osmotic concentration was first lowered by administration of water to the animals, anesthesia and operations gave the opposite effect. Changes in the sodium and potassium concentrations were not parallel to the corresponding changes in the total osmotic pressure of the blood.

During exposure to extreme conditions marked changes occur in the water and salt balance of the body, including changes in the osmotic pressure of the extracellular fluid [3, 4, 7].

The writers' previous investigations [6] showed that during operations the total osmotic pressure of the blood serum may change in either direction.

After analysis of clinical material the hypothesis was put forward that the reason for these opposite changes in the blood osmotic concentration could be differences in the initial level of this parameter.

EXPERIMENTAL METHOD

To test this hypothesis experiments were carried out on 48 male albino rats weighing from 200 to 340 g, divided into 6 series (with 8 rats in each series). Series I consisted of control (intact) animals, the rats of series II were anesthetized with ether for 5 min, the rats of series III were subjected to ether anesthesia and subsequent operative trauma, consisting of laparotomy and traction on the root of the mesentery for 30 sec (15-20 pulls), and the rats of series IV were warmed to 37°, given water by gastric tube in a dose of 3 ml/100 g body weight, in order to lower the total osmotic pressure of their blood. In the experiments of series V, water was given for a second time after an interval of 30 min, and 15 min later the animals were anesthetized with ether. In the experiments of series VI, after administration of water to the animals they were anesthetized with ether and trauma was then applied. The rats were sacrificed by decapitation. The total osmotic pressure of the blood was determined by the method of Barger and Rust,and the serum potassium and sodium concentrations estimated by flame photometry. The results were analyzed by statistical methods [8]. The ratio

$$K = \frac{\text{osmotic pressure produced by Na}}{\text{total osmotic pressure}}$$

was calculated [10].

EXPERIMENTAL RESULTS

In the intact animals ether anesthesia lowered the total osmotic pressure, but did not change the serum potassium and sodium concentrations of the value of K. The surgical operation, against the background of anesthesia, lowered the osmotic pressure of the blood still further. The decrease in the serum potassium

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TABLE 1. Changes in Osmotic Pressure and Concentration of Univalent Cations in Blood of Rats after Operative Trauma

Series of experiments	Osmotic concentration of blood serum (in osmol/kg H_2O)	Concentration of cations in blood serum (meq/liter)		
		Potassium	Sodium	*K*
I	290,05±9,23	6,57±0,26	152,2±3,36	0,52±0,06
II	250,5±3,40 $P<0,001$	5,11±0,74 $P>0,05$	141,41±4,79 $P>0,05$	0,56±0,05 $P>0,5$
III	180,16±5,35 $P<0,001$	4,6±0,29 $P<0,001$	147,33±6,09 $P>0,05$	0,82±0,08 $P<0,001$
IV	193,66±8,1 $P<0,001$	7,29±0,59 $P>0,05$	148,16±9,63 $P>0,05$	0,76±0,04 $P<0,001$
V	248,5±11,05 $P<0,001$	4,98±0,14 $P<0,001$	136,35±6,6 $P<0,001$	0,54±0,03 $P>0,05$
VI	242,3±21,5 $P<0,001$	6,17±0,68 $P>0,05$	149,0±7,8 $P>0,05$	0,64±0,08 $P>0,05$

concentration in this case, compared with its initial level, was statistically significant, but was indistinguishable from the values obtained during anesthesia. The value of K increased under these circumstances.

Administration of water to intact rats led to a marked decrease in the total osmotic pressure but had no effect on the level of univalent cations in the blood serum. The value of K rose sharply on account of the decrease in osmotic concentration.

Anesthesia after water loading raised the blood osmotic pressure above its initial level (series IV) but lowered the serum potassium concentration and the value of K.

Operative trauma, inflicted on the animals anesthetized after water loading, had no significant effect on the osmotic pressure. However, compared with the initial level (series IV), this still remained high (Table 1).

These experiments confirmed the hypothesis that changes in the total osmotic pressure of the blood serum after exposure to extreme conditions depend on the initial value of this parameter. If intact animals were anesthetized and traumatized, the osmotic concentration fell, but if its concentration was first lowered by administration of water, these procedures had the opposite effect. The experiments confirmed the development of hypokaliemia in response to operative trauma [5, 6]. The disparity observed previously by the writers [6] between the total osmotic pressure and the concentration of univalent cations in patients also was confirmed by these experiments. This was probably due to the presence of regulatory mechanisms of homeostasis, which, despite the fact that operative trauma was inflicted under different conditions from those which existed initially, are aimed at maintaining the optimal level of water and salt homeostasis.

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