RESISTANCE OF ERYTHROCYTES TO HARMFUL FACTORS DURING CARNIOCEREBRAL HYPOTHERMIA

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The effect of local brain cooling on the resistance of erythrocytes to chemical and osmotic hemolytics was studied in experiments on dogs. With lowering of the body temperature of the animals from 38 to 24° C, cells with increased resistance disappeared from the blood stream and erythrocytes with minimal chemical resistance became predominant. Meanwhile reticulocytes disappeared from the blood and erythrocytosis developed. The osmotic resistance of the red cells either rises a little or remains at its initial level in hypothermia.

KEY WORDS: hypothermia; resistance of erythrocytes.

The action of local brain cooling on the level of viability of the erythrocytes as reflected in their resistance to chemical and osmotic hemolytics was studied.

EXPERIMENTAL METHOD

After trimeperidine premedication and induction of anesthesia with hexobarbital, dogs (weighing 8-14 kg) were intubated and anesthesia maintained with ether and air. Craniocerebral hypothermia was produced by placing the animal's head in the factory-built "Termokholod-2F" hypotherm. Blood was taken from the femoral vein before exposure to cold and at every 2° drop while the body temperature was falling. The resistance of the erythrocytes to the hemolytic action of hydrochloric acid was studied by the acid erythrogram method [5] and their resistance to hypotonic sodium chloride solutions as described in [10]. Reticulocytes were counted in dried blood films [8]. The number of erythrocytes in 1 ml blood also was determined [10].

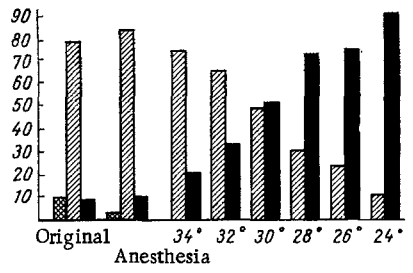

Fig. 1. Changes in chemical resistance of erythrocytes during craniocerebral hypothermia. Abscissa, time of taking blood samples; ordinate, concentration of erythrocytes (in %); obliquely shaded columns represent erythrocytes with average resistance, cross-hatched columns – with increased resistance, black columns – with decreased resistance.

EXPERIMENTAL RESULTS AND DISCUSSION

The results given in Fig. 1 show that as the temperature fell the number of cells with increased resistance fell until they completely disappeared from the peripheral blood. As the hypothermia deepened the number of cells with minimal chemical resistance increased on account of a simultaneous decrease in the number with average resistance. At the end of cooling (24° C) the mean concentration of cells with low resistance was 89.6 ± 3.3 %, but in 30 % of the experiments all the circulating erythrocytes had this type of resistance.

During cooling the number of reticulocytes in the blood fell from 1.05 ± 0.04 to 0.46 ± 0.021% (at 34°C). At 32° C and below, the immature erythrocytes disappeared completely from the circulation. The switch to all the erythrocytes in the group having lowered resistance was accompanied by the development of eryth-

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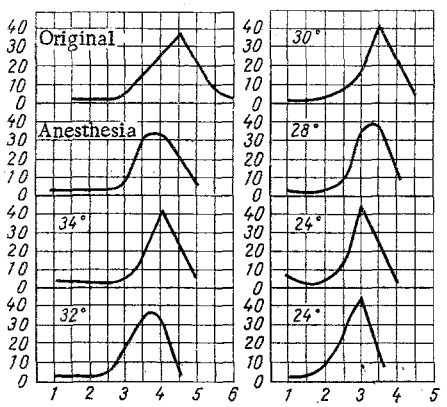

Fig. 2. Acid erythrograms during craniocerebral hypothermia. Abscissa, hemolysis time (in min); ordinate, concentration of erythrocytes (in %).

rocytes in 1 ml blood increased from 5.28 ± 0.08 to 8.29 ± 0.17 million. This can be explained by a decrease in the hemolytic activity of the hematopoietic organs, for the process of destruction of the red cells is always accompanied by erythropenia [11]. Craniocerebral hypothermia changes the configuration and size of the red cells, and these changes are opposite to prehemolytic changes [13]. The volume of the cells and their thickness decreased, so that the shape of the erythrocytes in the hypothermic organism becomes even less spherical than in the original state [9].

Local brain cooling altered the duration of hemolysis of the red cells under the influence of the chemical lysin. Rupture of the cell membranes began 1-1.5 min earlier and finished 2.5-3 min earlier than in the control. As the temperature fell, the time required for complete destruction of the cells was shortened from 4 min to 2.5 min. Under these conditions the outline of the acid erythrograms was altered: They were shifted to the left, the left wing was shortened, and the right was elevated (Fig. 2). A shift of the erythrograms to the left is known to indicate blocking of the hemolytic function of the blood system [7].

Since erythrodiaeresis is the initial stage of erythropoiesis [12], the level of hemolytic activity of the erythron determines the state of its blood-forming function. The regenerative power of the blood is determined by the number of cells with increased resistance to chemical hemolytics [1, 3, 4, 6, 7, 11]. It can therefore be deduced that in the early stages of craniocerebral hypothermia the delivery of red cells from the bone marrow to the blood stream is delayed, whereas with deepening hypothermia it ceases completely.

The osmotic resistance of the erythrocytes was not altered so regularly under the influence of craniocerebral hypothermia. In 60% of experiments increased osmotic resistance of the red cells was found. The lower limit of hemolysis was shifted from 0.43 ± 0.16 to 0.38 ± 0.42% and the amplitude of the resistance remained unchanged. In the remaining experiments hypothermia had no effect whatever on the resistance of the erythrocytes to hypotonic solutions.

The reason for the disparity between the changes in chemical and osmotic resistance of the erythrocytes [2] observed in the present experiments also may be that different structural elements that determine the resistance of the cell during craniocerebral hypothermia respond unequally to the action of the harmful agents.

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