

THE DEPOT FUNCTION OF THE SPLEEN IN NONPHARMACOLOGICAL HYPOTHERMIA

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The mobilization of the blood contained in the spleen is a factor accompanying many acutely developing pathological states.

In this study an attempt was made to determine the changes taking place in the depot function of the spleen at various stages of development of hypothermia not produced by pharmacological agents.

EXPERIMENTAL METHOD

The experiments were conducted on unanesthetized albino rats of both sexes, weighing 110-140 g, fasted for 5 h. The animals (72) were divided into four groups, with 18 in each group. Group 1 consisted of normal rats. The rats of group 2, after their skin had been moistened, were placed in a refrigerator at 5° for 5 min (during this time the rectal temperature fell by approximately 1°). The rats of the 3rd and 4th groups were cooled in a bath of ice-water until their rectal temperature had fallen to 30° (after 5-7 min) and 16° (after 12-18 min). At the end of the corresponding period of exposure to cold, the animals were sacrificed by immersion in liquid oxygen.

The spleen was extracted and weighed, and its weight expressed as a percentage of the body weight.

The degree to which the spleen was filled with blood was also determined by the following method [1]. The hemoglobin was extracted from a known weight of spleen tissue, ground in a mortar with powdered glass. The optical density of the extract was measured in a photoelectric colorimeter.* An extract of a known weight of blood taken from the chambers of the heart was measured in the same way. The amount of circulating blood equivalent to the amount of hemoglobin extracted from the spleen was then calculated. The final result was expressed in per cent (in g blood/100 g of organ).

In addition, the hemoglobin concentration in the blood taken from the chambers of the heart was determined by a photoelectric colorimetric method [4].

EXPERIMENTAL RESULTS

The experimental results are given in the table below.

It is clear from the table that in hypothermia there was a marked decrease in the weight of the spleen. Three references were found in the literature to a reaction of this type of general cooling of the organism. Barcroft and Elliott [8] observed contraction of the spleen in dogs, transplanted subcutaneously, after the animals had been kept for 20 min in a refrigerator (0°). Wendt [13] determined the size of the spleen roentgenologically in anesthetized rabbits with rectal temperatures of 30°, 26-24°, and 19-18°; hypothermia was accompanied by a decrease in the size of the organ, most marked at 26-24°. I. G. Varman [2] found no definite change in the volume of the spleen in dogs cooled under anesthesia to 35°; deeper hypothermia led to a considerable contraction of the organ.

*It must be admitted that besides hemoglobin, certain other pigments must have been transformed from the spleen tissue to the extract. However, by comparison with the hemoglobin their amount must have been small, and could not have introduced any significant error into the calculations.

Effect of Hypothermia on Depot Function of the Spleen and Hemoglobin Concentration in the Circulating Blood ($M \pm m$)

Group of animals	Spleen		Hemoglobin in circulating blood (in g %)
	weight (in % of body weight)	degree of filling with blood (in % of wt. of organ)	
1st (normal)	$0,82 \pm 0,045$	$52,8 \pm 3,04$	$14,1 \pm 0,39$
2nd (in initial period after cooling)	$0,62 \pm 0,056$ ($t=2,8$)	$38,8 \pm 2,68$ ($t=3,5$)	$14,0 \pm 0,40$
3rd (cooled to 30°)	$0,59 \pm 0,055$ ($t=3,2$)	$37,2 \pm 2,73$ ($t=3,8$)	$14,9 \pm 0,55$
4th (cooled to 16°)	$0,64 \pm 0,074$ ($t=2,3$)	$37,9 \pm 3,24$ ($t=3,4$)	$16,1 \pm 0,55$ ($t=3,0$)

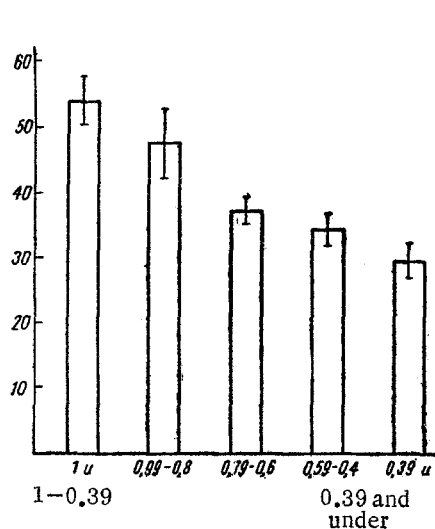


Fig. 1. Relationship between weight of spleen (along axis of abscissas, in % of body weight) and degree of its filling with blood (along axis of ordinates, in % of weight of organ) in rats in a state of hypothermia.

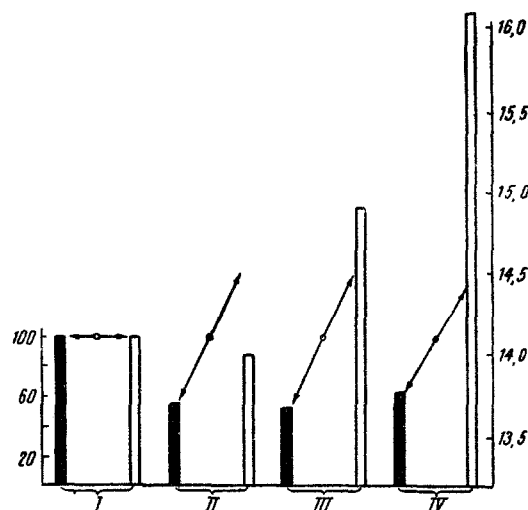


Fig. 2. Total content of hemoglobin stored in the spleen (dark columns, in % of normal level) and its concentration in the circulating blood (unshaded columns, in g %) in normal (I) and cooled (II, III, IV) rats. The arrows indicate the hemoglobin level in the blood which would be expected from mobilization of the reserves of the spleen with the other conditions unchanged.

The present experiments showed that during exposure to cold not only the weight of the spleen is reduced, but also the degree to which it fills with blood (the content of blood per unit weight of the organ). This fact must be borne in mind for the depot function of the spleen in different states has been assessed up to the present purely from changes in its size [3, 5, 9].

A direct relationship was found in the cooled rats between the weight of the spleen and the degree of its filling with blood. This is clear from Fig. 1, in which all the results obtained in hypothermic conditions are summarized regardless of the depth of hypothermia. The results obtained (the degree of filling of the spleen with blood estimated from the hemoglobin concentration in the blood and the weight of the spleen) given an idea of the total amount of hemoglobin contained in the spleen. Remembering that in normal rats the product of these three values is 100%, in the initial period of cooling its mean value was 55%, when the rectal temperature was 30° , it was 54%, and when the rectal temperature was 16° , it was 64%. In other words, definite mobilization of blood from its depot in the spleen took place in these experimental conditions in the initial period of cooling, and a further deepening of the hypothermia had no significant effect.

It is interesting to know what effect this mobilization has on the hemoglobin concentration in the circulating blood. Calculations* indicate that if all the hemoglobin present in the spleen of normal rats is released into the blood stream, its total level in the blood is increased on the average by 6.7%. Apparently, therefore, it is to be expected that the decrease in the hemoglobin reserves observed in the spleen in hypothermia would cause proportionate changes in its concentration in the blood. However, as Fig. 2 shows, no such correlation was observed. In the initial period of cooling, despite a sharp fall in the total hemoglobin concentration in the spleen, its concentration in the circulating blood remained as before. Conversely, after cooling to 30° and, in particular, to 16°, the hemoglobin concentration in the blood was much higher than could be attributed to mobilization of the reserves of the spleen. This may evidently be explained by variations in the total plasma volume (as a result of the displacement of water from the tissues into the blood and vice versa) or by the redistribution of water actually in the blood stream. Both mechanisms are possible in hypothermia [7, 10, 11, 12].

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*The mass of blood circulating in rats was taken to be 6.5% of the body weight (this figure was based on extensive information in the literature summarized in P. A. Korzhuev's monograph [6]; most workers cite a figure of between 6 and 7%).