EFFECT OF ACUTE ANOXIA WITH REDUCED BAROMETRIC PRESSURE ON MAST CELLS IN RATS

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A study of total preparations of the omentum, the mesentery of the small intestine, and the subcutaneous connective tissue, stained supervitally with neutral red, toluidine blue, azure A, and acridine orange, showed that in acute anoxia with a reduced barometric pressure the system of mass cells is activated in rats. The number of cells falls but the percentage of degranulated cells rises sharply.

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A study of the properties of the connective-tissue mast cells reveals the wide range of their functions. They are connected with the metabolism of heparin, histamine, serotonin, and other biologically active substances [7, 8, 10]. At the beginning of this century, on the basis of the paravascular location of the mast cells in the tissues, Samsonov and Unna [4, 11] postulated that the cells which Ehrlich described as mast cells play the role of oxygen storage cells in the tissues.

It has been shown that administration of oxygen and carbon dioxide reduces the number and stimulates degranulation of the mast cells [3]. The effect of anoxia with a simultaneous reduction of barometric pressure on the mast cell system has not been studied, although the suggestion has been made [1, 6] that mast cells probably participate in the response of the body to anoxia.

Accordingly, in the present investigation the state of the mast cell system was studied during exposure to acute anoxia with reduced barometric pressure.

EXPERIMENTAL METHOD

Experiments were carried out on 35 noninbred rats weighing 150-200 g. Acute anoxia with reduced barometric pressure was produced by placing the experimental animals under the glass bell jar of a Komovskii's apparatus, and by pumping air from beneath the jar until the animals developed periodic respiration (when the barometric pressure was 350-310 mm Hg). Exposure lasted for 3 min. The rat was then quickly removed from beneath the bell jar and killed by decapitation. The number of mast cells and qualitative differences among them were studied in unfixed preparations of the omentum, the mesentery of the small intestine, and in films prepared from the subcutaneous connective tissue by the method of supravital staining with neutral red (pH 3.0), toluidine blue, and azure A. The number of mast cells located in adipose tissue ("adipose"), along the blood vessels ("vascular"), and those located at some distance from them ("tissue") were counted separately. The number of mast cells was counted in 40 fields of vision in the omentum and mesentery and 20 in the subcutaneous connective tissue under a magnification of 400×. A detailed study of the heparinocytes was carried out under a 90× immersion objective and with the ML-2 luminescence microscope, in reflected blue-violet rays using FS-1-2, SZS-14-4, BS-8-2, and ZhS-12 filters. The preparations were stained with acridine orange in a dilution of 1:10,000. A rough estimate of adrenal function was obtained by investigating the ascorbic acid content of the glands [9]. The numerical data were analyzed by the method of indirect differences [2].

EXPERIMENTAL RESULTS

A study of the distribution of mast cells in the omentum of intact animals showed that they are mainly located in adipose tissue, the "tissue" heparinocytes were considerably fewer in number, and the vascular mast cells were fewer still. The distribution of mast cells in the mesentery was similar. In shape they were round or oval, and those along the blood vessels were slightly elongated. Granules in the mast cells

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TABLE 1. Number of Mast Cells and Percentage of Degranulated Mast Cells in Control and Experimental Animals

Group	Number of animals	Tissue from omentum		Tissue from mesentery		Percentage of degranulated mast cells in subcutaneous connective tissue
		M ± t	percentage of degranulated cells	M ± t	percentage of degranulated cells	
Control	26	257 ± 8.3	3.5–5.5	274 ± 9.0	3.5–7.0	4.0–22.0
Experimental	9	150 ± 15.4	18.0–42.0	159 ± 18.3	22.5–62.0	8.0 ± 46.0
T		6.1		5.6		
P		0.01		0.01		

were stained red with neutral red, with uniform intensity, and the nuclei were not stained. Mast cells stained with acridine orange gave the characteristic luminescence, distinguishing them from other cells: under low power the cytoplasm gave orange-red luminescence and the nucleus emerald green. Under high power, clearly outlined orange-red granules were detected in the cytoplasm. A few mast cells were seen with granules outside the cell–these were "active" heparinocytes.

Acute anoxia with a reduced barometric pressure caused the following changes in the system of mast cells.

As Table 1 shows, the number of degranulated mast cells was sharply increased, especially in the mesentery. Numerous such cells were found near the blood vessels. By contrast with the controls, preparations from the experimental rats stained with toluidine blue showed no γ-metachromasia. The mast cells themselves were slightly enlarged (especially the "tissue" and "vascular") and they appeared looser in structure. Their granules were a little smaller and they stained less intensely with neutral red. Despite the increase in the number of degranulated mast cells both in the omentum and in the mesentery, the total number of mast cells was reduced.

Luminescence microscopy of preparations stained with acridine orange revealed more intense luminescence of the nucleus and granules of mast cells from animals with signs of acute anoxia. Besides investigation of the mast cells, the ascorbic acid concentration in the adrenals was determined, having regard to reports in the literature of a possible connection between adrenal function and mast cell activity [5]. These investigations showed that such a relationship certainly exists: an increase in degranulation of the mast cells was accompanied by a decrease in the ascorbic acid concentration in the adrenals of the experimental animals (control 366 ± 9.0 mg%, experiment 281 ± 21.0 mg%; $P < 0.01$).

It can be concluded from these results that the system of mast cells participates in the response of the body to a decrease in the oxygen concentration in the inspired air with a reduced atmospheric pressure. This participation takes the form of activation of degranulation and metabolic changes, confirmed by an increase in the intensity of secondary luminescence of the mast cells.

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