stress conditions, may have its advantages and disadvantages. For instance, a decrease in the cyclic AMP content in erythrocytes may lead to changes in slow ability of the membranes and in other biophysical characteristics [4], whereas in the mast cells it may lead to an increase in histamine liberation. Both these factors, in turn, facilitate erythrocyte aggregation.

The experiments thus showed that an essential role in the mechanism of the microcirculatory disturbances following a single exposure to stressors and in the development of adaptation at the level of the microcirculatory system is played by catecholamines liberated from adrenergic nerve terminals.

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STUDY OF THE PURKINJE CELL POPULATION IN THE CEREBELLAR CORTEX OF DOGS AFTER SYSTEMIC CIRCULATORY ARREST

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KEY WORDS: Purkinje cells; systemic circulatory arrest; dark and pale neurons; regeneration.

Changes in the CNS after severe hypoxia resulting from systemic circulatory arrest are among the main pathogenetic mechanisms of postresuscitation sickness [5]. Different components of the nervous system respond unequally and at different times to hypoxia. The Purkinje cells (PC) of the cerebellar cortex are the most sensitive of the neurons to ischemia [2], and they are probably the first cells to be damaged in clinical death [4]. The need to study processes taking place in the cerebellar cortex after systemic circulatory arrest is also confirmed by the data of clinical observations on the role of cerebellar damage in the formation of delayed encephalopathy in patients surviving after clinical death [1].

In the investigation described below a morphological study was undertaken of the composition of the PC population in the medial, intermediate, and lateral zones of the cerebellum in dogs surviving systemic circulatory arrest (electric shock) for 12 min. The content of nucleic acid in pale and dark PC of intact animals and of animals surviving clinical death also was determined cytophotometrically, since the PC population is heterogeneous [14].

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TABLE 1. Density of Distribution of Normal and Changed PC (per millimeter length of PC layer) in Medial, Intermediate, and Lateral Zones of Cerebellum of Dogs Two Weeks after Systemic Circulatory Arrest for 12 min and in Control (M ± m)

Zone of cerebellum	Normal PC		PC with morphological changes		Total number of PC (allowing for parts of cells)	
	control	experiment	control	experiment	control	experiment
I	5,9±0,2 (89%)	5,2±0,4 (64%)	0,7±0,1 (11%)	3,0±0,4* (36%)	7,5±0,4	8,4±0,5
II	6,8±0,3 (92%)	4,8±0,6* (63%)	0,6±0,1 (8%)	2,8±0,6* (37%)	8,4±0,3	8,2±0,5
III	7,4±0,7 (94%)	5,3±0,2* (64%)	0,5±0,1 (6%)	3,0±0,3* (36%)	8,9±0,7	8,7±0,4

Legend. Number of PC of the given type shown in parentheses as percentages of total number of PC in that zone; * – $P<0.025$.

TABLE 2. Density of Distribution of Pale and Dark PC (per millimeter length of PC layer) in Medial, Intermediate, and Lateral Zones of Cerebellum of Dogs Two Weeks after Systemic Circulatory Arrest for 12 min and in Control (M ± m)

Zone of cerebellum	Pale PC		Dark PC	
	control	experiment	control	experiment
I	3,6±0,2 (61,0%)	2,6±0,4*(50,0%)	2,3±0,3 (39,0%)	2,6±0,1 (50,0%)
II	4,3±0,4 (63,2%)	2,5±0,4* (52,1%)	2,5±0,2 (36,8%)	2,3±0,2 (47,9%)
III	4,6±0,4 (62,2%)	3,0±0,2* (56,0%)	2,8±0,3 (37,8%)	2,2±0,1 (41,5%)

Legend. Number of PC of the given type shown in parentheses as percentages of total number of PC in that zone; * – $P<0.05$.

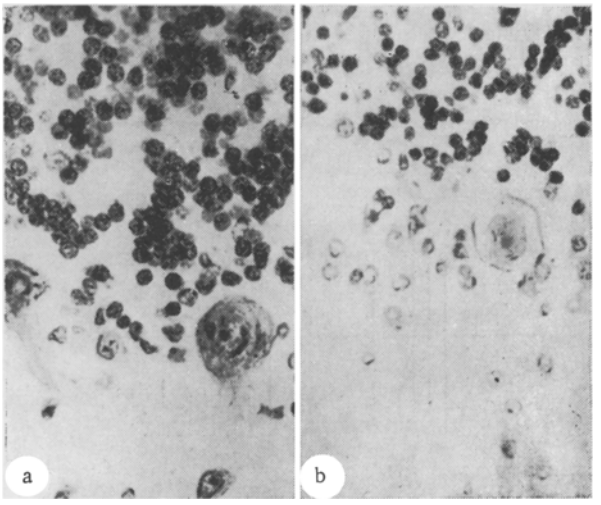

Fig. 1

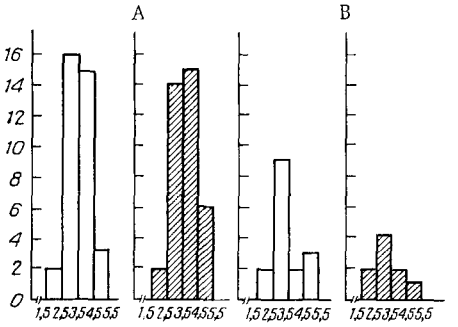

Fig. 2

Fig. 1. PC of cerebellar cortex of dog 2 weeks after systemic circulatory arrest for 12 min. a) Swollen PC of medial zone of cerebellum, b) PC of lateral zone of cerebellum with "heavy disease." Stained with cresyl violet by Nissl's method, 400 ×.

Fig. 2. Histograms of distribution of pale (unshaded columns) and dark (shaded columns). PC of cerbellar cortex by size in control dogs (A) and two weeks after systemic circulatory arrest for 12 min (B). Abscissa, dimensions of PC (conventional units); ordinate, number of PC.

EXPERIMENTAL METHOD

The PC of the cerebellar cortex on five mongrel dogs of both sexes were investigated two weeks after systemic circulatory arrest produced by electric shock. The right half of the cerebellum of the control (seven intact mongrel dogs of both sexes) and experimental animals was divided in the sagittal plane into medial (I), intermediate (II), and lateral (III) zones [13]. After fixation for 2 h in Carnoy's fluid and standard processing the material was embedded in paraffin wax. Sections 5-7 μ thick were cut from the paraffin blocks. For

TABLE 3. Number of PC with Principal Types of Morphological Changes Per Millimeter Length of PC Layer in Medial, Intermediate, and Lateral Zones of Dog Cerebellum Two Weeks after systemic circulatory Arrest for 12 min (M ± m)

Zone of cerebellum	Type of change		
	vacuolation of cytoplasm	swelling	"heavy disease"
I	0,14±0,04	2,1±0,4	0,7±0,1
II	0,40±0,14	1,2±0,3	1,1±0,2
III	0,43±0,05	0,9±0,3	1,5±0,2

Legend. $P_{I-III}<0.05$.

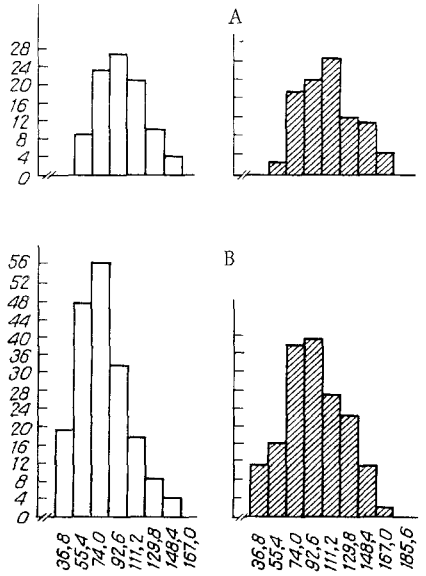

Fig. 3. Histograms of distribution of pale (unshaded columns) and dark (shaded columns). PC in cerebellar cortex of dogs by nucleic acid content in control (A) and two weeks after systemic circulatory arrest for 12 min (B). Abscissa, nucleic acid content (conventional units); ordinate, number of PC.

morphometric analysis, sections stained with cresyl violet by Nissl's method were traced under a photographic enlarger (magnification 10). The length of the PC layer was measured on the drawing by a curvimeter. The preparations were studied and PC counted under the microscope (magnification 400). The number of pale and dark PC and also of PC with morphological changes was counted per millimeter length of the PC layer. For cytophotometric determination of the nucleic acid content sections through the cerebellum of the control and experimental dogs were stained with gallocyanin and chrome alum by Einarson's method [6]. The nucleic acid content (in conventional units) was determined by means of a type MIF integrating photometric microscope [10] and wavelength of 546 nm. Only unchanged (normal) pale and dark PC in zone I of the cerebellar cortex were analyzed. The pale and dark PC were measured in conventional units (relative to the diameter of the diaphragm).

EXPERIMENTAL RESULTS

The total number of PC per millimeter length of the PC layer in the experimental dogs was not less than in the control in any of the zones. However, a significant change was observed in the composition of the PC population (Tables 1 and 2). To begin with there was a sharp increase in the number of PC with morphological changes. The regions studied did not differ with respect to the number of these PC, but changes of different types predominated in each zone. The main type of change in zone I was swelling, in zone II it was swelling and "heavy disease," and in zone III "heavy disease" (Fig. 1). The number of PC with swelling in zone I was significantly greater, but the number of PC with "heavy disease" significantly smaller than in zone III (Table 3).

The composition of the normal PC population also was changed in the cerebellar cortex of the experimental dogs. Whereas in the control the number of pale PC was significantly higher than the number of dark PC in all zones studied ($P<0.005$), in the experimental animals this difference was completely eliminated in zones I and II and was reduced in zone III. The number of pale PC in the experimental group was significantly lower in all zones than in the control (Table 2). The number of dark PC in zones I and II did not differ from the control, and only in zone III was it reduced a little ($0.05 < P < 0.1$).

Histograms of distribution of the pale and dark PC by size are given in Fig. 2. Estimation of the sizes of the PC in conventional units gave the following results: in the control the pale PC measured 3.5±0.1 and the dark PC 3.7±0.1, in the experimental group the figures were 3.4±0.2 and 3.2±0.3 respectively. The dark and pale PC were thus equal in size and their size was unchanged two weeks after systemic circulatory arrest for 12 min.

Cytophotometric determination of the nucleic acid contents showed that the dark PC contained more nucleic acids than the pale in both control and experimental groups. The ratio between the nucleic acid content in dark and pale PC two weeks after clinical death was the same as in the control (control 1.13±0.00, experiment 1.18±0.04). Histograms of distribution of the different types of PC by nucleic acid content in the control and experimental animals are given in Fig. 3. Clearly two weeks after clinical death there was a tendency for the nucleic acid content to fall in both pale and dark PC compared with the control (pale PC 103.8±4.7, dark PC 123.8±4.1 in the control, corresponding figures for the experimental group 90.0±8.6 and 105.6±8.9).

The morphometric investigation showed that the total number of PC per millimeter length of their layer in dogs with complete external recorvery of their neurologic status two weeks after recovery from systemic circulatory arrest due to electric shock for 12 min had not fallen below the number in intact animals in any of the zones of the cerbellum. However, a significant change was found in the composition of the PC population. Whereas in intact dogs the number of pale PC was greater than the number of dark PC in all zones studied, two weeks after clinical death the numbers of pale and dark PC were equal. Dimorphism of PC is a reflection of differences in the functional state of pale and dark PC. Actively functioning dark layers are characterized by a high metabolic level [7], they contain many organelles [14] and, according to the results of the present investigation, they add a higher nucleic acid content than pale PC. Having used up some of their structures and energy in the course of active work, the dark cells become pale, and by intercellular regeneration, they are reconverted into dark cells [7]. Consequently, the ratio of dark and pale PC reflects processes of intracellular regeneration taking place in the cerebellum. The change in the ratio between dark and pale PC in the cerebellar cortex of dogs after clinical death is probably the result of the transition from intercellular physiological regeneration into reparative regeneration, which is manifested in the nervous system as an increase in the rate of renewal of ultrastructures, i.e., compensatory intensification of the rhythm of intercellular physiological regeneration [7].

Two weeks after systemic circulatory arrest a process of intracellular reparative regeneration is thus observed in the cerebellar cortex of dogs and is manifested as an increase in the relative number of active (dark) PC, with an increased content of nucleic acids; i.e., compensatory-adaptive processes aimed at restoration of function take place in the CNS [9].

Besides compensatory processes, pathological processes also are observed. In all zones of the cerebellum the number of PC with various morphological changes showed a sharp increase. However, the changes observed were not all of the same kind. If "heavy disease" is evidence of irreversible injury to the neuron, whereas vacuolation reflects cell aging processes [11], swelling is an indication of intensive metabolism of the neuron [8]. The dominant type of change in zone I was swelling, whereas in zone III it was "heavy disease." Consequently, a process of activation of PC takes place in zone I whereas in zone III destructive changes in PC leading to irreversible changes in these neurons predominate. In zone III also, unlike in the other zones, the number of actively functioning (dark) PC was less than the number of "resting" (pale) PC and was significantly less than in the control. After systemic circulatory arrest PC in the lateral zone of the cerebellar hemisphere thus were damaged the most. The PC in the medial zone, corresponding to the vermis of the cerebellum, were the best preserved and were in a state of active function. This finding is in agreement with previous results of qualitative assessment of the state of the cerebellum in different pathological processes [3, 12]. However, by the use of morphometric and cytophotometric methods

it was possible not only to discover that the cerebellar hemisphere is more vulnerable in systemic circulatory arrest, but also to distinguish its lateral zone as the functional region of the hemisphere which suffers the greatest damage.

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EFFECT OF PRELIMINARY NEUROSENSITIZATION OF FEMALE RATS ON CONTENT OF DENSE SUBSTANCES IN CORTICAL NEURONS OF THE PROGENY

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The authors showed previously [5, 6] that sensitization of female rats before the beginning of pregnancy with cerebral cortical iosantigen disturbed the course of postnatal neuro-ontogeny in the offspring. These disturbances are expressed as retarded growth of the neurons in size, of the layers of the cortex in width, and of the total and perineuronal glial cells in number. A progressive decrease with age in a quantity of basophilic substances in the cytoplasm of the neurons was found. Since the content of basophilic substances in the cytoplasm of neurons is known to correlate with intracellular protein synthesis and accumulation [8, 10], it was postulated that a disturbance of protein accumulation takes place in the cortical neurons of the progeny of neurosensitized rats.

This paper gives the results of a cyto-interferometric investigation of the content of dense substances (protein) in the large cells of layer V of the sensomotor cortex at different stages of postnatal life of the progeny obtained from neurosensitized rats.

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