CHANGES IN SIZE OF PURKINJE CELL NUCLEOLI IN THE DOG CEREBELLUM IN THE POSTRESUSCITATION PERIOD

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Investigation of the principles of development of destructive reparative processes in the brain in the postresuscitation period is an essential step in the provision of goal-directed treatment, rehabilitation, and readaptation of patients surviving the terminal state [7].

According to clinical observations [1], an essential role in the formation of the encephalopathy in patients revived from clinical death is played by disturbance of functions of the cerebellum, whose Purkinje cells (PC) are highly sensitive to hypoxia. It was shown previously that in the postresuscitation period morphological and functional changes take place in PC in the cerebellum [3]. In particular, changes take place in the protein and RNA concentrations. These quantitative data, however, reflect only changes in cell metabolism and they indicate the need for a comprehensive study of the protein-synthesizing system of the neurons. Investigation of the nucleolus is interesting from this point of view, for we know that the size, structure, and number of the nucleoli are parameters of its function, i.e., of the intensity of production of rRNA [11].

The aim of this investigation was to study the size of the nucleoli of PC in the cerebellum of dogs with some degree of recovery of neurologic status after clinical death of different etiology and duration. PC were studied in the medial and lateral regions of the cerebellum. It was taken into account that injury to each of these functional regions of the cerebellum gives rise to different neurologic disorders [12].

EXPERIMENTAL METHOD

Purkinje cells in the cerebellum of eight dogs with different degrees of recovery of neurologic status after clinical death of different etiology and duration (12 min of systemic circulatory arrest due to electric shock, clinical death for 7 and 10 min due to acute bleeding (the experiments were carried out by members of the scientific staff of the Institute of General Resuscitation, Academy of Medical Sciences of the USSR – E. A. Mutuskina, I. S. Novoderzhkina, and S. V. Tolova), and in five intact dogs (control). The diameter of the nucleoli of PC was measured with an ocular micrometer 14 days after revival of the animals in squash preparations of the cerebellum [14], stained with cresyl violet by Nissl's method, after which their area was calculated. The size of the nucleoli was measured in 150 PC from each animal from the medial and lateral regions of the cerebellum. Attention was also paid to the number of nucleoli in the cell. The results were subjected to statistical analysis.

EXPERIMENTAL RESULTS

In intact animals the PC contained one nucleolus, whose area was the same in the medial and lateral regions (22.1 ± 1.5 and 22.5 ± 2.1 μ^2 respectively). In PC of the experimental animals there was always one nucleolus, whose size was different from that in the control. In other animals, for example in rats, binucleolar neurons are present under normal conditions also, and in response to the action of some factor not only the size of the nucleoli,

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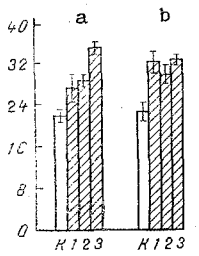

Fig. 1. Area of nucleolus of Purkinje cells in dogs with complete recovery of their neurologic status after clinical death of different etiology and duration. K) Control; 1) systemic circulatory arrest due to electric shock for 12 min; 2) clinical death from acute blood loss for 7 min; 3) clinical death from acute blood loss for 10 min; a) medial, b) lateral region of cerebellum. Ordinate, area of nucleolus, in μ^2.

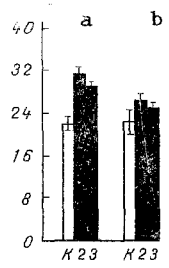

Fig. 2

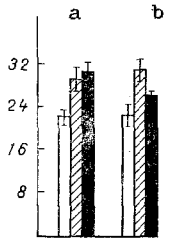

Fig. 3

Fig. 2. Area of nucleolus of Purkinje cells in dogs with disturbances of neurologic status after clinical death of different etiology and duration. Legend as in Fig. 1.

Fig. 3. Changes in size of nucleolus of Purkinje cells in cerebellum of dogs with different degrees of recovery of their neurologic status. Unshaded columns – control, obliquely shaded columns – complete recovery, black columns – disturbance of neurologic status. Remainder of legend as in Fig. 1.

but also their number may change [6, 8]. This is also valid for cells of certain other tissues [10, 13]. Consequently, it can be tentatively suggested that a sign of cell differentiation such as the number of nucleoli is determined, it determines the "norm of response" of the nucleolar apparatus of the cell [9] at the cell population level.

All dogs surviving systemic circulatory arrest due to electric shock for 12 min had full recovery of their neurologic status. In these animals an increase in size of the nucleoli of PC was found in both the medial (by 24.4%) and lateral (by 42.7%) regions of the cerebellum (Fig. 1). After clinical death from acute blood loss for 7 min, in animals with complete recovery of their neurologic status the area of the nucleolus of PC increased equally (by 30.7%) in both regions studied, whereas in dogs with disturbances of their neurologic status a marked increase (by 43.0%) in area of the nucleolus of PC was found in the medial region only, and in the lateral region the changes were not significant, namely 18.2% (Figs. 1 and 2). Differences in the area of the nucleolus of PC in the different regions of the

cerebellum, depending on the degree of recovery of the neurologic status of the animals were particularly striking after clinical death from acute blood loss for 10 min. In the case of dogs with complete recovery of their neurologic status the area of the nucleolus of PC increased by 60% in the medial region and by 43% in the lateral region, whereas if the neurologic status was disturbed, the increase in area of the nucleolus in the medial region was 45.2%, but only 19.5% in the lateral region (Figs. 1 and 2).

The results are thus evidence that if recovery of the animals' neurologic status was complete, regardless of the etiology of the clinical death, changes in the nucleolar system of PC were identical in the two regions of the cerebellum. If the neurologic status of the animals was disturbed, a significant increase in area of the nucleolus of PC was found only in the medial region of the cerebellum, whereas in the lateral it was not significant (Fig. 3). These results enable changes in the size of the nucleoli of PC to be analyzed in relation to the duration of ischemia survived by the animals. In these experiments the duration of the period of ischemia was minimal after systemic circulatory arrest for 12 min due to electric shock and maximal after clinical death due to acute blood loss for 10 min [2]. It will be clear from Fig. 1 that in dogs with complete recovery of their neurologic status the degree of increase in area of the nucleolus of PC in the medial region of the cerebellum correlated with the duration of ischemia. No such correlation was found for PC in the lateral region. An increase in the size of the nucleoli of nerve cells during hypoxia has been described in other animals also [4, 6]. It has been suggested that intensification of nucleic acid and protein synthesis is one possible mechanism of adaptation of cells to hypoxia [5]. If the results of the present experiments are examined from this point of view, it can be concluded that the adaptive properties of PC in the two regions of the cerebellum are different. One result of this is the greater vulnerability of PC of the lateral region of the cerebellum than of the medial region to severe hypoxia, and ultimately this is reflected in the degree of recovery of the animals' neurologic status after clinical death of different etiology and duration.

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