RELATIONSHIP BETWEEN CHARACTER AND SEVERITY OF LESIONS OF NERVE CELLS IN THE NUCLEUS CUNEATUS OF THE MESENCEPHALIC RETICULAR FORMATION AND THEIR BLOOD SUPPLY

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UDC 616.831.5-005-092.9-07: 616.831.5-018

Types of lesions of neurons of the nucleus cuneatus of the mesencephalic reticular formation under hypoxic conditions are apparently determined by the character of blood supply of these neurons. The severest changes occur in large nerve cells rich in chromatin, and the least marked changes occur in cells with a less well developed blood supply.

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The blood supply of nerve cells reflects the intensity of their metabolism, on which their various types of activity are based [1, 4]. The writers have shown previously [2] that in the nucleus cuneatus of the mesencephalic reticular formation in cats the most highly developed network of blood vessels is formed near the bodies of large neurons, resembling motoneurons, while the fewest blood vessels occur near small neurons, to which the role of interneurons is ascribed in the literature. If the cerebral circulation is disturbed, although different neurons are apparently under identical conditions of hypoxia, they undergo different changes: ranging from slight edema to the severe, irreversible changes typical of severe Nissl's diseases [3-5].

It was therefore decided to study the character and severity of the changes taking place in different types of neurons of the mesencephalic reticular formation when the circulation in this region was disturbed.

EXPERIMENTAL METHOD

In 10 cats occlusion of the quadrigeminal artery led to the formation of a focus of softening in the region of the nucleus cuneatus of the mesencephalic reticular formation. On the 7th day after operation, under inhalation anesthesia, the blood vessels of the brain were injected with a 4% solution of gelatin in ink. The brain was fixed in 10% formalin solution and paraffin sections were stained by Nissl's method. The character of the changes in the nerve cells was studied in a zone lying beyond the demarcation line and covering a width of three fields of vision under a magnification of 630×. Under the same magnification, the morphological state of 560 somatochromic neurons found in 100 fields of vision in the nucleus cuneatus of the mesencephalic reticular formation was studied. These neurons occur there as three types: type I – large neurons, giving off numerous processes, with a large nucleus occupying a comparatively small part of their body, with an arkyostichochrome type of tigroid structure, having small amounts of tigroid also in their dendrites; type II – medium-sized neurons with long, thin processes and an arkyochrome type of tigroid structure; type III – small neurons with a large nucleus, occupying a large part of their bodies, and with a gryochrome type of tigroid structure.

EXPERIMENTAL RESULTS

Morphological changes of various types were present, to a greater or lesser degree, in the cells of all three types. Of the 242 large neurons, 61 (25%) showed a simple edematous type of change, most of them having coarse changes in their cytoplasm and nucleus (Fig. 1b); 159 neurons of this type (65%) were in the

Institute of Neurology, Academy of Medical Sciences of the USSR, Moscow. (Presented by Academician of the Academy of Medical Sciences of the USSR E. V. Shmidt.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 69, No. 2, pp. 115-117, February, 1970. Original article submitted April 17, 1969.

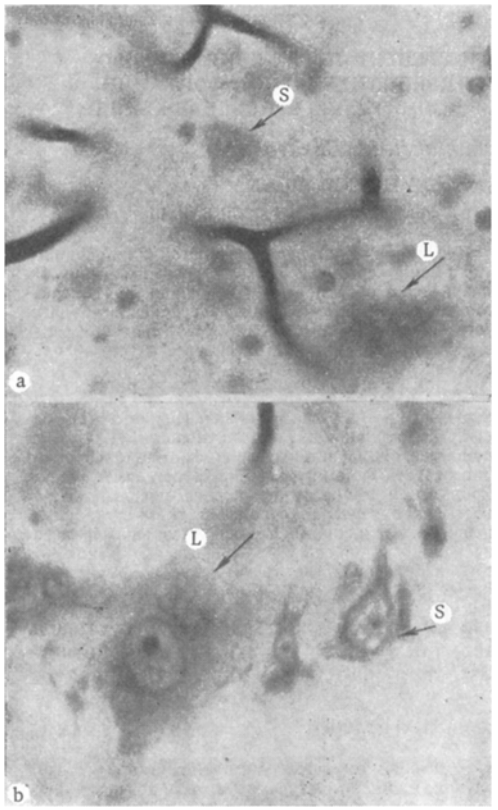

Fig. 1. Different degrees and character of changes in large (L) and small (S) neurons in nucleus cuneatus of mesencephalic reticular formation; a) large neuron in a severe state of the disease, small neuron unaffected; b) large neuron in a state of severe edema, small cell shows only slight evidence of edema. Capillaries injected with 4% solution of gelatin in ink. Nissl, 630×.

terminal phase of disintegration. The cytoplasm of these cells had a coarsely woven structure and it contained many vacuoles, in which glial cells could be seen penetrating inside the cells. Their nuclei were shrunken and pycnotic, or completely absent. Cases of liquefaction of the neurons while the nucleus remained intact were found (Fig. 1a). The accumulation of large numbers of glial cells around neurons showing severe pathological changes was a characteristic feature. Changes typical of ischemic disease were found in 21 neurons (8.5%). In half of these the signs of this disease were clearly defined: the nuclei were darkly stained and triangular in shape, and situated eccentrically. The body of the neuron was pale and homogeneous, with indentations on its edges.

Of the 217 medium-sized cells investigated, 164 were in a state of edema, although clearly defined changes were present in only 25% of the neurons; the rest showed slight vacuolation, with tiny vesicles around the periphery of the cell body and small clear areas near the nucleus. The nuclei were slightly swollen or unchanged. Severe changes were found in 25 cells (11.5%), of which 16 were in the stage of liquefaction, while the rest were less severly affected. Signs of ischemic disease were present in 23 neurons (10.5%), but these changes were ill defined. The nucleus was darkened and the cell body very slightly elongated. Juxtamembranous hyperchromatosis or the initial stages of karyorrhexis were observed in the nuclei of some neurons. Four neurons were in a state of chromatolysis.

In the group of small neurons 77 of 101 cells (76%) showed changes of the edematous type, although in 63 of them these changes were only slight: swellings and vesicles were formed in the basal part of the body of the neuron, the Nissl's substance was palely stained, and the nuclei were almost unchanged (Fig. 1b). Five neurons were in a severe pathological state, although only one cell was in the terminal stage of liquefaction. In 15 cells (14.7%) ischemic changes were present although only slight in degree. Four cells were in a state of chromatolysis.

Comparison of the morphological changes in the various types of neurons of the nucleus cuneatus of the mesencephalic reticular formation clearly show that the severest changes, in the form of liquefaction of the neurons and severe stages of cellular edema, affected the large neurons, rich in chromatin possessing normally the most highly developed capillary network around the bodies and processes. Less severe changes were observed in the group of small and medium-sized cells, in which the blood supply under normal conditions is less well developed.

In a number of characteristics, the character of the lesion in the small and medium-sized neurons was similar to the changes found in neurons during pharmacological sleep [4]. However, the period of 7 days elapsing after the operation, the short duration of the anesthesia before the animal was sacrificed, and also the presence of neurons showing changes characteristic of ischemia or of the severe form of the disease, suggest that these slight changes in the nerve cells are the result of the action of the hypoxia arising through disturbance of their intimate blood supply on them.

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