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MORFOLOGICAL CHANGES IN AMYGDALA AND HIPOTALAMIC NUCLEUS UNDER CONDITIONS OF THE DESTRUCTION OF DORSAL AMYGDALOFUGAL WAY

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Abstract — In chronic experiments on rabbits it has been shown that destruction of dorsal amygdalofugal ways leads to full and persistent blockade of hippocampal theta-rhythm**.** To elucidate the causes irreversible changes in different areas of the hippocampus and the medial nucleus of septum morphological studies were carried out in neurons and glial cells of bazolateral (AB), central (AC), lateral (AL) and cortical (ACO) nucleus of the amygdala and supraoptic (SO), ventromedial (VMH), lateral (AHL), medial mammilar (MM) nucleus of hypothalamus. Examination of the slices of the amygdalo (AB, AC, ACO, AL) and hypothalamic (SO, VMH, AHL, MM) nucleus of experimental animals after coagulation of the stria terminalis demonstrated that profound morphological changes were detected in neurons and glial cells of these structions. Morphological studies developed deep degenerative changes just lyzis of Nissel matter, swelling of apical dendrites, hyperchromatism of nuclei and decrease in the volume of the latter were typical findings, absence of tigroid matter in neurons and glial cells in different nucleus of hypothalamus and amygdala, under destruction of dorsal amygdalofugal tract. Neurons and glial cells are swelled.

One of the factors which modulates the excitability of neurons in septo-hippocampal system is supposed may be disturbance of hypothalamo-hypophysial neurosecretory system under the influence of destruction of amygdala-hypothalamic relations.

Keywords – dorsal amigdalofugal way, morphological changes, Nissl substance, glial cells, hypothalamus, amygdala.

I. Introduction

For many years, one of the controversial issues in the electrophysiology is the study of the hippocampal theta rhythm. The medial septum nucleus, standing at the entrance to the hippocampus, demonstrates the importance of this education [1; 2]. In addition to the data indicative of the pacemaker role of the septum, there are works which demonstrated the a definite role of stem-diencephalic structures in mechanisms of formation of hippocampal theta rhythm: of great importance given to the reticular formation [3], the hypothalamus [4], the thalamus [5], locus cereleus [6], nucleus raphe [1], etc.

Our previous studies have shown that destruction the dorsal amigdalofugal pathways (DAP), unlike the ventral (VAP), leads to a complete and irreversible blockade of hippocampal theta rhythm (7). To elucidate the causes irreversible changes in different areas of the hippocampus and the medial nucleus of septum morphological studies were carried out in neurons and glial cells of bazolateral (AB), central (AC), lateral (AL) and cortical (ACO) nucleus of the amygdala and supraoptic (SO), ventromedial (VMH), lateral (AHL) and medial mammilar (MM) nucleus of hypothalamus.

II. Methods

Experiments were carried out on 25 mature rabbits. The dorsal amygdalofugal way (DAW) was coagulated by 15-25-sec-long 1.0 mA current passed through an electrode implanted into the precommissural region. Both recording of the electrical activity from the hippocampus and septum and collection of the samplings for morphological studies were performed 18-27 days after such a destruction. For histological studies, brains of the animals were fixed in Carnoy solution and dehydrated using a series of alcohols of increasing concentrations; the blocks including the structures under study were embedded in paraffin. Frontal 10-µm-thick slices were prepared with a microtome, stained with 0.1% cresyl violet solution, treated with alcohol, cleared in xylene, embedded in balsam, and examined under a light microscope of firm “Amplival”. The objects under study were neurons and glial cells of the amygdala and hypothalamus.

III. Results and discussion

In the study of brain slices obtained from control animals in preparations stained by Nissl in the AB nucleus of the amygdala is allocated dorsal part, characterized by the presence of large, uniformly distributed cells. They are round or polygonal with a large nucleus and the hyperchromic cytoplasm. Encountered medium and small cells do not differ by cytological picture from the large. The ventral part of the AB contains only small cells with weakly hyperchromic cytoplasm. From the soma of large neurons departs a lot of branched dendrites covered by frequent spinules . Are short spinules, with heads of different thicknesses. Dendrites start out as thick trunks which are break down into numerous branches near the cell of soma. of large neurons number of dendrites, and more cells, than at all other neurons the amygdala.

In investigation of the AC, it was confirmed that the larger cells are located in the medial part of the nucleus smaller - in the lateral. Branched reticular cells penetrate in the form of

trace elements in all subcortical structures constructed from densely branched cells.

The characteristic feature of the AL, ACO nucleus of the amygdala is a large variety of cellular composition compared to AB. On preparations according to Nissl are different large, small and medium neurons. The large neurons of AL, in contrast to the shallower AB, cytoplasm them lighter. . Only neurons located near to the outer capsule, have a dark cytoplasm. Pyramidal neurons of AL sharply different from the other cells of amygdala , reminding pyramidal neurons. From soma radially departs many highly branched dendrites, which in turn is near the soma, are divided into the numerous appendages. One of the dendrites, more thick and long, can be called the apical. His direction is different: dorsally, or towards the outside of the capsule (Fig.1.A,B; Fig.2-A,B).

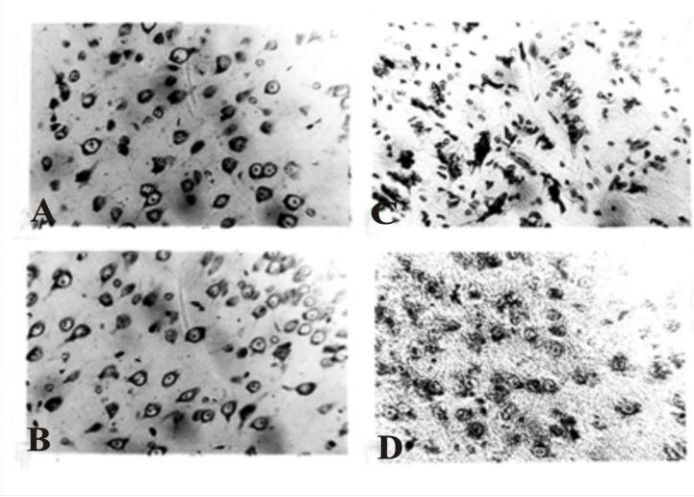

Fig. 1. State of the Nissl substance in neurons and glia of the AB and AC nucleus of amygdala before and after destruction of the dorsal amygdalofugal pathway. A,B - AB and AC nucleus of amygdala before; C, D - after destruction.

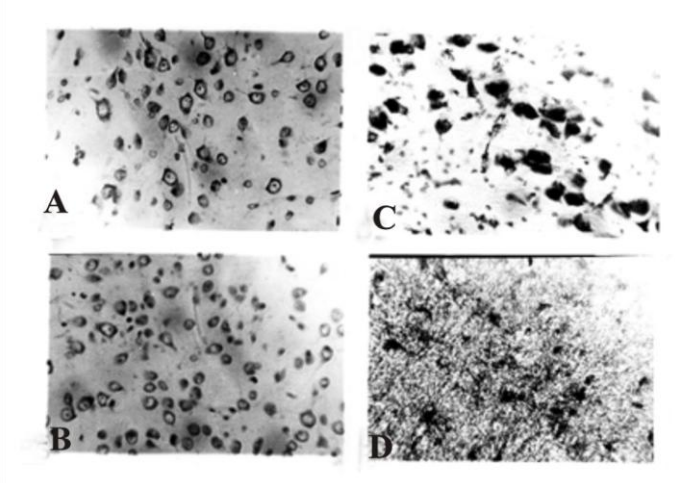

Fig. 2. State of the Nissl substance in neurons and glia of the AL and ACO nucleus of amygdala before and after destruction of the dorsal amygdalofugal pathway. A,B - AB and ACO nucleus of amygdala before; C, D - after destruction.

The study of neurons of different nuclei of the amygdala after the destruction of the dorsal amigdalofugal way showed significant changes. In the preparations obtained from the experimental animals is observed a central chromatolysis enlightenment cytoplasm and movement within tigroid to the peripheral part (cytoplasm) bodies of neurons. Are observed strongly expressed gidrofic changes, neurons are wrinkled and hyperchromic painted, with deformed nuclei. The described changes are found in the nucleus of AB especially sharply expressed in the part where begins the DAW. In the study of other nuclei of the amygdala AC, AL and ACO were found similar profound degenerative changes (Fig.1.C,D; Fig.2 C,D).

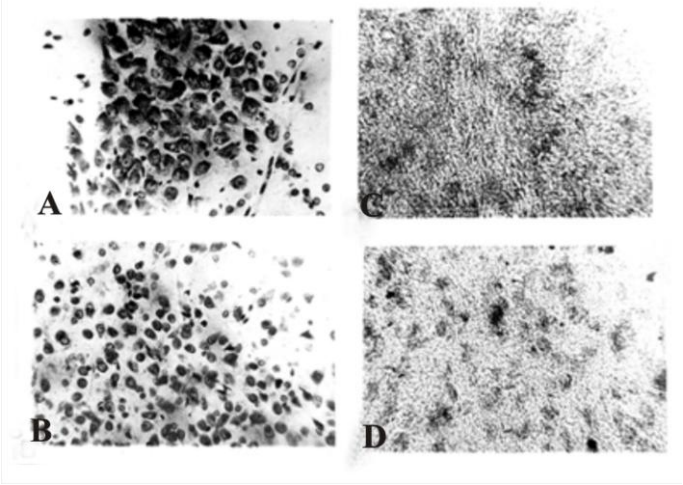

Fig. 3. State of the Nissl substance in neurons and glia of the SO and VMH nucleus of hypothalamus before and after destruction of the dorsal amygdalofugal pathway. A,B - SO and VMH nucleus of amygdala before; C, D - after destruction.

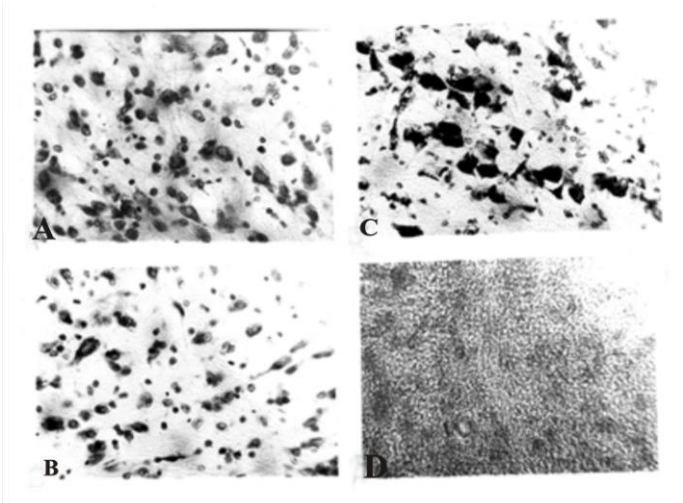

Fig. 4. State of the Nissl substance in neurons and glia of the AHL and MM nucleus of hypothalamus before and after destruction of the dorsal amygdalofugal pathway. A,B - AHL and MM nucleus of amygdala before; C, D - after destruction.

In nuclei of the hypothalamus befor the destruction of the DAP noted the following. In the studied hypothalamic nuclei the Nissl substance is distributed differently. If in large cell of SO nuclei of hypothalamus it occupies a total area of cytoplasm and distributed almost uniformly, and in the large neurons of the lateral nucleus clumps of tigroid located rarely and have a rhomboid shape. Nucleus of the neurons of the SO hypothalamus are quite large and occupy by 2-3 times larger area than the cytoplasm. The nucleoli intensively and evenly are painted, sometimes their quantity reaches two or three in a single neuron. In small-cell of SO, VMH and MM nuclei of hypothalamus and tigroid substance in the form of small grains evenly distributed in the cytoplasm and it takes quite the narrow area; the core of these neurons intensely colored and nucleoli have the form of small dots. In glial cells of the studied nucleus of hypothalamus substance represented basophilic as small dust grains and diffusely distributed throughout the cytoplasm. The nucleus of glial cells intensely colored in blue and violet color. In large cell of SO, VMH and MM nuclei of hypothalamus, especially in SO and PV, glia are composed of astrocytes in the VMH and MM areas glia is composed of oligodendrocytes (Fig.3.A,B; Fig.4-A,B).

In the preparations obtained from experimental animals is observed a central chromatolysis enlightenment cytoplasm and movement within tigroid to the peripheral part (cytoplasm) bodies of neurons. Morphological changes were observed in the neurons of the SO, expressed in moving tigroid large neurons in the peripheral part, hypertrophy of body and nucleus. For many neurons characteristically eccentrically located nucleus and nucleoli. Is noted increase of sattelit glia - basic - oligodendroglia. Considerably decreases content of the Nissl substance primarily in mass VMN neurons, there is a swelling of a nuclear device with a sharp his enlightenment. In neurons marked giperhromatoz cytoplasm and nucleus .

The neurons of the SO, VMN, AHL and MM hypothalamic nuclei are observed pronounced morphological changes especially in the cytoplasm. In some large neurons againist the background swelling of cellular body is allocated ectopia nuclei and nucleoli. In some of them have observed hydropic changes in the cytoplasm. There are neurons with elements of total chromatolysis and severely swollen appendages. In the neurons of the anterior hypothalamus was visible the different distribution clumps of tigroid. Be traced the sharp enlightenment cytoplasm and nucleus, the disappearance the contour of nuclei of the neurons (Fig.3.C,D; Fig.4 C,D).

The possibility for modulation of the electrical activity of the hippocampus, and especially of the EHipG theta rhythm, because of changes in the functional state of extrahippocampal structures of the brain (including the hypothalamus and amygdala) was demonstrated earlier [1-3]. A basic aspect of the data we obtained in our experiments is that we demonstrated deep and longlasting depressive modulation of the mass electrical activity of the hippocampus under conditions of coagulation of the DAW. Our data allow us to believe that the above depression is related to changes in the functional state of hippocampal neurons themselves, but not to DAW destruction determined modification of the pattern and intensity of afferent impulsation coming from extrahippocampal structures (amygdala, hypothalamus). The characteristic effects of electrical stimulation applied to the septum of experimental animals are indicative of a significant decrease in the excitability of the hippocampal neurons. Histological and observations, according to which deep changes occur in the structure of amygdala and hypothalamus neurons and satellite glia after coagulation of the stria terminalis, also confirm the conclusion of decreased excitability of the neurons in the septohippocampal system.

Recovery of electrical activity in the form of regular oscillations only in response to factors inducing stable neuron membrane depolarization may be evidence primarily of profound metabolic derangements occurring simultaneously in all hippocampal fields and indicating the diffuse, neurohumoral nature of changes resulting from lesioning of the amygdalofugal connections. It can be suggested that the long-term depression of the hippocampal EEG observed here results from disturbance to the normal functioning of the hypothalamo-hypophyseal neurosecretory system due to lesioning of the stria terminalis, which ultimately leads to long-lasting changes in the excitability of hippocampal neurons. However, whatever the mechanism of EEG depression in this experimental situation, it is clear that the integrity of the dorsal amygdalofugal pathway is one of the key factors in regulating neuron excitability in the septo-hippocampal system.

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