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## MODERN IDEAS ABOUT MORPHOLOGICAL CHANGES IN THE CEREBELLAR CORTEX UNDER INFLUENCE OF FACTORS OF DIFFERENT ORIGIN

Nataliia Ohinska, Zoia Nebesna, Solomiia Kramar

I. Horbachevsky Ternopil National Medical University, Ternopil, Ukraine

Department of Histology and Embryology

*Nataliia Ohinska*: <https://orcid.org/0000-0003-4398-8744>; [ohinska@tdmu.edu.ua](mailto:ohinska@tdmu.edu.ua); corresponding author

*Zoia Nebesna*: <https://orcid.org/0000-0002-6869-0859>; [nebesna\\_zm@tdmu.edu.ua](mailto:nebesna_zm@tdmu.edu.ua)

*Solomiia Kramar*: <https://orcid.org/0000-0003-3654-4950>; [kramarsb@tdmu.edu.ua](mailto:kramarsb@tdmu.edu.ua)

### Abstract

The work is a fragment of scientific research “Peculiarities of structural reorganization of the nervous, digestive, endocrine systems, hematopoietic and immune organs under conditions of thermal injury and the use of corrective factors” (0120U104152).

The study of the state of internal organs and systems of the body under the influence of external factors that are stressful is relevant. The negative impact of environmental factors on the central nervous system, including cerebellum, leads to their structural and functional restructuring. The cerebellum is a multifunctional component of the brain and the object of numerous lesions.

The purpose of this work is analysis of scientific literature which is dedicated study of the influence of exogenous and endogenous factors on the morphological structure of the cerebellum.

The article analyzes the scientific literature of the effects of hypodynamia, hypothermia, hypokinesia, alcohol intoxication, toxic effects of Lead, drugs, pharmacological

agents, low-frequency pulsed electromagnetic field on the micro- and submicroscopic organization of the cerebellum. In lots of experimental studies, which were analyzed it is established that in the dynamics of the influence of different factors there is a reorganization of the cerebellar cortex layers and disruption of the microcirculatory bed structures. Purkinje cells change shape to spherical, their processes are thinned, sharply hyperchromic neurocytes prevail over normochromic ones. The functional activity of neurons is reduced, because the chromatophilic substance is almost absent. The thickness of the molecular and granular layers decreases. The ganglionic layer loses its single-row arrangement of neurons. There are erythrocytes in the coin columns in the lumens of hemocapillaries. The dilatation and prevascular edema are observed. Thus, under the conditions of negative influence of various factors in neurocytes of a cerebellar cortex and links of a microcirculatory channel there are destructive and degenerative changes on micro- and submicroscopic levels. In the long run there are adaptive-compensatory processes and necrotic, which had a phase dependence. So, destructive and degenerative changes on micro- and submicroscopic levels. In the long run there are adaptive-compensatory processes and necrotic, which had a phase dependence.

**Key words: cerebellum; neurons; micro- and submicroscopic changes; exogenous and endogenous effects.**

### **Introduction**

The connection of the cerebellum with many parts of the brain and the complex neural system of reading information that enters into its cortex, makes this organ unique in its versatility [13]. The cerebellum is not only the center of coordination of movements and balance, but also participates in the regulation of various functions organism. Nuclear organization of cerebellum determines his morphofunctional relationships with different centers of the nervous system and its impact on trophic, autonomic functions of the body [14, 20]. Disruption of activity as a result of the negative impact leads to defects in the body and the emergence of diseases [4]. It should be noted that a large amount of scientific literature covers the effects of exogenous and endogenous factors, but the results of some studies are multifactorial.

### **Description of the state of knowledge**

According to studies about morphofunctional features of the cerebellum under the influence of hypodynamics, alcohol and low temperature, these factors lead to dystrophic and degenerative changes in organ. These processes depend on the term of exposure and have a phase character. According to electron microscopy, scientists have found a violation of the

microcirculatory system. Dilatation was expressed in the capillaries, the nuclei of most endothelial cells were swollen, enlarged, and the nuclear envelope was uneven with numerical intussusception. Reactive changes were observed in pericytes. Pinocytosis was expressed in the cytoplasm. Scientists claim that long-term exposure leads to changes in the cytoarchitectonics of the cerebellar cortex, which are manifested in a decrease in the number of neurons per unit area of molecular and granular layers. The death of neurons and glial cells increases with prolonged exposure to factors. Perikaryons of neurons are swollen, nuclei are eccentrically displaced, peripheral chromatolysis, vacuolation of cytoplasm is noted. A small number of ribosomes on the granular endoplasmic reticulum indicates that neurons are characterized by reduced functional status [11].

A comprehensive experimental study of morphological features of cerebellum by actions alcohol was performed. On electron microscopic level in the early stages found that neurons are characterized by high structural and functional activity. The nuclei are light, well-defined granular endoplasmic reticulum, a large number of ribosomes, indicating high nucleoprotein synthesis, in the cytoplasm there are single lysosomes. Morphometric data showed that the Golgi complex and the endoplasmic reticulum under the influence of alcohol tend to increase in volume. The authors note that after 30 days of the experiment there is a decline in the vessels of the microcirculatory tract, but there are capillaries with dilated lumens. Endothelial and pericyte hypertrophy is observed. There are significant ultrastructural changes in cerebellar neurons. Destruction of the inner membrane of mitochondria. In the cytoplasm there are osmophilic bodies with dense granules located around them. The number of lysosomes and phagosomes increases. The nucleoli are vacuolated [11, 21].

Toxic effects of lead compounds cause the development of pathological conditions of the nervous system. One of the brain structures that responds quickly to the action of lead-containing compounds is the cerebellum. It is established that the density of neurons in the molecular layer decreases, becomes more porous, and the number of glial elements increases. In the ganglion layer, neurons lose their single-row location and deepen into the granular layer. The contours of the perikaryons are not clear, the nucleus and cytoplasm have no clear boundaries, it is enlightened. In the study of the granular layer, the migration of grain cells into the molecular layer was noted, as a result of which their density decreases [6, 8, 9].

Electron microscopic examination of the effects of drugs (nalbuphine) on the cerebellum showed that the microcirculatory bed is decompensated. The lumens of hemocapillaries are narrowed due to edema of the cytoplasm of endothelial cells and filled with erythrocytes. The basement membrane is thickened, there are areas of stratification.

Neurons of all layers of the cerebellar cortex are disorganized, the boundaries between them are not clear. Neuroplasma is electron-dense. The nuclei are irregularly shaped, the nucleoli are not detected. The tubules of the granular endoplasmic reticulum are uneven extended. Membrane mitochondria is fuzzy, cristae destructed, the matrix is enlightened [1, 15].

Nervous tissue has a high plasticity and the ability to adapt to various endogenous and exogenous factors, which is actually an important point in the launch of stress-limiting systems to the action of stressors. Under the influence of the general deep hypothermia structural changes of neurocytes are observed. The nuclei are deformed, reduced in volume, the nucleoli are decentralized, loosened. Heterochromatin is located on the periphery. A small number of mitochondria, their matrix is electron-dense, the cristae are fragmented. Destructively altered Golgi complex and endoplasmic reticulum are observed [12].

At chronic action of a low-frequency pulsed electromagnetic field in neurocytes there is a change of tinctorial properties of cytoplasm, swelling of perikaryons and nuclei, processes are thinned. Total and peripheral chromatolysis is noted. Ischemic changes and pyknosis of neurons, as well as cell hypertrophy and atrophy. Shadow cells and neuronal death are observed. The researchers noted that these results show the dynamics of changes in the structure of neurons that depend on the time and physical and biological parameters of electromagnetic radiation [2]

A large number of studies have shown that active movement is the main condition without which the body can not function properly. Cerebellum is involved in various activities of the body: somatic, autonomic, sensory, integrative and motor. The researchers found that insufficient motor activity (hypokinesia) causes changes in neurocytes and glial cells of the cerebellum. Disturbances of energy and protein-synthesizing organelles in neurocytes, decrease in the number of mitochondria and absence of ribosomes on the endoplasmic reticulum were revealed. The authors note that in conditions of hypokinesia is primarily a functional disorder that leads to structural rearrangement of the organ [19].

CR Erickson-Davis, NH Barmack, ED Louis found conglomerates perikaryons of Purkinje cells with axons of basket-like neurons in patients with tremor. In percentage, the number of entangled neurons in the ganglion layer of the cerebellar cortex was 25%, while in the control group this figure did not exceed 4%. According to the authors, this morphological picture arises due to the fact that basket-like neurons redirect their axons from Purkinje cells in which the structure is disrupted or they died on neighboring functionally active neurons of the ganglion layer. As a result of such interactions, the authors note the compensatory mechanism of hypoplasia of these neurons in tremor [3, 5, 7].

According to DK Mwangi studies, induced hypothyroidism in female rats causes morphological disorders in the cerebellum in the offspring, which manifested in a decrease in the volume of neurons in the granular and molecular layers, decreases the density of granule cells and an increase in glial elements [18].

Lethal-toxic dose of dimephosphon leads to the appearance of cavities and cell-shadows at the site, where previously were located Purkinje cells, there is enlightenment around their perikaryons. These changes were observed by researchers on histological preparations of the cerebellum impregnated with silver. Most degeneratively altered neurons have pyknotic nuclei. Central and peripheral chromatolysis was observed. The shape of pear-shaped neurons changes to spherical. The results of microscopic examination indicate deep irreversible malnutrition [10].

Morphine, as a narcotic drug, is not always used only for medical purposes, which causes an increase in drug addiction, disability, and causes death. In the study of morphometric parameters of the layers of the cerebellar cortex under the conditions of morphine administration, the experiment revealed thinning of all layers of the cerebellar cortex, a decrease in the number of Purkinje cells, the size of preserved cells smaller than control animals, which according to the authors can be explained by the duration of morphine exposure. [16, 17].

### **Conclusions**

As a result of the literature sources analysis it is established that different factors cause first of all violation of the cerebellar microcirculatory bed elements. Against the background of hypoxia and hypoxemia, structural rearrangements of neurons of all layers of the cerebellum occur. The degree of morphological changes is directly dependent on the nature, concentration and duration of the negative factor on the body. However, there is not enough information about the effects of thermal trauma on the histocytoarchitectonics of the cerebellar cortex, because the relevance of this problem remains in the focus of scientists and require further experimental studies.

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