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MORPHOLOGY OF THE PITUITARY GLAND IN RATS UNDER EXPERIMENTAL SLEEP DEPRIVATION

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Abstract. This study is devoted to the investigation of morphological and morphometric changes occurring in the pituitary gland under experimental sleep deprivation. Experimental sleep deprivation may lead to disturbances in the functioning of the nervous and endocrine systems, reorganization of neuroendocrine regulation, and alteration of adaptive mechanisms. The study focuses on the assessment of the cellular and vascular components of the pituitary gland, the structure of the adenohypophysis, morphometric parameters of endocrine cells, as well as microcirculatory changes. The obtained morphological data make it possible to determine structural alterations in the pituitary gland and its adaptive responses within the neuroendocrine system under the influence of sleep deprivation.

Keywords: sleep deprivation, pituitary gland, adenohypophysis, morphology, morphometry, endocrinocytes, microcirculation.

Relevance. Sleep is one of the important physiological states that ensures vital activity of the organism, neuroendocrine balance, metabolic processes, and adaptive mechanisms. Disturbances in the duration and quality of sleep affect not only the central nervous system but also the functioning of the endocrine system. In particular, under conditions of prolonged or recurrent sleep deprivation, activation of stress-response reactions, disruption of hormonal rhythms, and morphofunctional remodeling within neuroendocrine systems may occur.

The pituitary gland consists of anterior, intermediate, and posterior lobes, and its anterior lobe, the adenohypophysis, is a complex assembly of endocrine cells that produce a number of tropic hormones [3,6]. The adenohypophysis contains somatotrophs, corticotrophs, thyrotrophs, gonadotrophs, and other cell types. The morphological condition of these cells is considered one of the important indicators reflecting the functional and hormonal regulation of the organism [2,4].

Under experimental sleep deprivation, morphological remodeling of the pituitary gland may primarily manifest itself in its cellular composition, cell size and nuclear-to-cytoplasmic ratio, the condition of capillary blood vessels, and the relationship between the glandular parenchyma and stroma. As a result of prolonged sleep deprivation, hypertrophic changes associated with increased functional activity may develop in some endocrinocytes, whereas degenerative-dystrophic processes may occur in some cases against a background of functional overload and metabolic disturbances [1,5].

Morphometric parameters such as the total area and volume of the gland, adenohypophyseal thickness, dimensions of endocrinocytes, nuclear and cytoplasmic areas, nuclear-to-cytoplasmic ratio, cell density, and the diameter and density of blood vessels can be used to assess pituitary morphology. Comparison of these parameters with those of a control group makes it possible to objectively evaluate structural changes induced by sleep deprivation. Changes may also be identified in the arrangement of cells within the pituitary parenchyma, staining intensity of the

cytoplasm, shape and size of nuclei, distribution of chromatin, and the condition of microcirculatory vessels.

Therefore, a comprehensive study of the morphological and morphometric characteristics of the pituitary gland under experimental sleep deprivation makes it possible to gain a deeper understanding of the mechanisms underlying the effects of sleep deprivation on the endocrine system. In particular, simultaneous assessment of morphological changes in the pituitary and adrenal glands is of important scientific significance for identifying structural reorganization of the neuroendocrine system responding to sleep deprivation.

Aim of the study: To investigate the nature of morphological changes in the pituitary gland under experimental sleep deprivation.

Materials and Methods.

The study was aimed at investigating the morphological and morphometric characteristics of the pituitary gland in rats under experimental sleep deprivation. Experimental animals were maintained in accordance with established bioethical standards and current requirements for working with laboratory animals. The animals were randomly divided into control and experimental groups. Animals in the control group were maintained under normal conditions. In the experimental group, a chronic sleep deprivation model was established through regular disruption of the sleep-wake cycle. The sleep deprivation model was implemented under laboratory conditions according to a validated experimental protocol. Throughout the experiment, the animals' general condition, body weight, food and water intake, locomotor activity, and behavioral changes were regularly monitored.

For histological examinations, tissue samples were taken from the heart. Pituitary gland tissue was fixed in a 10% formalin solution, dehydrated in alcohol, and paraffin blocks were prepared. Histological sections 8–12 μm thick were obtained from the prepared paraffin blocks and stained with hematoxylin and eosin. Thirty and 60 days after the experiment, the rats were euthanized. The experiments and euthanasia of the animals by decapitation were performed in accordance with the European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes (Strasbourg, 1985). Histological sections with a thickness of 8–10 μm were prepared using a rotary microtome and stained with hematoxylin and eosin according to the standard method [Volkova O. V. V., Yeletsky Yu. K., 1982].

Results of the Study. In rats, the pituitary gland (hypophysis cerebri) is a complex neuroendocrine structure located at the base of the brain in the region of the sella turcica of the sphenoid bone (Fig. 1). The pituitary gland is anatomically and functionally closely connected with the hypothalamus and occupies a central position in regulating the activity of many endocrine glands in the organism.

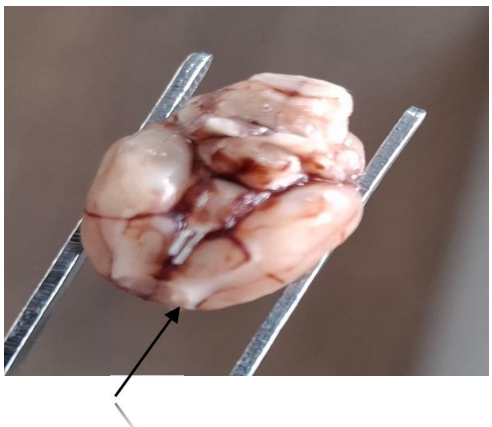


Figure 1. Location of the rat pituitary gland at the base of the brain.

The anterior lobe of the pituitary gland, the adenohypophysis, has a complex reticular glandular structure. Its parenchyma consists of trabeculae that branch repeatedly and form a dense network. The spaces between the trabeculae are occupied by loose connective tissue and blood vessels (Fig. 2). The adenohypophyseal parenchyma consists of three main cell types: chromophobes (main cells), eosinophilic cells, and basophilic chromophilic cells.

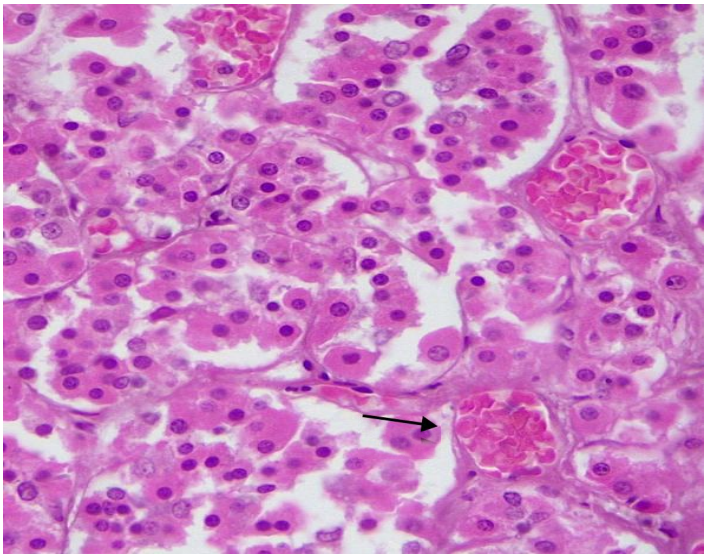


Figure 2. Pituitary gland of a rat from the control group. Blood vessels between the trabeculae are visible. Hematoxylin and eosin. ×10×40

Significant changes were observed in the cellular composition of the adenohypophysis following experimental sleep deprivation. In the control group, the main chromophobe cells constituted the predominant portion of the parenchyma, whereas their number decreased during the initial stage of sleep deprivation. This change was associated with the transformation of chromophobe cells into chromophilic cells with higher secretory activity. At the same time, the number of eosinophilic cells increased approximately twofold compared with the control values, while the number of basophilic cells increased by approximately 1.5-fold.

After sleep deprivation, the increase in secretory activity of the adenohypophysis was manifested particularly by an increase in the number of basophilic cells. Since basophilic cells include cells producing adrenocorticotropic, thyrotropic, and gonadotropic hormones, these changes were interpreted as a morphological response associated with activation of the hypothalamic-pituitary-adrenal axis. The increase in the number of eosinophilic cells indicated enhanced activity of somatotropic hormone-producing cells.

Analysis of the cell ratio also demonstrated functional reorganization of the adenohypophysis under the influence of sleep deprivation. In the control group, the ratio of the main chromophobe cells to secretory cells (eosinophilic and basophilic cells) was 2.9:1. Following sleep deprivation, this ratio decreased to 1.2:1.

Histologically, active hyperemia, vascular dilation, and blood filling were observed in the adenohypophyseal capillaries following sleep deprivation. These vascular changes were

accompanied by increased activity of secretory cells and more rapid release of hormones into the bloodstream.

Significant changes were also recorded in the ratio between stromal and vascular components. In the control group, the ratio of stroma to blood vessels was 1:1.6, whereas after sleep deprivation it changed to 1:3. Thus, the morphological and morphometric findings demonstrated gradual reorganization of the cellular and stromal-vascular components of the adenohypophysis under the influence of cold stress. During the acute stress stage, an increase in the number of secretory cells, particularly basophilic and eosinophilic cells, together with active hyperemia in the capillaries was observed, whereas under conditions of long-term stress, partial restoration of the number of main chromophobe cells and approximation of the number of eosinophilic cells toward control values were noted. At the same time, persistence of changes in basophilic cells and in the vascular component indicated morphofunctional adaptation of the adenohypophysis to continuing stress exposure.

Conclusion. Under experimental sleep deprivation, morphofunctional changes were identified in the cellular, stromal, and microcirculatory components of the adenohypophysis in rats. At the initial stage of sleep deprivation, a decrease in the proportion of chromophobe cells accompanied by a twofold increase in the number of eosinophilic cells and a 1.5-fold increase in the number of basophilic cells represented morphological signs of enhanced functional activity of the adenohypophysis.

Under the influence of sleep deprivation, dilation of capillaries, increased blood filling, and hyperemic changes were observed in the microcirculatory bed of the adenohypophysis. Under conditions of prolonged sleep deprivation, these findings indicate the development of compensatory-adaptive processes in the adenohypophysis. At the same time, persistence of changes in the number of basophilic cells and in the vascular component morphologically reflected the continuing influence of the stress factor and persistent functional overload of the hypothalamic-pituitary system.

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