ASPECTS OF THE STATE OF THE AUTONOMIC NERVOUS SYSTEM IN HYPOXIA

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Abstract. *This article presents a change in the functioning of the autonomic nervous system under hypoxic effects on the body. Information is also given about the alternative influence of the sympathetic and parasympathetic nervous systems in the course of compensating for the lack of oxygen in the blood and tissues.*

Keywords: *Hypoventilation, hypobaric hypoxia, adaptation, partial oxygen pressure.*

АСПЕКТЫ СОСТОЯНИЯ ВЕГЕТАЦИОННОЙ НЕРВНОЙ СИСТЕМЫ ПРИ ГИПОКСИИ

Аннотация*. В данной статье представлено изменение функционирования вегетативной нервной системы при гипоксическом воздействии на организм. Приводятся также сведения об альтернативном влиянии симпатической и парасимпатической нервной системы в ходе компенсации недостатка кислорода в крови и тканях.*

Ключевые слова*: Гиповентиляция, гипобарическая гипоксия, адаптация, парциальное давление кислорода.*

Relevance. Despite the unprecedented development of the medical field in the field of health preservation and the increase in the number of processes and diseases that are prevented or at least controlled by humans, some of them still have a huge impact on the life and activity of people. One of them is the body's response to lack of oxygen, in particular the reaction of the autonomic nervous system. In the fall of 2019, a group of scientists from the Institute of Cell Biology and Neurobiology of Charite University in Germany and Lobachevsky University discovered a way to prevent the death of nerve cells during hypoxia. According to the above data, a decrease in oxygen concentration leads to a violation in the metabolism of nerve cells. In this case, interactions between cells are destroyed, and the cells themselves die. Since nerve cells, interacting, form neural connections, and those, in turn, transmit information, the loss of links in this network leads to a violation of the central nervous system and ANS. As a result, a person's vital functions are disrupted, severe forms of disability arise. It is for the correction of hypoxic conditions that Maria Vedunova from Lobachevsky University suggests using the body's own capabilities. There are signaling molecules in the human body that take an active part in the growth and development of nerve cells in the embryonic period. They also implement the protection and adaptation of CNS cells under the influence of various adverse factors already in an adult individual. These molecules form GDNF-glial neurotrophic factor. In the course of research, scientists have confirmed that the activation of this factor (GDNF) inhibits the death of nerve cells and supports the activity of neural networks after suffering a lack of oxygen.

The main part. The autonomic nervous system is actively involved in the regulation of the respiratory process. At the same time, the sympathetic nervous system is involved when there is intensive work and the body is in a stressful situation, stimulating energy expenditure. Consequently, it accelerates breathing. The parasympathetic nervous system stimulates the processes of calm, narrows the bronchioles. However, sometimes under external influence or violation of any internal processes, the respiratory function is disrupted and a state of hypoxia occurs. Hypoxia is a pathological process that occurs due to a lack of oxygen and is

characterized by a lack of biological oxidation and a violation of energy supply. One of the types of respiratory disorders can be alveolar hypoventilation, in which the minute volume of alveolar air does not provide the metabolic needs of the body. One of the reasons for such a violation is damage to afferent and efferent regulatory links or violations of synaptic conduction. Hypoxia in humans is often observed when climbing to low altitudes, where atmospheric pressure is below average. At the same time, according to research, both the sympathetic and parasympathetic nervous systems are activated. For example, an increase in the heart rate is considered a sign of the active influence of the sympathetic nervous system on the myocardium. Many of the subjects had dilated pupils, which also indicates an increase in the tone of the sympathetic department. When an individual inhales air with an oxygen content of up to 16%, the electrical activity of the vagus fibers that innervate the heart increases. This is proof of the involvement of the parasympathetic departments. However, most researchers adhere to the hypothesis of the predominance of the sympathetic department: during exposure to a low concentration of oxygen in the blood, the content of catecholamines and glucose concentration increases, which contributes to a faster and more complete adaptation of the body to new conditions. The exception is the natives of the highlands, who do not have such adaptive reactions. According to research conducted by Daniyarov.S.B. and Zarifyan.A.G early (2-3 days) reactions of adaptation of the organism to mountainous areas are stereotyped. In the first 10-15 days, the tone of the vagus nerve is usually reduced. Further adaptation reactions are already more specific. Already after 15 days of staying in conditions of low oxygen concentration, the tone of the parasympathetic department gradually increases (especially the activity of the vagus), for the second month of stay in the highlands, this department of the ANS already prevails in its effect on the body. A group of individuals were subjected to hypoxic stimulation sessions to study the effect of hypoxia on the state of the gastrointestinal tract. In the first group, to which intermittent normobaric hypoxia (with 10% oxygen content) was applied, the tone of the parasympathetic nervous system was markedly predominant. This predominance can explain the antispasmodic effect, a decrease in flatulence and dyskinesia, a decrease in the tendency to constipation. Also, these data were confirmed in experiments on dogs. They were trained by sessions of intermittent normobaric hypoxia for 20 days and this led to an increase in the tone of the parasympathetic link of the ANS, as can be judged by the aggravation of bradycardia in response to vagus nerve stimulation

Materials and methods :The study of studies conducted at the Institute of Physiology of the National Academy of Sciences of Ukraine by Professor V.A.Berezovsky, as well as the study of the works of professors of the Medical Institute of the Moscow State Technical University, data from the Internet. Empirical conclusions after climbing the highlands.

Results and discussions: Hypoxologist, co-founder of Russian hypoxology N.N. Sirotinin was convinced of the leading role of systemic adaptations to hypoxia in high-altitude conditions. Z.I. Barbashova, researcher of adaptation processes, was a supporter of the theory of tissue adaptation. Often, a controversy of the highest intellectual level broke out between the two scientists at scientific conferences. Time has shown that both of them were right. Systemic adaptation, like tissue adaptation, is equally involved in the process of adaptation of the body to hypoxia. Hazen's research.I.M., who worked in the field of the influence of normobaric hypoxia on the functions of intestinal secretion and excretion, sees a large role of the parasympathetic nervous system in the above-mentioned processes. The studies of Daniyarov and Zarifyan also

prove, along with others, the high role of the autonomic nervous system in the processes of adaptation to the conditions of the mountain climate. According to them, with long periods of stay in the highlands and adaptation, there is a relative predominance of the tone of the parasympathetic department over the sympathetic. This can explain the difference in the adaptation of people who live permanently in these conditions and have recently encountered them. In the former, the parasympathetic department prevails constantly. According to Orbeli's research.L.A low atmospheric pressure affects the body in two phases. The first phase is due to the exciting and activating effect of the reduced partial oxygen content. As this happens, the higher centers of vegetative regulation are suppressed and disinhibited. The second period leads to the excitation of the parasympathetic department.

Conclusion: Each type of tissue consumes a characteristic amount of oxygen. However, the most sensitive in this regard are nerve cells. Faced with conditions of lack of oxygen, the body launches its own compensatory mechanisms to preserve homeostasis. One of them is a change in the ratio of the influence of the sympathetic and parasympathetic nervous system. According to the mass of studies conducted, it can be concluded that hypoxia has a two-phase effect on the body as a whole. The first phase is characterized by activation of the tone of the sympathetic, and the second phase of the parasympathetic nervous systems. However, depending on the fitness of the organism to such conditions, the data may vary. For example, the indigenous inhabitants of the mountains prevail in the constant process of the predominance of the parasympathetic department. Thanks to the study of these processes, it is possible to develop methods for the treatment of certain gastrointestinal diseases. These methods are described in detail in the classical studies of Razenkov.I.P.

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