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PHYSIOLOGICAL SIGNIFICANCE OF RESPIRATORY SINUS ARRHYTHMIA AND ITS FEATURES IN VAGO - AND SYMPATHICOTONIA

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Abstract: Respiratory sinus arrhythmia is one of the types of cardiorespiratory interactions. It is used as an indicator of vagal tone and contributes to heart rate variability. The stability of the heart rate in various types of autonomic reactivity at rest is provided by central and autonomous (mostly parasympathetic) influences. There are differences in the correlations between the parameters of heart rate variability and hemodynamic parameters with different dominant types of autonomic regulation.

Key words: respiratory sinus arrhythmia, heart rate variability, autonomic reactivity

The cardiac and respiratory systems form an integral physiological system with complex dynamics of changes in their parameters. The interaction of these systems obeys certain rhythms and is regulated by internal feedback mechanisms [1, P. 10181–86].

There are a number of sources of rhythms in the cardiorespiratory system. The main ones are heart contractions, respiration, changes in blood pressure, thermoregulatory activity and endothelial activity, etc. The interactions of these rhythms lead to heart rate variability and affect the variability of respiration patterns and other indicators of the cardiovascular system [2, P. H6–H17].

Rhythm variability is periodic changes in the duration of the heart rate intervals. In an integral organism, the circulatory regulation system consists of several levels and circuits, the changes in the parameters of which over time are characterized by sufficient complexity in the formation of the adaptive reactions of the organism. Heart rate variability is thought to reflect the complex interactions between the brain and the cardiovascular system [3, P.1-10].

The formation of the heart rhythm is carried out by the integration of the cerebral and intracardiac rhythm generators into a two-level system, which ensures the reliability and functional perfection of the functioning of the heart. The central generator of the heart rhythm generates impulses, which, entering the heart through the vagus nerves and interacting with the intracardiac generator, is a source of excitation in the heart. Thus, normally, the formation of a heart rhythm occurs in the central nervous system - the cardiac center of the medulla oblongata, i.e. the control mechanism is central, and the heart repeats the rhythm set extracardially [4, P.230-240]. This ensures adaptive responses of the heart in vivo.

The functional organization of adaptive reactions is individual, therefore, the implementation of the next optimal adaptive response reflects the state of the mechanisms for regulating the work of the heart and their autonomic support. The dominant role of individual links in the functional system of blood circulation regulation is determined by the current needs of the body [5, P. 66–85].

Measurement of the duration of time intervals of cardiac cycles and further analysis of their series allows us to characterize the influence of various links in the complex mechanism of regulation of cardiac activity. Changes in rhythm are considered as a manifestation of the formation of various functional systems, the organization of which is determined by the required result. Thus, heart rate variability reflects the intensity of the involvement of individual links of the general regulatory system in the emerging adaptive response. The formation of heart rate variability is associated with the inclusion of suprasegmental structures.

Respiratory sinus arrhythmia is one type of cardiorespiratory interaction. Respiratory sinus arrhythmia (RSA) is the alignment of heart rate with a respiratory pattern. This is reflected in an increase in heart rate during inhalation and a decrease during exhalation.

An inverse relationship has been found between RSA and age [6, P. 212-223], may increase with physical training. RSA is also enhanced by deep, slow breathing [2, P. H6–H17].

The mechanism of heart rate variability associated with the phases of the respiratory cycle occurs from the interaction of the respiratory and cardiac centers of the medulla oblongata [7, P. 1021-1028]. These centers coordinate their activity coupled with each other in accordance with the afferentation coming to them from the receptors of the lungs and heart. This complex cardiorespiratory regulatory network modulates both preganglionic vagal and sympathetic motor neurons, resulting in respiration-related heart rate fluctuations - short-term heart rate variability, determined mainly by the influence of the efferent vagus nerve. In addition to the above, the regulatory system includes some other mechanisms, which include the centers involved in the formation of emotional states and mental activity. Respiratory short-term heart rate variability is associated with several central regions, such as the prefrontal or cingulate cortex [8, P. S163–S169].

RSA is a manifestation of an oscillatory parasympathetic effect on the sinoatrial node, which is associated with the respiratory cycle. In heart rate variability, it looks like a high frequency component. The origin of the low-frequency and ultra-low-frequency components of heart rate variability is assumed to combine sympathetic and parasympathetic activity. Sympatovagal balance is determined by the ratio of low and high frequencies. At the same time, the RR interval more accurately characterizes the sum of sympathetic and parasympathetic influences on the sinus node than other parameters of heart rate variability.

RSA is used as an indicator of vagus tone and contributes to heart rate variability [9, P. 263–285]. RSA, quantified by various time- and frequency-domain analyzes of heart rate variability, can provide important information about discrete abnormalities in cardiac vagus nerve control [10, P. 86-92].

In assessing cardiovascular risk, the role of respiratory regulation of the vagus nerve (indexed short-term heart rate variability) is of particular importance. The cause of various diseases that increase cardiovascular risk can be autonomic sympatovagal imbalance - a decrease in parasympathetic activity associated with increased sympathetic activity. The physiological significance of RSA is still unclear. One of the predicted values is a possible improvement in the RSA of pulmonary gas exchange, an improvement in cardiac efficiency while maintaining physiological levels of arterial CO2 and / or stabilization of arterial blood pressure and systemic blood flow [11, P. 521–530].

The features of RSA in different types of autonomic reactivity have not been adequately studied. The study of heart rate variability in adolescent boys with different types of autonomic reactivity showed that in young senior school students of all types, the stability of the heart rate at rest is provided by central and autonomous (mostly parasympathetic) influences. The restoration of the heart rhythm after performing active orthostasis occurs due to the autonomous regulation circuit with a predominance of sympathetic modulations. Parasympathetic influences decreased in young men of normotonic and asympathicotonic types, and in young men of hypersympathicotonic type, the proportion of humoral factors also slightly increased. [12, P. 27-30].

Students with different dominant types of autonomic regulation showed differences in correlations between heart rate variability parameters and hemodynamic parameters. In sympathotonics, the autonomous mechanisms of heart rate regulation were reoriented to higher central mechanisms of regulation. In normotonics, a decrease in the activity of the parasympathetic link of autonomic regulation was revealed [13, P.113-117].

The study of the physiological nature of interactions that lead to heart rate variability is the basis of prevention, diagnosis, prognosis and treatment of diseases of the cardiovascular, respiratory and autonomic nervous systems.

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