Modern approach in functional assessment of adaptation of athletes with heart rhythm disorders

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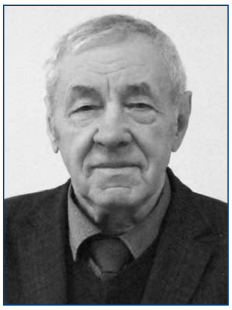

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Abstract

Objective of the study was to identify types of heart rhythm migration disorders and their impact on the adaptation of athletes with foci of chronic infection and signs of maladaptation.

Methods and structure of the study. 421 athletes of qualification from the 1st category to the master of sports were examined. A comprehensive medical and functional examination included clinical and instrumental methods of examination (ECG, RKS-01 Rhythmocardioscope). The health status of the athlete, the electrical function of the heart were assessed, heart rhythm disturbances were detected, the index of the functional state was calculated according to the parameters of the correlation rhythmogram.

Results and conclusions. One of the tasks of monitoring the functional state of athletes is to identify early signs of overstrain syndrome (stress damage to the heart), which occurs in them under conditions of inconsistency of physical activity with the functional adaptive reserve of the body. The article substantiates the expediency of using a special technique: electrocardiography and correlation rhythmography to identify types of pacemaker migration and calculate the functional state index for athletes with heart rhythm disturbances. Indicators of active and passive types are combined with a decrease in the index of the athlete's functional state, they are harbingers of cardiac pathology that develops with excessive physical exertion and lead to a decrease in the athlete's performance.

Keywords: *heart rate migration, correlation rhythmography, adaptation, disadaptation, stress cardiomyopathy.*

Introduction. The impact of various factors, training and competitive loads on the athlete's body is characterized by both physiological adaptation and its disorders, overstrain syndrome. The clinical characteristics of this syndrome are manifested by disorders in various organs and systems, but most often in the circulatory system, cardiac arrhythmias, arterial pressure, stress cardiomyopathy [9]. According to modern scientific research, the basis of cardiac dysfunction and myocardial metabolism is a psychoneuroimmunoendocrine imbalance [6]. It is characterized by stressful cardiomyopathy with impaired electrical and contractile function of the heart [3]. Disorders of the electrical function of the heart and the process of repolarization form various types of cardiomyopathies. Identification of early signs of stress damage to the heart is an urgent task in the preparation of athletes [4].

One of the methods of studying the adaptation of an athlete's heart to training and competitive loads is variational heart rate monitoring and its mathematical analysis by the method of R.M. Bayevsky [1]. The combination of this method with an active ECG orthoprobe makes it possible to detect early signs of stress cardiomyopathy and its types depending on the type of overstrain of a nonspecific stress reaction [7].

If the function of heart automatism is impaired due to the migration of the rhythm driver (MRD) from the sinus node to the atria or atrioventricular node, it is necessary to use another technique: a combination of electrocardiography and correlation rhythmography. This technique allows you to determine the type of migration of the rhythm driver, the index of the functional state of the heart and thereby assess the adaptation of an athlete with a violation of the function of automatism. MRD in athletes is observed twice as often as in non-athletes and ranges from 11.1% to 48.5%, it has a different genesis and requires an individual assessment of the nature of adaptation [2, 5].

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The essence of the method of correlation rhythmography (CRG) is a sequential, pairwise analysis of 100 R-R intervals, which are represented in a rectangular coordinate system by a point on the plane [11]. The heart rate is represented by a group of points, and the graph itself is a correlation rhythmogram. The main population is determined by measuring the longitudinal ("a") and transverse ("b") axes and the value of their ratio ("a / b"). The values of these axes are determined by the value of their projections (PR, PCH) onto one of the coordinate axes (Fig. 1). The value of the axis "a" reflects the amplitude of the respiratory waves, and "b" and "a / b" - the period of the respiratory waves of the heart rhythm. Based on a pairwise analysis of the R-R intervals, the index of the functional state is calculated, which is the product of the functions of three variables R-Ravg, "a" and deviation "a / b". This index allows assessing the functional state of an athlete with heart rate migration.

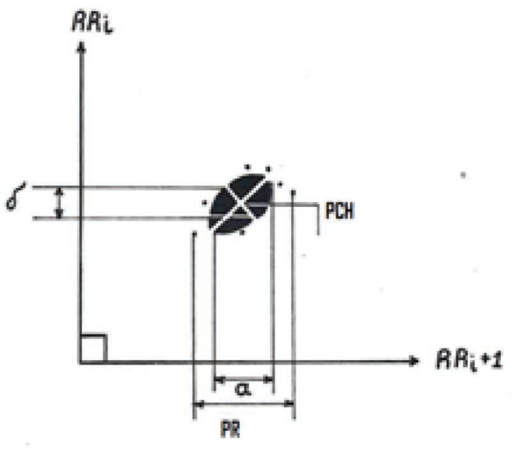

Figure 1. *Measurement of the main parameters by the CRG method*

Results of the study and their discussion. During the examination, 204 athletes (48.5%) revealed cardiac arrhythmias. At the same time, the migration of the heart rhythm was observed in athletes with health abnormalities. They were characterized by foci of chronic infection (52.9%), signs of stress cardiomyopathy (9.3%), frequent colds (7.3%). These health deviations determine the frequency of the types of migration of the rhythm driver (MRD). Thus, the active type of MRD was often observed in athletes with foci of chronic infection (66.6%), and the passive type was combined with both signs of stress cardiomyopathy (21.2%) and foci of chronic infection (48%). The normosystolic type of MRD was detected in athletes without deviations in the state of health, it can be evaluated as a variant of the physiological norm of the function of automatism.

Based on the examination data by the CRG method, the parameters of the types of migration of the heart rhythm were studied and the index of the functional state was calculated (Table 1).

Heart rate indicators in athletes with MRD significantly differed from those without automatism dysfunction (rigid rhythm). The greatest differences are determined by the magnitude of sinus arrhythmia (RR). The lower functional state of the heart of athletes with MRD corresponds to low average values of FSI compared to athletes without arrhythmias. Analysis of heart parameters within groups of athletes with MRD showed that all types of MRD significantly differ in the magnitude of sinus arrhythmia. The lowest average value of RR was observed in athletes with MRD of the normosystolic type (0.039±0.01 s). The highest RR value was found in athletes with the passive type of MRD. They, against the background of relative resting bradycardia (RRavg =1.05±0.14 s), showed a significant lengthening of intersystolic intervals (RR=0.56±0.14 s). With the active type of MRD, the average values of RR are significantly lower (0.48±0.01 s) than in athletes with a passive type of migration. The active type of MRD, as a rule, occurs against the background of severe bradycardia (RRavg=1.12±0.032 s) and is often assessed as physiological.

From our point of view, it is not justified to evaluate all cases of MRD of the active type in bradycardia only as a variant of physiological arrhythmia. With the active type of MRD, foci of chronic infection are especially often detected, which gives reason to assert that the active type of MRD, as well as the appearance of ectopic activity in the case of atrial extrasystole, is due to foci of chronic infection.

Based on the analysis of the frequency of detec-

Table 1. *Indicators of heart rhythm and functional state index in athletes with different types of migration of the rhythm driver*

Groups of athletes by types of migration of the rhythm driver	Indicators (X±σ)					
	RR	∆RR	a	b	a/b	IFS
I. Athletes with MRD, n=204	1,034±0,01	0,44±0,009	0,26±0,005	0,19±0,005	1,51±0,026	260±25,8
a) normosystolic type, n=140	1,02±0,014	0,39±0,01	0,26±0,005	0,19±0,005	1,52±0,035	247±13,1
b) active type, n=12	1,12±0,032	0,48±0,035	0,26±0,023	0,20±0,029	1,35±0,11	272±26,0
c) passive type, n=52	1,05±0,021	0,56±0,014	0,26±0,012	0,18±0,008	1,53±0,045	292±17,7
II.Athletes without MRD, n=217	1,01±0,014	0,33±0,01	0,23±0,005	0,14±0,004	1,64±0,05	331±8,5
Reliability of differences (p)						
I-II	>0,05	<0,05	<0,05	<0,05	<0,05	<0,05
a – b	<0,05	<0,05	>0,05	>0,05	>0,05	>0,05
a – c	>0,05	<0,05	>0,05	>0,05	>0,05	>0,05
b – c	>0,05	<0,05	>0,05	>0,05	>0,05	>0,05
II – a	>0,05	<0,05	<0,05	<0,05	<0,05	<0,05
II – b	<0,05	<0,05	>0,05	<0,05	<0,05	<0,05
II – c	>0,05	<0,05	<0,05	<0,05	>0,05	<0,05

Note: MRD – migration of the rhythm driver; RRsr – duration of the cardiac cycle (c); ∆RR – intersystolic interval (sinus arrhythmia) (c); a – amplitude of respiratory waves (c); "b", "a/b" – periods of respiratory waves of the heart rhythm (c); IFS – index of functional state hearts (c.u.); p – the level of significance; n – the number of athletes.

tion of clinical significance and the nature of the heart rhythm in athletes with MRD, it can be concluded that the clinical significance of MRD depends on the type of migration. The active and passive types of MRD have the greatest clinical significance, in which signs of stress cardiomyopathy and foci of chronic infection are significantly more likely than in the normosystolic type, which makes it possible to consider these two types of migration as precursors of cardiac pathology that develops with excessive exercise. The normosystolic type in most cases is associated with physiological fluctuations in parasympathetic tone and can be attributed to physiological arrhythmias. It should be noted that the IFS in all athletes with active and passive MRD is significantly less compared to the group of athletes without heart rhythm disturbance, and is an objective sign of a decrease in their functional state.

The pathogenesis of cardiac arrhythmias in athletes is due to a nonspecific phase of the pituitary, hypothalamic-adrenal adaptive stress response [10]. It is characterized by both the activation of the functions of these adaptation systems and their decrease. This pattern is also observed during the adaptation of the athlete's heart to physical activity. An increase in the risk of maladaptation of the athlete's heart is associated with the pathological influence of foci of chronic infection, especially in chronic tonsillitis. This is due to the constant irritation of the receptor zones of the palatine tonsils. Due to the inflammatory process (tonsillitis, tonsillitis), pathological slow wave bioimpulsation reflexively occurs in the posterior hypothalamus, and the reactivity of adrenergic receptors changes. It is characterized by the fact that in the nuclei of the posterior and anterior parts of the hypothalamus, in the structures of the limbic region, there is a sharp decrease in the frequency of neuronal discharges and the generation of high-amplitude impulses, which indicate the development of a neurodystrophic process in these formations, that is, in higher autonomic centers [8]. As a result, there is a violation of the double autonomic regulation of the heart, changes in the content of adrenaline, noradrenaline and serotonin in the blood, brain, heart and adrenal glands, corticosteroids in the blood.

Secondary changes are characterized by a regular phasing: at first, there is a sharp activation of the sympathoadrenal system, the predominance of the tone of the sympathetic nervous system, and in subsequent periods, on the contrary, a decrease in the content of catecholamines in the blood and an increase in serotonin (the predominance of the tone of the parasympathetic nervous system). In the tissues of the heart, the content of adrenaline significantly increases, the amount of norepinephrine decreases. Such an imbalance of catecholamines is a pathogenetic mechanism of myocardial dystrophy.

With a tonsillogenic neurodystrophic process, the normal hierarchical functional system for regulating the work of the heart turns into a pathological functional system. This pathological functional system begins to work according to the principle of a "vicious circle" and constantly causes dysregulation of the functions of the heart. The consequence of this are diagnostic signs of violation of the electrical and contractile functions of the heart. At the same time, cellular dystrophy leads to damage to mitochondria and, thereby, to a decrease in intracellular energy supply, and, as a result, to a decrease in the contractile function of the myocardium and the performance of the athlete. In this regard, heart rhythm disturbances in the form of pacemaker migration should be assessed as one of the symptoms of arrhythmogenic cardiac pathology, a sign of a decrease in the athlete's functional state.

Conclusions. To assess the adaptation of athletes with heart rhythm disorders, it is necessary to use a special technique: electrocardiography and correlation rhythmography. This technique makes it possible to identify the types of pacemaker migration - normosystolic, passive, active - and to calculate the index of the athlete's functional state. It has been established that with active and passive type of pacemaker migration in athletes, the functional state index is significantly reduced. These types of pacemaker migration should be evaluated as early diagnostic signs of cardiac pathology, a variant of arrhythmic stress cardiomyopathy. Migration of the pacemaker is a compensatory response to maintaining the function of automatism and, thus, contractility in stress cardiomyopathy in athletes.

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