Efficiency of training correction in canoeing based on post-exercise electrocardiogram changes

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Abstract

Objective of the study was to assess the diagnostic potential of post-training electrocardiogram alterations in the context of current training regimen optimization for elite kayakers and canoeists.

Methods and structure of the study. The electrocardiogram was taken from 28 male rowers aged 18 to 36 (3 Olympic champions, 7 international-level masters, 18 masters) and 18 female athletes aged 18 to 33 (2 Olympic champions, 4 international-level masters, 12 masters). The examination was conducted using the Valenta diagnostic system, with 12 standard leads, repeated at intervals of 3 to 12 days throughout the annual training cycle. A total of 1,360 measurements were taken. The following data were recorded: heart rate, the position of the heart's electrical axis AQRS, the duration of the P, T, and QRS complexes, the PQ, QT, and QT corrected (Bazett) intervals, and the ST segment.; The Macruz index, the height of the R and T waves, and the ratio of the R to T wave heights in the fifth and sixth thoracic leads, the waveform, and the T-wave amplitude in all leads, the position of the PQ and ST segments relative to the isoelectric line, and the shape of the ST segment ascent were examined.

Results and conclusions. It was discovered that the diagnostic value of an electrocardiogram diminishes significantly when it is taken only as part of a routine annual medical examination. To detect the slightest alterations that enable timely adjustment of training loads, it is essential to conduct at least one recording per week. Moreover, the new electrocardiogram must be meticulously compared with the previous one. It is also crucial to incorporate the ratio of K to N in the left chest leads and the measurement of the angle between the ascending and descending portions of the T-wave with its characteristic dome-like shape into the calculation of the recorded parameters.

One of the initial abnormalities in the electrocardiogram of athletes may be the alignment of the S-T segment and the ascending portion of the T wave, as well as an increase in the absolute QT interval due to the S-T segment with a relatively stable corrected QT.

Keywords: *highly skilled canoeists and kayakers, electrocardiogram, post-load changes, overexertion criteria, training process.*

Introduction. The current approaches to the selection of medical and biological markers of the need for short-term correction of the training process in certain situations are not always sufficiently substantiated. This is due to the lack of a number of examinations relevant for current monitoring and taking into account the different individual diagnostic significance of each of the recorded physiological and clinical laboratory parameters. The results of the research conducted by us over a period of six years (2028-2023) showed that in fact none of the physiological (heart rate, systolic and diastolic blood pressure, double product index, body components, integral indices of the functional state of the hardware and software complexes «Omega» and «Cardiovisor») and clinical and laboratory parameters (morphological, protein composition of the blood and a number of biochemical parameters – the content of urea, glucose, cortisol, total and free testosterone, iron, alanine aminotransferase, aspartate aminotransferase, total creatine phosphokinase), registered within the framework of systematic current medical and biological monitoring of highly qualified kayakers and canoeists, with the exception of stabilization in the negative zone of the criteria of psychoemotional status (sleep, mood, appetite), does not allow us to argue for coaches the need to regulate training loads [5, 6, 7, 8, 9, 10, 12]. Turning to the works of the founders of domestic sports medicine of the 70-90s of the last century, we considered it justified to return to the method of electrocardiography from the perspec-

tive of not chronic and urgent (as is customary), but its possible delayed post-load changes, which can be stopped by a short-term reduction in training loads.

Objective of the study was to assess the diagnostic potential of post-training electrocardiogram alterations in the context of current training regimen optimization for elite kayakers and canoeists.

As a specific task, the substantiation of the algorithm for analyzing the electrocardiogram in athletes when using it in the system of current medical and biological control of rowers on kayaks and canoes of high and higher qualification was chosen.

Methods and structure of the study. The electrocardiographic examination involved 28 male rowers aged 18 to 36 years (3 Honored Masters of Sports, 7 Masters of International Class, 18 Masters of Sports) and 18 female athletes aged 18 to 33 years (2 Honored Masters of Sports, 4 Masters of International Class, 12 Masters of Sports). The examination was conducted using the Valenta diagnostic system in 12 generally accepted leads, in the morning, immediately after sleep, in the supine position, on an empty stomach, repeatedly, with an interval of 3-12 days at all stages of the annual training cycle. The total number of measurements was 1360 (740 for males and 620 for female athletes). The following were recorded: heart rate (beats/min), position of the electrical axis of the heart AQRS (deg), duration of P waves (sec), T (sec), QRS complex (sec), PQ intervals (sec), PQ from the end of the P wave to the beginning of the Q wave (sec), QT (sec), corrected QT (Bazett) (sec), ST; the Macruse index – P/(PQ-P), amplitude of R and T waves in the fifth (V5) and sixth (V6) chest leads (mm), ratio of R and T wave amplitudes in V5 and V6, shape and amplitude of the T wave in all leads, position relative to the isoelectric line of the PQ and ST segments, shape of the ST segment elevation were also calculated and analyzed. As criteria for myocardial repolarization disorders in athletes, the indicators presented in the classification of the dystrophic variant of chronic overstrain of the cardiovascular system (according to A.G. Dembo, 1980 [2], according to L.A. Butchenko and V.L. Butchenko, 1984 [1]), in the works of S.A. Dushanin, V.V. Shigalevsky, 1988 [3] were analyzed.

Results of the study and discussion. According to the results of the conducted studies, the examined athletes can be divided into three subgroups – with a consistently normal electrocardiogram, with a consistently pathological electrocardiogram, consistent with chronic physical overstrain of the heart with periodic deterioration and improvement in terms of the terminal part of the ventricular complex, as well as with delayed post-load repolarization disorders, which, as a rule, normalize after a short-term regulation of loads.

Of the 28 rowers, 14 people (55,0%) consistently had a normal electrocardiogram, 6 (21,5%) consistently had a pathological one, and eight (21,5%) had periodic improvement or deterioration. Among women, out of 18 athletes, 10 people (55,5%) had a consistently normal electrocardiogram, three (16,7%) had a consistently pathological one, and five (27,8%) had a periodic improvement or deterioration. In the absence of a stable delayed negative reaction of the electrocardiogram in athletes to training loads of varying volume and intensity, it is reasonable to assume that electrocardiography can serve as one of the sufficiently reliable physiological examination methods in determining the degree of tolerance to physical activity, a high level of which is a necessary condition for improving athletic skills. At the same time, we have found that the most effective regulation of loads is against the background of the beginning of «leveling» of the S-T segment and the ascending knee of the T wave. According to L.A. Butchenko and V.L. Butchenko, [9], this corresponds to the 4th variant of the S-T segment. It is found in 1,4% of athletes, regardless of the type of sport. It is not found in healthy people who do not play sports. The frequency of this variant on the ECG is the same for athletes of both sexes. Its characteristic feature is the ascending direction of the S-T segment with a gradual transition to the T wave. Since there is no clear boundary between the segment and the wave, the width of the T wave increases. Such changes, according to our observations, can be recorded both in the chest and in the standard leads, they are characterized by high variability and can be corrected with a short-term decrease in loads.

In general, when examining a selected contingent of athletes, changes in the amplitude and shape of the T wave in standard leads II, III, AVF and chest leads V5, V6, as well as a domed T wave in leads V5-V6 were recorded as delayed post-load repolarization disorders according to electrocardiogram data. Changes in the amplitude and shape of the wave in standard leads II, III, AVF and chest leads V5, V6 required a longer regulation of loads, and the domed T wave in leads V5-V6, as a rule, remained stable, with the exception of a slight decrease in the amplitude of the domed T and an increase in the angle between the ascending and descending knees of the T wave.

Conclusions. It has been established that the informative value of the electrocardiogram in the system

of medical and biological monitoring of highly skilled canoeists and kayakers is sharply reduced with an insufficient number of its registrations. In order to detect the slightest changes in the ECG, allowing timely regulation of training loads for a short period of time (without practically disrupting the training process), it is necessary to record and analyze it at least once a week. It is very important to carefully compare the electrocardiogram with the previous one. In order to correctly detect the slightest changes in the amplitude of the T wave in the left chest leads, it is necessary to introduce the ratio of R to T into the calculation of the registered parameters, as well as the measurement of the angle between the ascending and descending knees of the T wave with its dome-shaped form. In general, according to the data obtained, it is electrocardiography, with strict observance of all the above conditions (including the time of registration, the position of the subject, the absence of food intake), that can serve as one of the informative methods of ongoing monitoring of a selected contingent of athletes and will allow simultaneously assessing the level of their tolerance to training loads. In highly qualified athletes with a consistently normal electrocardiogram, the criteria of the psychoemotional state are more diagnostically significant. Separately, it is necessary to dwell on the analysis and assessment of the QT interval in athletes, which is the subject of active discussions among specialists [4, 11]. According to the data we have obtained, one of the early violations of electrocardiograms in athletes can be an increase in the absolute QT interval due to the ST interval with a sufficiently high stability of the corrected QT interval. In our opinion, specialists dealing with this problem should return to the problem of ongoing changes in the QT interval in athletes against the background of high training loads once again.

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