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REORGANIZATIONS IN CARDIORESPIRATORY SYSTEM AFTER TRAINING LOADINGS BY PREPARATION OF PROFESSIONAL DIVERS

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Abstract. In article on results of research of a complex of the cardiorespiratory parameters, allowing to describe levels of professional readiness of divers.

ПЕРЕСТРОЙКИ В КАРДИОРЕСПИРАТОРНОЙ СИСТЕМЕ НА ФОНЕ НАГРУЗОК ПРИ ПОДГОТОВКЕ ВОДОЛАЗОВ-ПРОФЕССИОНАЛОВ

Ключевые слова: *кардиореспираторная система, физическая нагрузка, погружение под воду, ортостатическая проба.*

Аннотация. В статье обсуждаются результаты исследования комплекса кардиореспираторных параметров, позволяющих описывать уровень профессиональной подготовленности водолазов.

The topicality of the research. It is obvious that nowadays in sports and professional activity related with high extreme loads is saved the deficiency of methods and tools which allow to describe the features of the current state of human, to prognose the dynamic its perfomance and potential health problems, that is especially important in the system of training highly qualified specialists. Approaches are well known for use in the «field» functional diagnosis parameters of the cardiorespiratory system and, primarily, the electrocardiogram. Nevertheless, the saved problem is axioms formalization and implementation of these methods in practice, the formation of individual standards and reliable forecasts. Work under water – one of the most difficultx areas of human activity – is a hobby, a sport and professional activity. In accordance with the Regulations on military-medical examination, approved by the Decree of the Government of the Russian Federation for a health service fit for military submarines and divers for underwater operations are the most stringent.

The aim of this research was the reseach of the complex of the cardiorespiratory parameters that allow to describe the level of professional training divers.

The research methods. In the research have taken part the drivers, which are having trainings (the beginners) and which are working (the professionals, working under water 300 hours and more) in the conditions of the Artctic: the group of the beginners – 8 people, average age 18,8±1,7 years, medically

approved learning divers case; the group of the professionals – 8 people, average age 28,6±3,9 years. The research was conducted in April – May and August – September in the Murmansk region, the water temperature in the Kola Bay at this time was positive, not more than 4–5 °C.

While researching there were special equipment for underwater work: dry type wetsuits (body warm underwear), respiratory system of open type (cylinders with compressed air) or closed loop weighing more than 20 kg, special loads (weighing 6 to 12 kg, were selected individually).

The test functional load is the active orthostatic probe. There were a "rest lying" before the stage of Functional test, that allowed to form the state of sufficiently deep relaxation (background state). After a smooth ascent to the sitting position, the surveyed remained in a relaxed position for 2–3 minutes The active orthostatic probe was complicated by the fact that the test was performed after wearing a wetsuit, immediately after diving. We took into account that the process of preparing for a dive is always associated with serious instruction, test equipment and putting defining additional psycho-emotional and physical stress.

The discussion and results. As one of the leading components that determine the level of professional training of divers, we consider the reactivity of the cardiorespiratory system in the implementation of test loads and in the implementation of individual tasks of professional activity . In this work we examine some comparative characteristics of professional divers and novice divers when the orthostatic test and work under water – an attempt to transport heavy cargo subjectively (stone) work to failure.

The active orthostatic, as a special case of the changing of human body position in space as the input for the study of the impact of the functional state of the human body, test is realized in practice of functional diagnostics long time ago [6, 7].

The orthostatic reactions of the human body due to the fact that at the active transition of the body from horizontal position to the vertical in its lower half of the large amount of blood is deposited. Obviously, changing the position of the body there is a movement of a significant amount of blood, mainly in the area of low pressure – in the venous net, which is largely due to the relative elongation venous walls. By the way, the modern models of adjustment of the circulatory system to orthostatic stress includes processes of reduction of plasma volume due to transcapillary transfer fluid from the blood to the interstitial space, that happens mainly in the lower limbs [9]. In accordance with submissions when discussing the phenomena associated with the transition of the body in a vertical position, you should consider: the increase of flow of afferent signals from venous vessels, stretching in a standing position, the pulses of interoceptors, reacted to displacement of the abdominal organs, the signals vestibular system with its powerful connections with the sympathetic nerve system [12].

Natural reaction to orthostatic test is acceleration of pulse. Due to this the minute volume of blood flow is significantly reduced. Stabilization of blood pressure in the system in the coronary and peripheral departments observed in well-trained athletes after 10-12 sec. [5]. The reaction of younf athletes may be more severe and prolonged. The systolic blood pressure can keep constant or even decreases slightly (2-6 mm hg); diastolic blood pressure increases regularly by 10-15% related to its size in the horizontal position. If during the 10-minute study the systolic pressure approaches the outcome values, then the diastolic pressure remains elevated.

Pic. 1 shows examples of the restructuring of the cardiovascular system (kardioritmogramma, cardiograph of current values (RR) – intervals) when the active orthostatic test, combining all the variety of individual choices, and thus allowing the reaction to distinguish a professional diver (two upper graphics) from beginner (two lower graphs).

On the upper graph (D.V. from the group of experienced divers) we can see one of the embodiment of the optimum adjustment of the cardiovascular system. In the quiescent state occurs expressed respiratory arrhythmia, the average duration is kardiontervalov 1197,97 ± 3,48 ms, respectively HR = 50.08 u. / Min . In the «sitting « state, after the transient appears significant (up to 38%) in heart rate acceleration (855,21 ± 4,42 ms , HR = 70.16 u. / Min), a monophasic recovery period, rapid stabilization of respiratory arrhythmia after lifting.

The second graph – examined by A.P. of experienced divers. In the quiescent state occurs very pronounced respiratory arrhythmia, on average, minute interval, characterized – RR = 1068,60 ± 20,02 ms, HR = 56.15 u. / Min, inspiratory RR– interval reaches 1521 ms on exhale – 765 ms. In the «sitting» state, after climbing – more rapid heart rate to 80% (593,66 ± 3,70 ms , HR = 101,07 u. / Min. Extremely intense reactivity. And in the first and second cases we can talk about high lability adaptation of the cardiovascular system – fitness, allowing quickly compensate for the change in blood redistribution active orthostasis. There is a reason to talk about the reliability of the system of regulation, the prognosis is favorable.

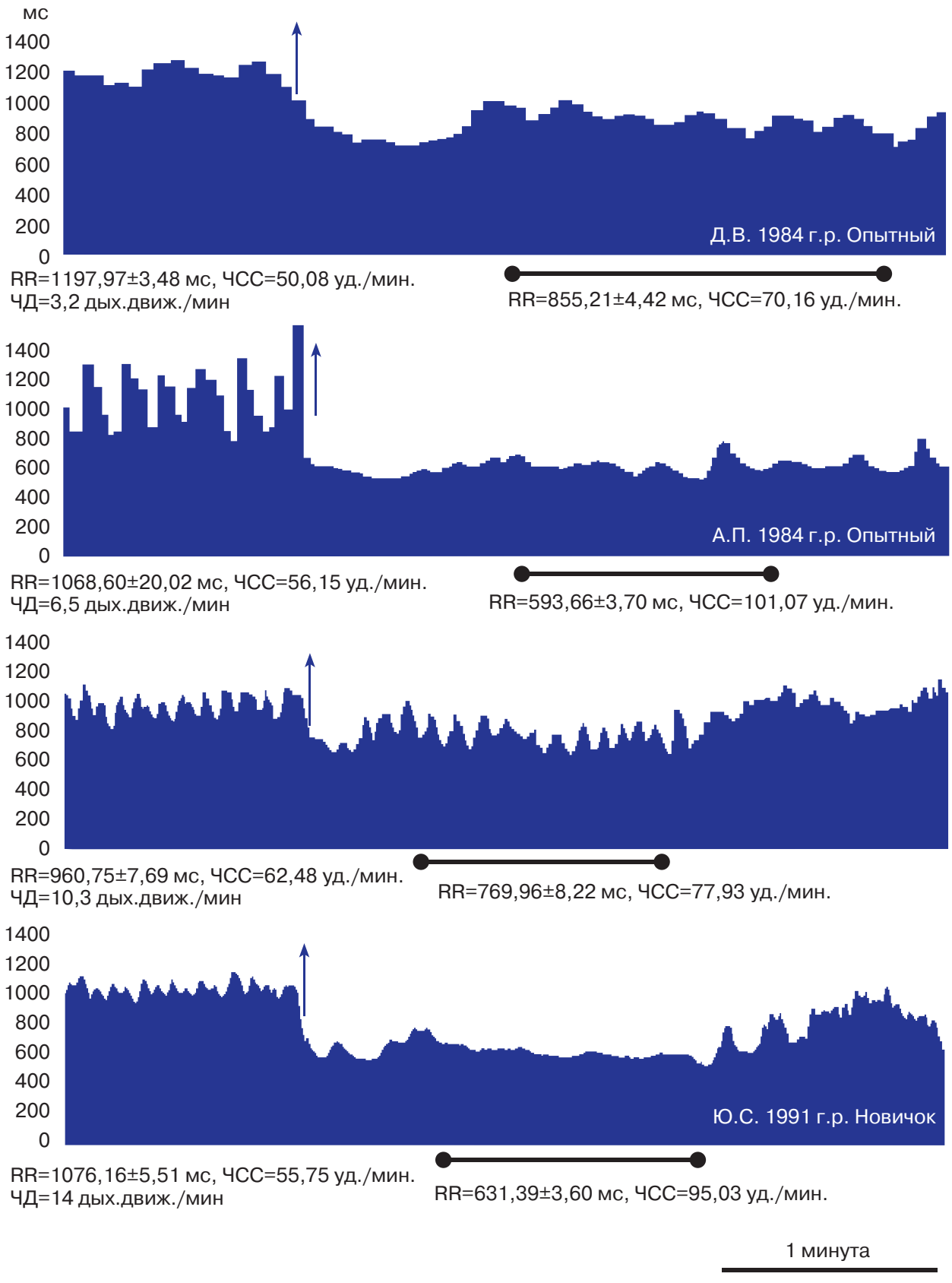
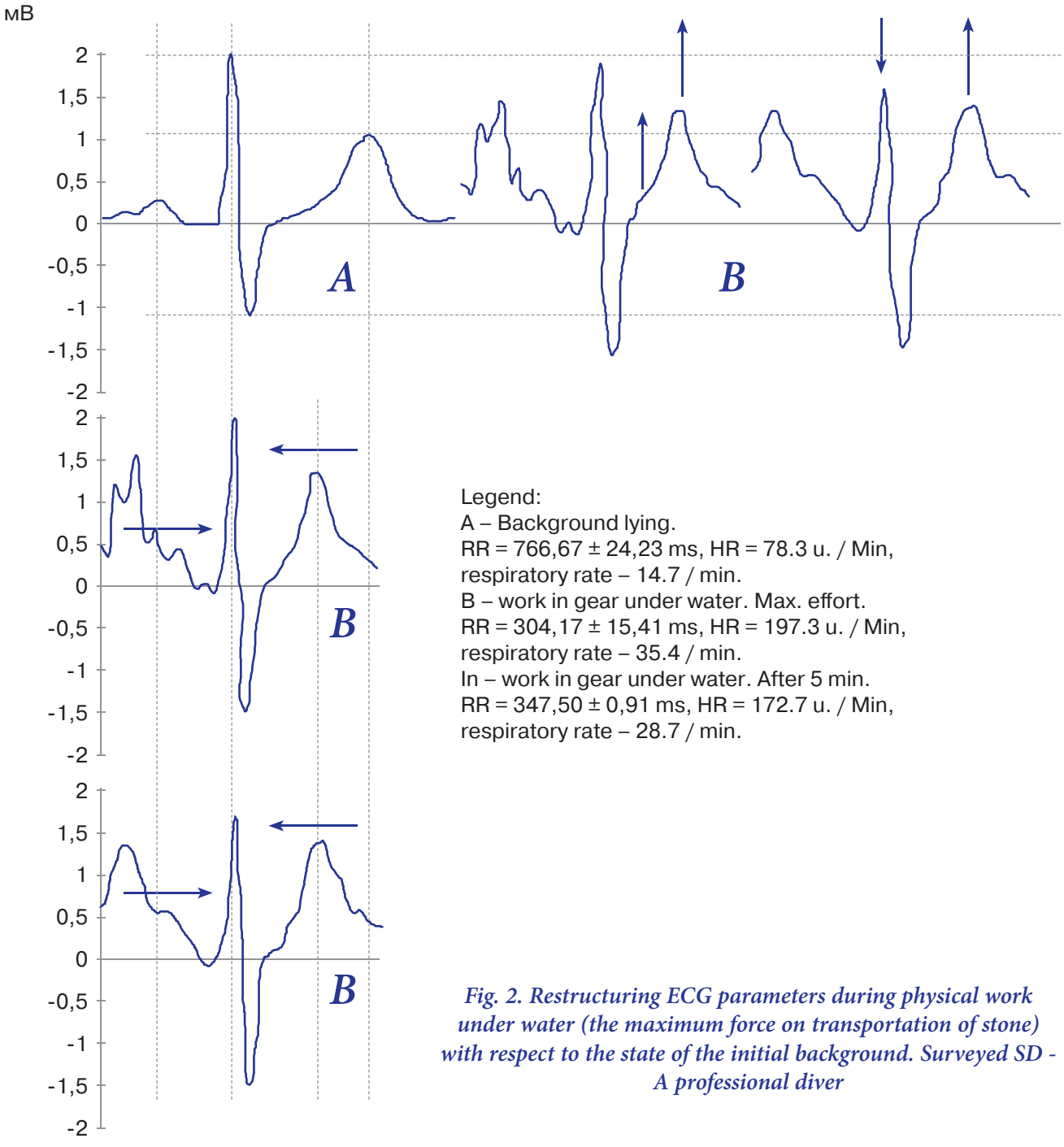


Fig. 1. Dining rearrangements kardioritmogramm surveyed: trained, experienced divers (DV, AP) and novices without aerobic training (SK, YS) with functional load – «active orthostatic test».

Given by us infromation contradict is some way with the information in the literature about the insignificant level of the reconstructions of the cardiovascular system in a model of orthostatic test in well-trained athletes. In particular, in the works of I.T. Korneev, S.D. Polyakov observed an increased heart rate in the range of 5 to 15 u./min. In the work of Sobolevskiy as one of the characteristics of a good response to orthostatic test for divers determine the increase pulse rate by 11 beats./min, increased pulse rate by 19 beats or more /min is a bad reaction. In all surveys of the professional divers we observed pronounced rearrangements in which a pulse after rising from a lying position increased to 16-50 u. /min [5, 10].

In the case of beginners (two lower graphs in Fig.1), with low level of training in with respect to physical, primarily, aerobic exercise, we can talk about or (unresponsiveness) regulation system (SK), or low level of cardiorespiratory coordination (YS). It should be noted that it is typical for beginners that the «complex» profile of the transition process on the graphs it has a biphasic shape. It should be assumed that the results allow to identify the scenario of regular training loads.



Legend:
A – Background lying.
RR = 766,67 ± 24,23 ms, HR = 78.3 u. / Min,
respiratory rate – 14.7 / min.
B – work in gear under water. Max. effort.
RR = 304,17 ± 15,41 ms, HR = 197.3 u. / Min,
respiratory rate – 35.4 / min.
In – work in gear under water. After 5 min.
RR = 347,50 ± 0,91 ms, HR = 172.7 u. / Min,
respiratory rate – 28.7 / min.

Fig. 2. Restructuring ECG parameters during physical work under water (the maximum force on transportation of stone) with respect to the state of the initial background. Surveyed SD - A professional diver

Comparison of parameters of human electrocardiogram, recorded during performance of physical work with the background parameters, is always complicated by the fact that with the change in oxygen inquiry, including relating to changes in breathing pattern on kardirespiratornuyu system affects the change in body position. In our case, functional load is the performing work under water, was complicated by breathing through the system of of scuba diving and specific conditions of diving – the depth of 4-5 meters, the lowest temperature of the water. Despite the fact that scuba diving produced in special vehicles and they are taught when working in the special conditions do not hold breath, it is expected that the restructuring of the cardiorespiratory system parameters will be reflected widely described in the literature «dive reflex», primarily associated with the cooling surface receptor skin and by the very fact of submersion [1, 11, 12].

Fig. 2 and 3 show two typical cases of rearrangements ECG of divers when performing physical work. On the pic. 2 we can see a better option of rearrangements of cardiovascular characteristic for professionals: primarily chronotropic response to the load, increasing heart rate and respiratory rate more than doubled, the shape of cardiocomplex practically dont changed – increasing the amplitude of S-and T– teeth decreases the duration of PQ interval and ST. It should be noted that the increase in heart rate is achieved not only decrease the duration of the diastole (interval RR), but actually systole.

As one of the components of the observed mechanisms can be assumed that the removal of parasympathetic effects on the duration of atrioventricular

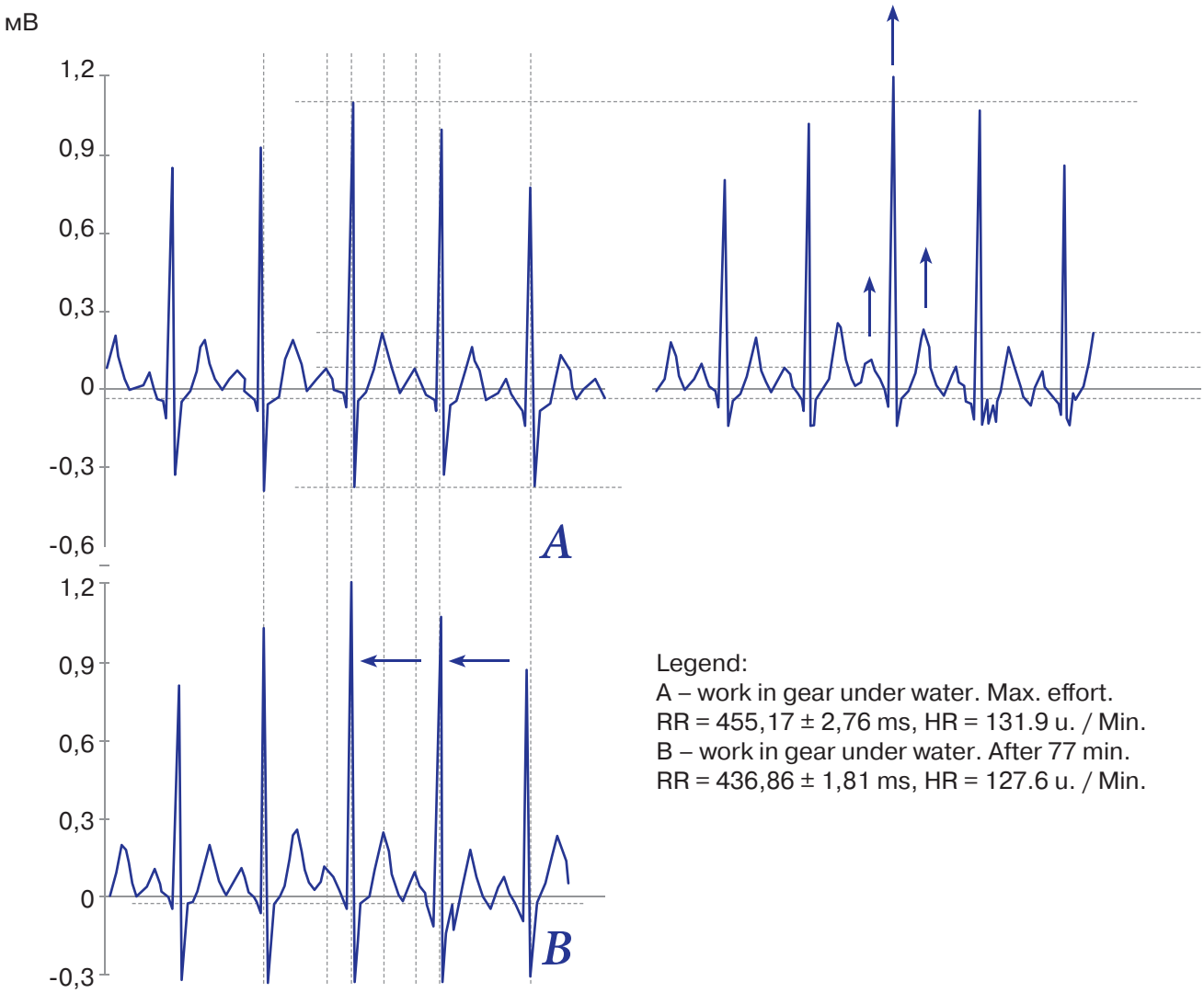


Fig. 3. Restructuring ECG parameters during physical work under water (the maximum force on transportation of stone), two serial interval (B – after 77 seconds after A). Surveyed AS – Beginner. ECG fragments correspond to the respiratory cycle – from the «exhalation» to «exhalation»

conduction, and as a consequence of PQ-interval shortening and systole in general. In its turn, the increase in amplitude of the T-wave, especially towards the end of the implementation of physical activity, may reflect the natural processes of growth of regenerative processes in the myocardium against the background of hypoxemia [2, 8].

The marked restructuring have some similarities with the dynamics of parameters of cardiocomplex described for weightlifting athletes, performing physical work lifting rods [3]. However, in the case of weightlifting athletes the exercise is largely static, culminating in «explosive» lifts, and realized with a single breath, and in a simulated situation with professional divers breath persists.By the way, divers observed in the high values of heart rate can be determined by secondary processes associated with a decrease in venous blood flow to the heart on the background of a high degree of effort (straining) [3].

The Pic. 3 shows a less optimal reorganization of the cardiorespiratory system, which is very typical for the beginners group. The type of restructuring is inotropic. Even when comparisons in frames of physical activity it is marked the increase in the amplitude of the R-wave, which may reflect an increase in cardiac output, at the same time the increase in heart rate in this case, obviously, does not reach the point of inflection – PWC170 [4]. Reconstructions of the timing parameters of cardiocomplex practically absent, the increase in heart rate is realized by reducing the duration of RR– intervals. Respiratory arrhythmia ECG is not expressed, which is reflected in the low value of the variance of durations of RR-intervals, it does not allow, in particular, to calculate the respiratory rate examinees on the background peak. In addition, in some cases, there are beginners unit violations heart rate, mainly in the form of single PVCs, which disappear after reducing the load intensity. All novice divers after the completion of the water noted significant fatigue with strong emotional arousal.

Conclusion. The obtained results allow us to distinguish and describe the individual effects of cardiorespiratory fitness consistency due to regular loads associated with the work under water. The combination of in-depth diagnostic ECG-stage input control (just before the descent into the water) with the current ECG monitoring on the performance of educational background and professional tasks will optimize the training process and increase the resilience of professional divers.

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