Features of adaptation to intensive physical load of skilled cyclists specializing in mountain bike

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Abstract

Objective of the study was to identify the features of the adaptation of the neuromuscular apparatus and vegetative functions to physical activity of progressively increasing power and the mechanisms for maintaining the performance of qualified cyclists specializing in mountain biking.

Methods and structure of the study. The work was attended by five cyclists of CMS and MS qualifications, specializing in mountain biking (MTB). As a model testing load, a standard stepwise test was used, performed to "failure". The test load was performed on an ELITE bike machine, REAL-TURBO-MUIN model (Italy).

Results and conclusions. This study shows that, along with additional activation of presumably fast muscle fibers at a power of 75-80% max, an effective mechanism for maintaining the special performance of qualified cyclists is the level of intermuscular coordination, which provides synergism in the work of the thigh and lower leg muscles with a further increase in pedaling power.

Keywords: *cyclists, mountain bike, working capacity, adaptation, physical activity, working capacity.*

Introduction. In order to identify effective training means of special speed-strength training of qualified athletes specializing in sports whose competitive activity is associated with a high manifestation of power qualities, including mountain biking, it is necessary to have an idea about the features of the regulation of the locomotor apparatus and vegetative functions when performing exercises in different intensity modes.

In scientific research, to assess the activation of working muscles, vegetative and metabolic reactions of athletes, methods of registration of surface electromyogram (EMG), indicators of external respiration and gas exchange are used.

When athletes perform loads of increasing power, researchers identify threshold changes in EMG (EMGTh) [3,8]. It has been shown that EMG thresholds correlate with lactate and ventilation thresholds [6].

It is believed that performance in the zone of aerobic-anaerobic transition and, accordingly, in the zone of submaximal power is ensured by additional activation of type II-A (FR - Fast Fatique Resistant) muscle fibers, which positively affects the increase in the functionality of the neuromuscular apparatus [7,9].

At the same time, it is known today that in professional cyclists, changes in the nature of recruitment of motor units do not depend on the composition of muscle fibers [4,6]. Maybe it has to do with the pedaling technique. It is assumed that each muscle performs a specific task depending on the ability of the athlete to press and pull the pedal [2].

Objective of the study was to identify the features of the adaptation of the neuromuscular apparatus and vegetative functions to physical activity of progressively increasing power and the mechanisms for maintaining the performance of qualified cyclists specializing in mountain biking.

Methods and structure of the study. The focus of this study is determined by the state task of the Federal Scientific Center of Physical Culture and Sport (VNIIFK), No. 777-026-22 (topic No. 001-22/4).

The indicators of adaptation of the neuromuscular apparatus and vegetative functions in qualified cyclists were studied during the performance of a special bicycle load in different intensity modes. The study involved five cyclists with the qualification of Candidate for Master of Sports and Master of Sports, specializing in mountain biking (MTB). Age - 18.2±0.9 years, body length - 177.2±4.8 cm, body weight - 67.3±3.1 kg.

As a model testing load, a standard stepwise test was used, performed to “failure”. The study was carried out in laboratory conditions. The test load was performed on an ELITE bike machine, model REAL-TURBO-MUIN (Italy) (athletes used their racing bikes), step time - 2 min, initial power - 140 W, with an increase in power by 30 W at subsequent work steps.

The electromyographic activity of the muscles was recorded using the SportLab hardware and software system (Russia), consisting of an eight-channel telemetric electromyography, an accelerometer, a video camera, and a synchronization device. During the testing load, the electrical activity of the following muscle groups was studied: thigh muscles - m. vastus lateralis; m. rectus femoris; m. biceps femoris caput longus; leg muscles - m. tibialis anterior; m. soleus; m. gastrocnemius medialis. All measurements were taken on the right side. The electromyogram was inverted and smoothed by the moving average method (averaging window, 50 ms). The indicators of the average myocost of one revolution of the pedal and myoroborot per minute were calculated [8].

To study external respiration and gas exchange during the test, the system of cardiorespiratory stress diagnostics Meta Lyzer 3B manufactured by CORTEX (Germany) was used. The air flow was measured using a turbine transducer (Triple V). A two-point gas calibration (first gas 15% O_2, 5% CO_2; second gas ambient air) was performed daily. Prior to each test, a one-point gas calibration was performed using ambient air, as well as a flow sensor calibration using a 3 L syringe (Hans Rudolph, Kansas City, USA).

In the process of performing the testing load, the dynamics of pulmonary ventilation (VE), oxygen consumption (VO_2), carbon dioxide release (VCO_2), respiratory equivalents for O_2 and CO_2 (VE/O_2 and VE/CO_2) were studied. Ventilatory thresholds (VT1 and VT2) were determined based on the dynamics of VE/O_2 and VE/CO_2 [9].

Results of the study and their discussion. The maximum indicators of aerobic performance, work power and lactate concentration (M ± σ) in MTB cyclists participating in the study, respectively, were: VO_2max - 4.58 ± 0.19 l (68.7 ± 0.78 ml/min/kg); Power - 473±13 W (7.09±0.11 W/kg); La - 11.6 ± 1.2 mmol / l.

On Figure 1 (A, B) shows the dynamics of ventilation equivalents (VE/VO2 and VE/VCO2) and myowork, identifying the parameters of ventilation (VT1 and VT2) and electromyographic (EMGTh1 and EMGTh2) thresholds.

It was found that the threshold power indicators (VT1 and EMGTh1) demonstrate similar values (55-60% Powermax). At the same time, it can be seen that EMGTh1 for the thigh muscles is localized at a power of 55%, and EMGTh1 for the calf muscles, at a power of 60% of the maximum power achieved in the test.

Threshold power indicators (VT2 and EMGTh2) also have close values (75-80% Powermax). At the same time, EMGTh2 for both thigh and calf muscles is localized at the output power level of 75% max. At the same time, the tension of the thigh muscles (60% max) is significantly higher than the tension of the calf muscles (50% max).

Obviously, muscle groups or individual muscles of the thigh and lower leg have different values of electromyographic thresholds, which, apparently, is necessary for effective adaptation to different motor modes.

An analysis of the electrical activity (myoratory work) of different muscle groups during the stepwise test showed that the thigh muscles perform the greatest work in the process of pedaling: the lateral (lateral) head of the quadriceps femoris muscle - m. vastus lateralis, anterior head of the quadriceps femoris muscle - m. rectus femoris and biceps femoris - m. biceps femoris caput longus. Leg muscles: tibialis anterior - tibialis anterior; calf muscle - m. gastrocnemius; soleus muscle - m. soleus also take an active part in pedaling, however, their electrical activity begins to increase significantly only at high intensity (power) modes.

A high synergistic effect of the muscle groups of the thigh and lower leg is manifested when their EMG activity reaches more than 80% max.

Thus, in order to achieve a coordinated work of different muscle groups of the lower extremities in real-

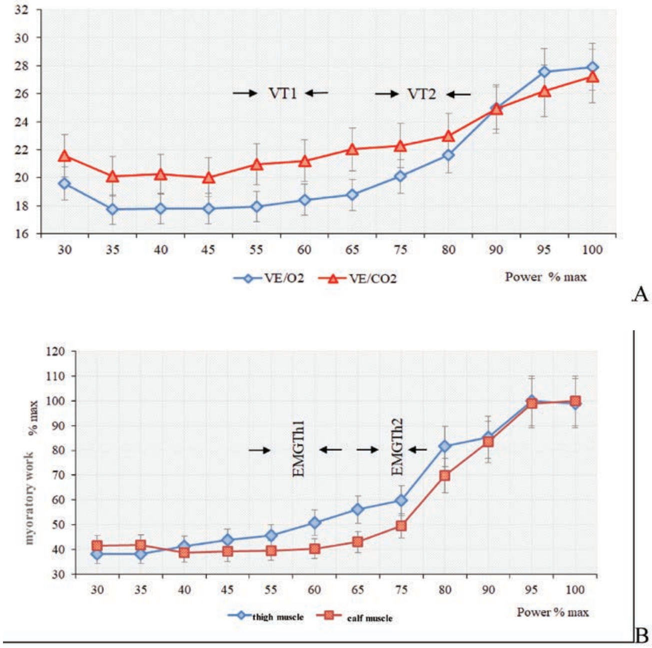

Figure 1. *Dynamics of ventilatory equivalents (VE/VO2 and VE/VCO$_2$), EMG amplitudes, parameters of ventilatory (VT1 and VT$_2$) and electromyographic (EMGTh1 and EMGTh2) thresholds recorded during the maximum test with increasing load*

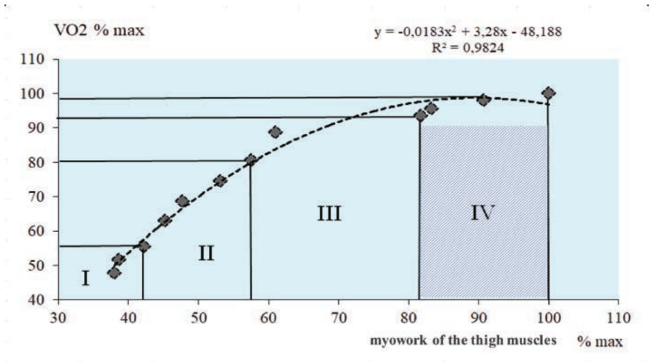

Figure 2. *Interrelation of indicators of aerobic metabolism and the implementation of the power capabilities of the muscles of qualified MTB cyclists when performing a load of different physiological power: I - zone of moderate power (active recovery); II - zone of moderate power (development of aerobic endurance); III - zone of high power (ANP); IV - zone of submaximal (critical) power.*

izing their power potential, it is necessary to increase the intensity (power) of the load performed to a submaximal level (90% max).

On Figure 2 shows the relationship between the indicators of aerobic metabolism and the implementation of the power capabilities of the muscles of qualified MTB cyclists when performing loads of different physiological power. It was revealed that the realization of the power potential of the muscles of the lower extremities in MTB cyclists reaches high values when they achieve aerobic performance at the level of 90% VO2max and above.

Of particular interest is the identification of the fact of a sharp increase in the gradient (rate of rise) of the myowork of muscle groups in the zone of submaximal power. The high speed of activation of the mechanism of intermuscular coordination to coordinate the work of different muscle groups with an increase in the requirements of the external load ensures the maintenance of the required level of performance.

Conclusions. It was found that the threshold power indicators (VT1 and EMGTh1) and (VT2 and EMGTh2) demonstrate similar values, respectively 55-60% and 75-80% Powermax. When the threshold values (EMGTh1 and EMGTh2) of the pedaling power are reached, the indicators of myowork for the muscles of the thigh and lower leg have differences. The muscle work of the thigh muscles increases in proportion to the pedaling power up to the level of EMGTh2, while the indicators of the muscle work of the lower leg muscles are significantly lower. Then the muscle work of the thigh and lower leg muscles actively increases, reaching a synergistic effect at the level of 90% of the maximum pedaling power (Fig. 1, bottom).

This study shows that, along with additional activation of presumably fast muscle fibers at a power of 75-80% max, an effective mechanism for maintaining the special performance of qualified cyclists is the level of intermuscular coordination, which provides synergism in the work of the thigh and lower leg muscles with a further increase in pedaling power.

These results suggest that training exercises performed in the submaximal power mode (90-95% max) will be the most effective for the development of special strength qualities of highly qualified cyclists specializing in mountain biking.

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