Peripheral circulation indicators in veteran trail runners

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Abstract. [Purpose] Competitive sport places strict demands on the cardiovascular systems of veteran trail runners. Our research objective was to evaluate the dynamics of microcirculation parameters of veteran runners in hypoxic and mid-altitude conditions. [Subjects and Methods] Seven male runners from Russia and Italy between the ages of 50 and 60 years were examined whilst competing at mid-altitude (1,500–2,000 m above sea level). The same runners were examined in a simulated mid-altitude hypoxic environment, which was a hypoxic chamber with 16% oxygen concentration, for 720 minutes. Under both conditions, peripheral circulation was studied using a laser Doppler flowmeter attached to the distal phalange of the second finger of the subject’s right hand. All subjects had a microcirculation parameter assessed, which was the standard deviation of the erythrocytes flow vibration in peripheral circulation, under both conditions. In order to assess the intensity of vasomotor reactions of the microcirculatory vessels, the coefficient of variation was used. [Results] In the hypoxic environment, a decrease in the microcirculation parameter was noted in the short-term (360 minutes), with a subsequent compensatory increase in the long-term (720 minutes). However, the coefficient of variation showed a reverse trend with an increase in the vasomotor activity of microvessels from 12.4% to 18.2% at the stage of maximum training load within one month in the mid-altitude in the hypoxic environment, with a consequent reduction in preparation for the start. [Conclusion] In the hypoxic environment, the subjects demonstrated a two-stage change in the dynamics of the microcirculation parameter: an initial fall and a subsequent increase reaching the initial values. Similar changes were found when subjects were competing at mid-altitude. Our results show that the assessment of the peripheral circulation in a simulated mid-altitude hypoxic environment can be used to determine the readiness of veteran sportsmen for long-term trail running in mid-altitude conditions.

Key words: Veteran trail runners, Peripheral circulation, Middle altitude

INTRODUCTION

Competitive sport places strict demands on the cardiovascular systems of veteran trail runners. The condition of a runner’s cardiovascular system can be determined using hemodynamic parameters. However, modern cardiovascular disease prevention strategies among sportspeople are predominantly based on the assessment of systemic hemodynamics, without taking microcirculation parameter evaluate blood flow using laser Doppler and the laboratory low pressure and low oxygen chamber into account. The existing methods for the evaluation of veteran sportsperson’s cardiovascular systems do not allow for proper appraisal of the hemodynamic parameters of the peripheral circulation⁴-⁵. Our research objective was to evaluate the dynamics of microcirculation parameters of veteran runners in hypoxic and mid-altitude conditions. Specifically, our study aimed to: 1) evaluate the dynamics of runners’ microcirculation after being in a hypoxic environment for 12 hours (720 minutes), 2) assess the peripheral circulation of veteran sportsmen at mid-altitude, and 3) evaluate the differences in their...
SUBJECTS AND METHODS

All subjects understood the purpose of the study and provided written informed consent prior to participation. This study was conducted in accordance with the ethical standards of the Declaration of Helsinki. Approval was granted by the Ethics Board of the Institute of Physical Education, Sport and Tourism, St. Petersburg, Russia.

Seven runners from Russia and Italy between the ages of 50 and 60 years were examined in mid-altitude conditions (1,500–2,000 m above sea level). The relief of the mountain terrain was the same as the competition (Fig. 1). The first part of the experiment was conducted in the mountains, and the second part was conduction in a laboratory using simulated conditions. The air temperature was 24 degrees Celsius at an altitude of 1,500 meters above sea level to 15 degrees at an altitude of 2,100 meters above sea level. The humidity was in the range of 71%. To achieve this, subjects were placed in a hypoxic chamber with 16% oxygen concentration for 720 minutes. The same subjects were examined in both environments. In a hypoxic chamber created conditions similar to the conditions of middle mountains. The air temperature was 21 degrees, humidity was 71%. The examiner was in a hypoxic chamber with the subjects. The subjects in the hypoxic chamber were in a state of rest.

Peripheral circulation was measured using a laser Doppler flowmeter on the distal phalange of the second finger of the subject’s right hand. All the subjects had a microcirculation parameter assessed, which was the standard deviation of the erythrocytes flow vibration in peripheral denominations. In order to assess the intensity of vasomotor reactions of microcirculatory vessels, the coefficient of variation (VC) was used. The research data were subjected to mathematical processing. The following statistical parameters were identified: the arithmetic mean, the standard deviation, the arithmetic mean error, and the difference according to a Student’s t-test. When analyzing mathematical parameters, the level of statistical significance was set at p=0.05.

RESULTS

In the hypoxic environment, the subjects showed a decrease in the microcirculation parameter in the short-term (360 minutes), with a following compensatory increase in the long-term (720 minutes) (Fig. 2).

The initial fall in peripheral circulation occurred as a result of the subject’s biomicroscopy at mid-altitude (Table 1). Conversely, VC showed a reverse trend with an increase in the vasomotor activity of microvessels from 12.4% to 18.2% at the stage of the maximum training load within one month (from 21 July to 22 August 2016) in the mid-altitude in the hypoxic environment, with a consequent reduction in preparation for the start. Within three weeks, all subjects ran at 20–25 km daily with a total climb of 2,000–2,400 meters. After two weeks of training, all subjects ran a long run of 37 km with a total climb of 2,800 meters. At the final stage, all athletes participated in the competition, which took place on 25 August in Chamonix (France). All subjects ran a distance of 55 km in the mountainous area part of a world tour UTMB Mont-Blanc with a total
It has been suggested that the peripheral vascular resistance of the arterial bed is preconditioned by arterioles and that the prevalence of different regulatory mechanisms depends on the diameter of these blood vessels. This was confirmed by our study. Large-diameter arterioles (70–100 microns) are characterized by a pronounced endothelium-dependent vasomotor activity. This type of reaction is characterized by the direct dependence of the lumen of blood vessels on the changes in the blood flow. Arterioles 40–70 microns in diameter are largely regulated by the stretching receptors of smooth muscle cells. This regulation is determined by the narrowing of the lumen of arterioles with increasing internal pressure, as well as the expansion of the microvessels with a decrease in pressure. The tone of arterioles with a diameter less than 40 microns is simulated by the metabolic activity of tissues, which are modified under the influence of the training load on runners at mid-altitude\(^1,^3\).

An insufficient amount of incoming oxygen has been reported following the decrease in metabolic activity and short-term inhibition of microcirculation pre-conditions the arteriolar dilatation. This is accompanied by the accumulation of under-oxidized metabolic products that lead to lower pressure in the arterioles. The growth in the coefficient of variation that we have revealed in this study characterizes stronger vasomotor reactions of microvessels and supports the mechanism described above\(^1\).

**DISCUSSION**

This study showed that in the simulated hypoxic environment, the runners demonstrated a two-stage change in the microcirculation parameter dynamics: an initial fall and a subsequent increase up to initial levels. We found similar results in the runners when competing at mid-altitude. Our results show that the assessment of the peripheral circulation in a simulated hypoxic environment can be used to determine the readiness of veteran sportspersons for long-term trail running in mid-altitude conditions. The discussion did not include any limitations to the study. This study only focused on veteran male runners so may not apply to female and younger runners.

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