

## Impact of Occlusion Manoeuvre on Arterial Blood Flow Intensity at Onset of Exercise

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**Introduction.** Changes in muscle's blood flow directly influence intensity of oxidative metabolic processes in the muscle, and at the same time, their working capacity [1 - 3]. Thus, it is important to take into account the factors influencing blood circulation in solving a problem of how to increase muscle working capacity. We tested the hypothesis that it would be possible to decrease the so called "blood debt" which appears at the beginning of the intensive work, and in this way to increase muscle working capacity.

**Methods.** Fourteen middle distance runners participated in the study. Arterial blood flow intensity (ml/min/100cm<sup>3</sup>) in the calf was measured by vein-occlusion plethysmography while subject was sitting comfortably. The electroplethysmograph EMPR-01 and Witney type sensors were used. We conducted the following studies trying to reach the stated objectives.

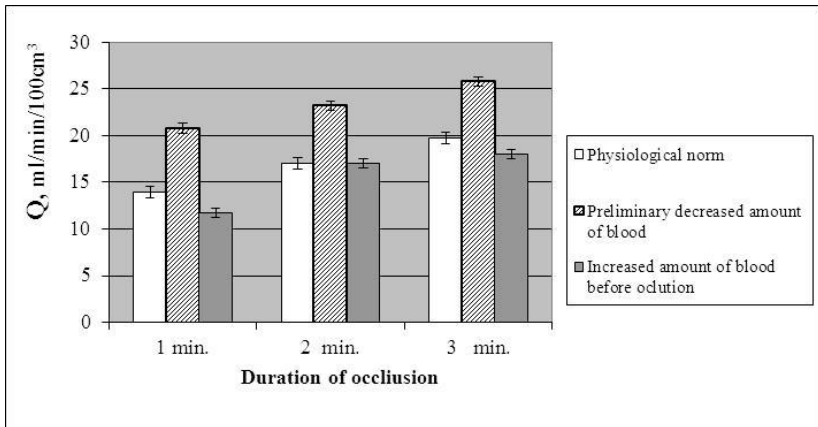
I study – influence of the short term occlusion on the dynamics of the arterial circulation in calf muscles. This research consisted of three parts: the first part – investigation of changes in blood flow intensity after 1, 2, and 3 minutes of occlusion under the conditions of physiological norm, i.e. when the occlusion cuff was quickly inflated with air up to 250-260 mmHG of pressure in it. In this way, we have considered that the amount of blood in the calf's blood vessels during the occlusion was close to the conditions of physiological norm; the second part - after lifting the leg above the heart level and sustaining it in that position for 30 seconds. The amount of blood in the calf decreased by this manoeuvre and after a quick occlusion the leg was let down. The readings of arterial blood circulation after the end of the occlusion was over registered in the sitting position; the third part - slowly blowing the air into the occlusion cuff (5mmHG/s or slower), filling of the calf blood vessels with blood increases before the blood flow is arrested. There is larger amount of blood in the calf blood vessels than under conditions of physiological norm.

II study – influence of the short term preliminary occlusion on the working capacity of the calf muscles. The values of maximal voluntary contraction of calf muscles and ergogramma were registered with special ergodynamograph. We calculated a total amount of work in the workout of registered foot extension movements by lifting a weight which equalled 70% of maximal voluntary contraction 30 movements per minute continuing this work up to the point when it is impossible to continue further. Local calf muscle working capacity (*ergogramma*) was registered before application of short term preliminary occlusion and after that.

III study – influence of a short term preliminary occlusion on the dynamics of the arterial blood flow at onset of calf exercise. The arterial blood flow intensity was registered during performance the same intensity of workout of calf muscles. A short interval of break of exercising i.e. 4s was used periodically as to register the magnitude of blood flow intensity. The two exercise test was performed i.e. control exercise and exercise after exposure of short term preliminary occlusion.

**Results.** I study: influence of the short term occlusion on the dynamics of the arterial circulation in calf muscles.

The research results presented in Figure 1 indicate that the increase of arterial blood flow in the reactive hyperaemia phase depends on the character and duration of the occlusion and on the degree of filling with blood the calf's vessels before the arrest of blood flow. The highest readings i.e. the peak blood flow were registered after the occlusion conducted when the amount of blood in the limb was decreased before the occlusion and the lowest blood circulation readings were registered after the occlusion done when there was increased filling with blood of blood vessels. The duration of the occlusion had direct influence on the maximal blood flow figures which were registered immediately after the occlusion was over. In all the cases the largest amount of blood flow intensity was observed after the 3 minutes occlusions.



**Fig. 1.** Peak blood flow in the reactive hyperaemia phase on dependence of duration of occlusion and on the degree of filling with blood of the segment.

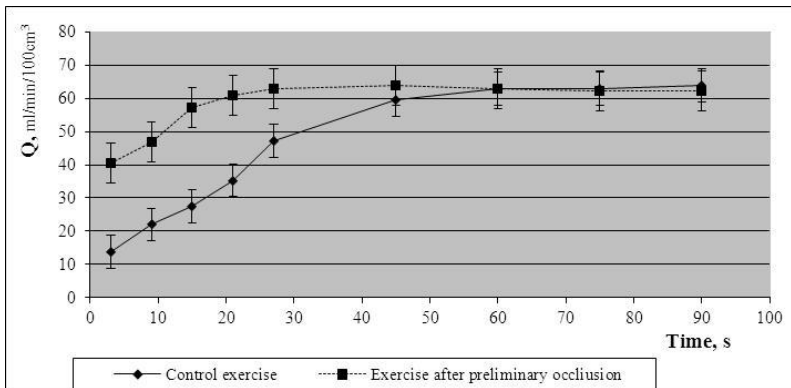
II study: influence of the short term preliminary occlusion on the working capacity of the calf muscles.

The calf muscle working capacity indexes registered during the control exercise test and before the exposure to the experimental influence showed good stability of the method applied. Subjects did  $1877.1 \pm 27.2$  J and  $1880.6 \pm 24.7$  J of work in the average. The muscle working capacity after the

exposure of 1 minute preliminary occlusion is improved. Subjects were able to do more workout after a preliminary short term occlusion, i.e.  $2100.6 \pm 31.2$  J ( $p < 0.05$ ). It was  $11.7 \pm 0.31\%$  better than during the control exercise.

III study: influence of a short term preliminary occlusion on the dynamics of the arterial blood flow at onset of calf exercise.

The results of this series of investigation are presented in Figure 2. During the control exercise till to 60 seconds the arterial blood flow intensity rise up to the steady state. The preliminary occlusion made a significant influence to the dynamics of blood flow in the calves at the beginning of exercise. The intensity of the arterial blood flow even during the first seconds was significant higher i.e.  $40.54 \pm 4.87$  ml/min/100 cm<sup>3</sup> in comparison to the control exercise test i.e.  $13.89 \pm 2.84$  ml/min/100 cm<sup>3</sup> and reached the steady state up to 30 seconds. There was no difference in the peak blood flow readings during both of exercise.



**Fig. 2.** Dynamics of arterial blood flow during the two exercise test

**Discussion and Conclusions.** Regulatory mechanisms of the systemic blood circulation is oriented to sustain a gradient of pressure, necessary to insure needed blood circulation intensity in organs/working muscles. This happens in the combination of heart work indexes and changes of total peripheral resistance [1, 3]. The most effective regulations of local blood circulation could be done mostly by changing hydrodynamic resistance of blood vessels, i.e. by changing their diameter [1]. As hydrodynamic resistance is oppositely proportional to the blood vessel diameter in fourth degree, the changes in their diameter have much bigger importance to the intensity of blood circulation in the organs, than changes in the arterial pressure [2]. Thus a local response, i.e. vasodilation in skeletal muscle plays an important role in the development of functional hyperaemia at the onset of exercise.

The results of our investigation have shown that a exposure of short term preliminary occlusion decreased so called "blood debt" which appears at the

beginning of the intensive work, and in the same way increased muscle working capacity. Our findings demonstrate that a local response, i.e. vasodilation in skeletal muscles plays an important role in the development of functional hyperaemia at the onset of exercise. In conclusion, a short term preliminary occlusion improves muscle blood flow and as a result local muscle working capacity is improved.

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We tested the hypothesis that it would be possible to decrease the so called "blood debt" which appears at the beginning of the intensive work, and in this way to increase muscle working capacity. Fourteen middle distance runners participated in the study. The aim of this study. We conducted the following studies trying to reach the stated objectives: I – influence of the short term occlusion on the dynamics of the arterial circulation in calf muscles; II – influence of the short term preliminary occlusion on the working capacity of the calf muscles; III – influence of a short term preliminary occlusion on the dynamics of the arterial blood flow at onset of calf exercise. The results have shown that a exposure of short term preliminary occlusion decreased so called "blood debt" which appears at the beginning of the intensive work, and in the same way increased muscle working capacity. Our findings demonstrate that a local response, i.e. vasodilation in skeletal muscles plays an important role in the development of functional hyperaemia at the onset of exercise. In conclusion, a short term preliminary occlusion improves muscle blood flow and as a result local muscle working capacity is improved.