CHANGES IN THE HUMAN CARDIOVASCULAR SYSTEM DURING THE WORK OF SMALL SKELETAL MUSCLE GROUPS

K. M. Smirnov, I. M. Popov, and V. M. Komarova

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In modern conditions of work and in everyday life, movements of small muscle groups, especially the muscles of the hands and fingers, are mainly used. This lowers the level of training of the body as a whole, and is also associated with certain specific consequences for the working population. The effect of activity of these types has received little study [2, 3].

For the present investigation, tapping movements of the right hand in the fastest possible rhythm for a period of 15 min was chosen as the laboratory model of these types of work. This activity caused fatigue of the forearm muscles, and the need for maintaining the maximal speed of the movements was attended by considerable nervous stress.

EXPERIMENTAL METHOD

In the investigations of series I the subjects sat on a stool with their working hand on a table. When they had finished tapping, after an interval of 2-3 min they started work on a stationary bicycle and kept this up, also at the fastest possible speed, for 3-15 min. Preliminary tests showed that the changes observed were independent of the order of the loads. Before beginning of the exercises, on several occasions

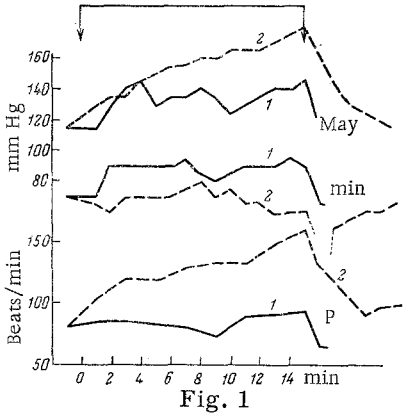

Fig. 1

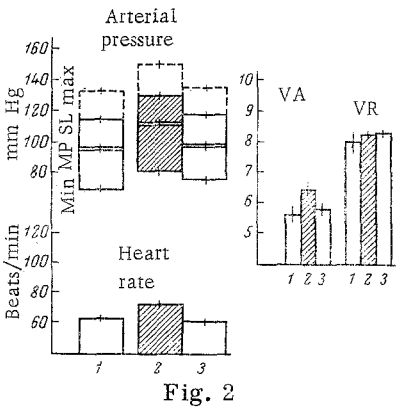

Fig. 2

Fig. 1. Changes in pulse rate and arterial pressure of subject K., male, aged 24 years (volley ball player, 2nd class). Max.—maximal, Min.—minimal pressure, P—pulse rate. 1) Changes associated with tapping with the hand; 2) associated with work on the stationary bicycle. The gap in the minimal pressure line corresponds to the appearance of a "continous" tone. The arrows denote the beginning and end of work.

Fig. 2. Mean changes in certain indices during tapping with the hand. 1) Before work; 2) in the last minute of work; 3) in the first minute after work. Max.—maximal, SL—lateral systolic, MP—mean, and Min.—minimal pressure. VA—velocity of spread of pulse wave in the aorta, VR—in the radial artery. The short vertical lines on the columns correspond to the mean errors.

S. M. Kirov Leningrad Postgraduate Medical Institute (Presented by Academician V. N. Chernigovskii).
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Changes in Hemodynamics during and after Work (mean data)

Time of observation	Heart rate (in beats/min)	Stroke volume (in ml)	Minute volume (in liters)	Overall peripheral resistance (in conventational units)
Before work	63	106.5	6.7	14.1
At the end of tapping	73	97.4	7.1	15.8
After work	62	95.0	5.8	16.8

during both tests, and after they had ended, the pulse rate of the subjects was counted and their arterial pressure was measured by the auscultative method. In the experiments of series II the same persons did the tapping exercises only, while lying on a couch. The working hand lay on the stool placed beside them. Before the tests began, several times during them, and after they had ended an investigation was carried out by means of the LITMO mechanocardiograph [4].

Altogether 14 clinically healthy males aged from 24 to 52 years and in various stages of physical training were investigated. Their arterial pressure was within normal limits. Altogether 665 measurements of the pressure were made by the auscultative method, and 178 tachoscillograms and 89 sphygmograms were recorded.

EXPERIMENTAL RESULTS

In all the investigations the results obtained were similar. The results of one test are shown in Fig. 1. During work on the stationary bicycle, in complete agreement with data in the literature, a marked increase in the pulse rate and in the maximal arterial pressure was observed. The minimal pressure was raised on the average by 10 mm, and some subjects it was sometimes raised, sometimes lowered. During tapping the pulse rate rose on the average by 12 beats per minute, the maximal pressure rose by 17 mm, and the minimal pressure rose in all subjects on the average by 20 mm (significantly higher than during work on the stationary bicycle). The mean arterial pressure was also raised, and the velocity of spread of the pulse waves was slightly increased (Fig. 2).

From the results of the mechanocardiographic investigation the principal hemodynamic indices were calculated approximately (see table). Tapping was reflected little or not at all in the minute volume of the heart, whereas the overall peripheral resistance to the blood flow was slightly increased. Meanwhile, during work in which the greater part of the body musculature is involved, the peripheral resistance, on the other hand, falls [5, 6].

The different pattern of changes during work of the small muscle groups was evidently due to the fact that the resistance of the blood stream increases during intensive activity more in the nonworking limbs than in the working limbs [1]. During intensive work of large masses of muscles, these regional changes in vascular tone are directed toward the maintenance of homeostasis during redistribution of the blood. During intensive work of small muscle groups, similar regional changes probably take place, but all the rest of the body muscles are not working in these circumstances and the resistance in the greater part of the blood stream is increased. As a result, widespread changes of tone of this type do not maintain, but on the contrary, disturb homeostasis and cause a marked increase of the minimal and mean arterial pressures. It must be considered that the regulation of vascular tone, which has evolved during man's phylogenetic and historical development, cannot provide complete adaptation to the new, modern types of fatiguing and intensive work performed by limited muscle groups only.

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