ELECTRICAL ACTIVITY OF INSPIRATORY AND EXPIRATORY MUSCLES OF PERSONS DOING REPEATED STATIC WORK

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In untrained subjects the periodic activity of the inspiratory muscles during static exercise is masked by continuous impulse activity arising at the beginning of the work and disappearing after its end. As training proceeds, the continuous impulse activity diminishes while the periodic increases.

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The pneumogram and lung ventilation figures do not give sufficient information for judging the relationship between inspiratory and expiratory activity of the respiratory center. It is also important to record the electrical activity of the inspiratory and expiratory muscles during the action of various factors on the respiratory center. In earlier studies published by M. E. Marshak and co-workers the nature of the relationships between the electrical activity of inspiratory and expiratory muscles was investigated and described in man and animals under conditions of hyper- and hypoxia, of hyper- and hypocapnia, and in the presence of additional resistance to respiration [5-9].

In the present investigation an attempt was made to study the dynamics of the relationship between the inspiratory and expiratory muscles in persons during training for repeated static work.

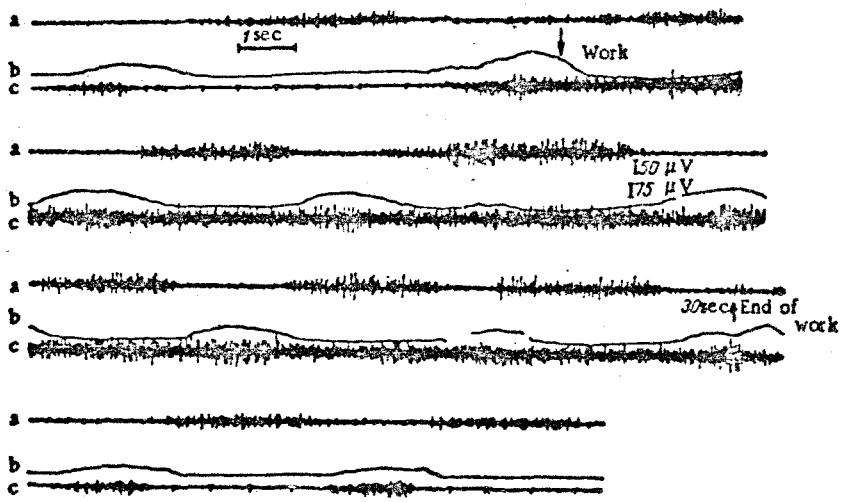

Fig. 1. EMG of expiratory (a) and inspiratory (c) muscles during weight lifting by a subject not trained to perform static work. b) Pneumogram (inspiration above, expiration below). The arrows denote the beginning and end of work.

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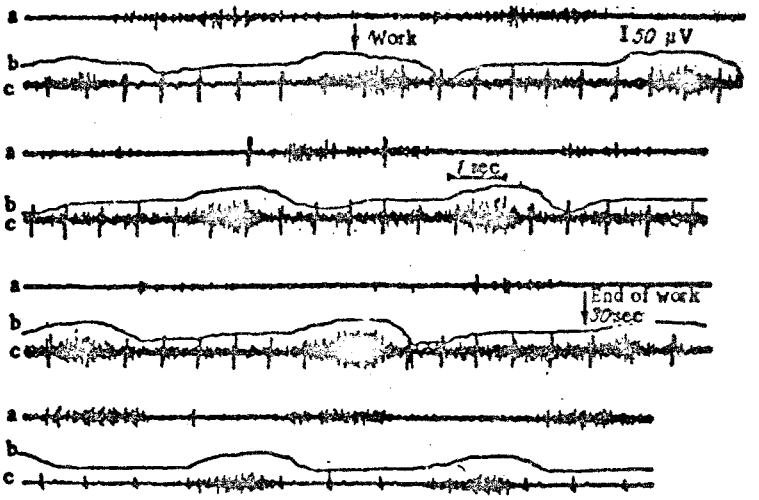

Fig. 2. EMG of inspiratory and expiratory muscles after four successive exercises. Explanation in text. Legend as in Fig. 1.

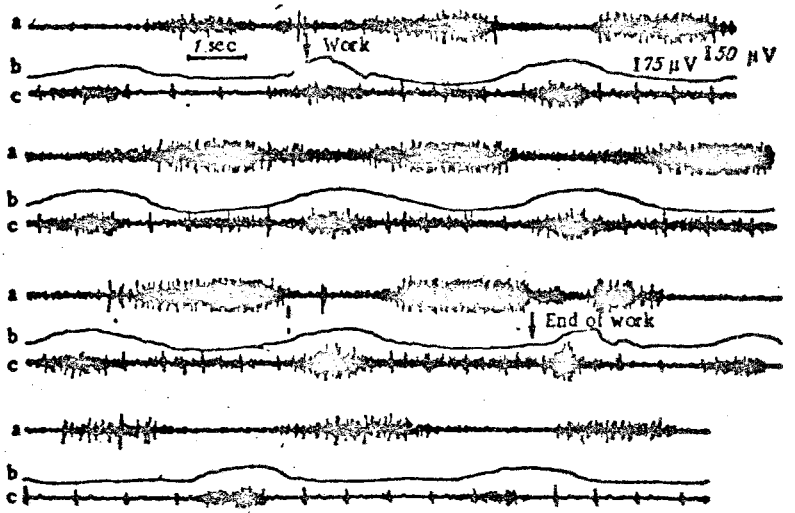

Fig. 3. EMG of inspiratory and expiratory muscles after training for weight lifting for one month. Explanation in text. Legend as in Fig. 1.

EXPERIMENTAL METHOD

The electrical activity of the inspiratory (intercostal) and expiratory (external oblique) muscles was recorded during static muscular work, consisting of lifting dumbbells weighing 5 kg with the upper limbs extended or flexed at the elbows. Potentials were recorded with disc electrodes fixed to the skin in the 7th-8th intercostal space and above the external oblique muscle. The composite electromyogram (EMG) was recorded with a "Disa" electromyograph.

Three subjects aged 21-24 years were examined in more than 80 experiments. In each experiment 4-6 exercises were performed with an interval of 5-10 min between them. Lifting the weight occupied from 20 sec to 4 min. The lung ventilation and dynamics of oxygen saturation of the arterial blood were determined at the same time.

EXPERIMENTAL RESULTS AND DISCUSSION

The EMG of the inspiratory and expiratory muscles at rest and during weight lifting could be recorded only after a preliminary increase in activity of these muscles. This was achieved by training the subjects for 20-30 days to breathe against additional resistance of 40-50 mm water at inspiration and expiration.

In the case of subjects not trained for static work the volleys arising in the inspiration phase were masked by continuous and rapid impulse activity of low amplitude. This continuous impulse activity appeared at the very beginning of work and disappeared soon after its end (Fig. 1). After a few repetitions of the exercises it diminished in intensity, while the periodic activity became stronger (Fig. 2).

Continuous impulse activity was observed in the expiratory muscles only in rare cases. Usually the impulse activity in the expiration phase was of higher amplitude and longer duration in the initial period of the work (see Fig. 1). As the work continued, against the background of increased activity of the inspiratory muscles the electrical activity of the expiratory muscles diminished (see Fig. 1), and sometimes almost completely disappeared (see Fig. 2). In such cases expiration evidently took place passively on account of elastic forces. Sometimes the rhythm of the respiratory movements was disturbed and a slight increase in oxygen saturation of the arterial blood (2–4%) was recorded.

As soon as the subjects stopped working the electrical activity of the inspiratory muscles decreased while that of the expiratory muscles returned to its original level, or sometimes higher.

During weight lifting after training for 1.5–2 months no continuous electrical activity was observed in the inspiratory muscles. From the beginning of muscular work until its end the periodic electrical activity was stable in character in both the inspiratory and expiratory muscles (Fig. 3), and uniform rhythmic respiratory movements were performed.

Comparison of the dynamics of electrical activity of the inspiratory and expiratory muscles in trained (Fig. 3) and untrained subjects (Figs. 1 and 2) clearly showed that during training the general level of electrical activity of the inspiratory muscles fell appreciably, while that of the expiratory muscles rose; the duration of weight lifting for the trained subjects increased from 20 sec to 1–2 min with the elbows extended and to 2.5–4 min with the elbows flexed.

The continuous character of the impulse activity may be attributed to the influence of tonic cervical labyrinthine reflexes on the respiratory muscles [1, 12, 13] and of increased irradiation of excitation during muscular work in untrained subjects to muscles not participating in the work performed [1–3, 10, 11]. In the course of training these reflex influences are weakened and the continuous impulse activity in the trained subject disappeared.

The increase in electrical activity of the inspiratory muscles at the beginning of training was thus accompanied by a decrease, and often by complete inhibition, of the electrical activity of the expiratory muscles. The decrease in electrical activity of the inspiratory muscles immediately after the end of work and in the course of training was combined with an increase in electrical activity of the expiratory muscles.

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