ON THE CHARACTERISTICS OF RESPIRATORY REGULATION FOLLOWING CERTAIN SURGICAL PROCEDURES IN THE THORACIC CAVITY

AN ELECTROMYOGRAPHICAL INVESTIGATION

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In our previous investigations [6, 7, 10], involving an electrophysiological study of the work done by the respiratory muscles, it was shown that with nonspecific chronic pulmonary diseases (emphysema, bronchial asthma) the activity of the respiratory center is elevated. We postulated that even with other forms of pathology the ventilatory indices change not only as a result of injury to the respiratory apparatus itself but to respiratory regulation. Based on this, we undertook an electromyographical investigation of patients having undergone unilateral effective thoracoplasty for fibrous-cavernous tuberculosis of the lungs; as we know, this operation is usually accompanied by significant changes in the motor characteristics of respiration [12]. Data on changes in the state of the respiratory center following removal of the lung were obtained by E. L. Golubeva, using the electromyographic techniques [1].

EXPERIMENTAL METHOD AND RESULTS

We examined 40 patients who underwent the operation indicated above, at intervals of from 2 to 8 years after the procedure. In all cases we recorded the bioelectric activity of the intercostal muscles bilaterally [6], both in the resting state and during certain functional tests.

The bioelectric activity of the intercostal muscles, in the resting state, were not the same on the healthy side and the side of the operative procedure in 23 of the 40 subjects; in this case, in the vast majority (19 of the 23 patients) the action potentials were markedly manifested on the operated side, while on the healthy side they were either weakly apparent or were absent (Fig. 1). In the remaining 17 patients the action potentials of the intercostal muscles did not appear or were accentuated on both sides of the thoracic cavity to the same degree. In healthy individuals, using our amplification, the bioelectric activity of the respiratory muscles is not observed [6].

In 31 of the subjects we applied functional stresses, in order to stimulate respiration; physical stress (22 patients) and inspiration of air with an elevated concentration of CO_2 (9 patients) were used. In 25 of the subjects, under the influence of these stresses, the bioelectric activity of the intercostal muscles on both sides of the thoracic cavity increased to a different degree; in 18 of the 25, the action potentials again appeared considerably more obvious on the operated side (Fig. 2). In healthy individuals, subjected to functional stresses, the biocurrents of the intercostal muscles are either not seen, or there is a very slight symmetrical accentuation.

Increased bioelectric activity in the intercostal muscles may be regarded as a compensatory phenomenon. However, in the majority of subjects the activity of the intercostal muscles was manifested primarily on the side of the surgical procedure, and was observed even in those cases where almost the entire lung was fibrotically altered (for example, with a 10- or 11-rib thoracoplasty), and, therefore, could not take part in respiration. The absence of a ventilatory effect in these patients is confirmed by comparison of the results from the electromyographic investigation with data from roentgenokymography. Along with a clearly manifested bioelectric activity from the intercostal muscles on the operated side, the roentgenogram shows a decrease in the respiratory excursions of the lung, or even

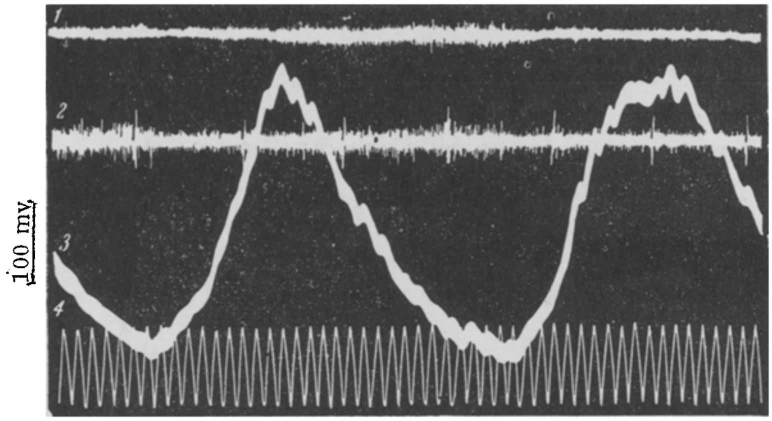

Fig. 1. Electromyogram of the intercostal muscles in a patient who underwent a left-sided 9-rib thoracoplasty (interval following the operation of 8 years), in the resting state. The electrocardiogram is observed superimposed on the electromyogram. 1) Electromyogram of the intercostal muscles on the right; 2) electromyogram of the intercostal muscles on the left; 3) pneumogram; 4) time markings (0.1 seconds).

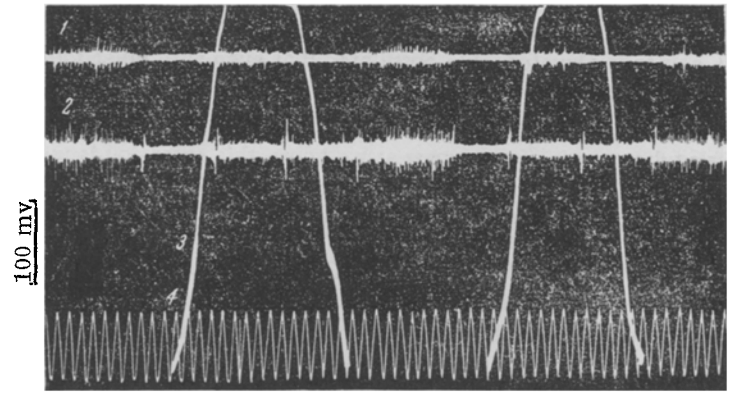

Fig. 2. Electromyogram of the intercostal muscles in a patient who underwent a lest-sided 9-rib thoracoplasty (interval following the operation of 8 years), after physical stress. Designations are the same as in Fig. 1.

their complete absence. Thus, the work of the respiratory muscles on the side of the operation cannot possibly be effective under these conditions, and the compensatory significance of an increase in the activity of the intercostal muscles is essentially lost.

It may be postulated that, in the observed increase of the intercostal muscle biopotentials, a role is played by the constant afferent impulsation, impinging on the respiratory center and not directly related to the respiratory excursions of the lung. This unilateral impulsation may be caused, in our opinion, by deformation of the thoracic cavity as a result of the operative procedure, by adhesions, by pleural fusions, and even may stem from a cirrhotically altered lung.

Anatomical and functional changes, arising on the operated side of the thoracic cavity, cause a change in the conditions of the respiratory motor patterns, and create a persistent resistance to respiration, which can become a source of pathological impulsation. These afferent stimuli possibly lead to a shift in the work of the respiratory center, wherein it begins to send out efferent impulsation which is inadequate for the requirements, this being seen in recording the biopotentials of the respiratory muscles.

T. I. Goryunova and S. I. Frankshtein [3, 4, 9], in experiments on animals, showed that with thermic injury of the lungs in rabbits a change occurs in the state of the respiratory center, manifested by panting and an asymmetrical increase in the biocurrents of the intercostal muscles and the diaphragm.

The work of L. N. Smolin [8] is pertinent to our investigations. He demonstrated an asymmetry in the electroencephalogram of the rabbit, secondary to thermic injury of one lung and manifested by the unilateral formation of "spindles."

It is possible that in the observed individuals the operative procedure, and the increased resistance to respiration associated with it, could firmly alter the functional state of the respiratory center, resulting in its increased excitation; this might be one of the reasons for the panting seen in these individuals (frequently an inadequate degree of pulmonary ventilation).

In addition to an increase in the biocurrents of the intercostal muscles on the operated side, in some of the patients examined we observed structural changes in the electromyogram, reflected by the appearance of impulses with the so called palisades form, characteristic of functionally altered spinal motor neurons [11]. It is possible that in these cases the change in excitability of the motor neutrons leads, as postulated by certain authors [2, 5], to a change in their reaction to impulsation from the respiratory center, and serves as a reason for the described asymmetry.

SUMMARY

With the aid of the EMG method the work of respiratory muscles was studied in persons who underwent a unilateral effective thoracoplasty in connection with fibrous-cavernous tuberculosis of the lungs. In the majority of the persons investigated there was an assymmetry of the bioelectric activity of the intercostal muscles manifested in a greater biocurrent value on the operated side. This is explained by the unilateral pathological afferent impulsation into the respiratory center, caused by a rise of resistance to respiration. Inadequate work of the respiratory center was the result of this.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.