CHANGES IN THE ELECTRICAL ACTIVITY OF THE RESPIRATORY MUSCLES OF CATS DURING COUGHING

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In previous investigations we have shown that in coughing evoked by mechanical stimulation of the mucous membrane of the pharynx and larynx, inspiration preponderates over expiration; in coughing evoked by stimulation applied to the bifurcation of the trachea and bronchi expiratory coughing contractions preponderate over inspiratory movements. Also the "pharyngeal" and "laryngeal" coughs are of a convulsive spasmodic type [2, 3].

The reason for these features is to be found in the different innervation of the regions concerned. The pharynx is supplied by the glossopharyngeal and (probably) the trigeminal nerve, while the bifurcation of the trachea and bronchi is supplied by the vagus. The sympathetic nervous sytem has no special influence on the differences in the coughs [5, 8]. The differences in the reflex response from the regions mentioned has been found in cats and other laboratory animals [4, 6, 7].

For a further investigation of the characteristic features of different types of cough it has been important to study the change of electrical activity of the inspiratory and expiratory muscles during coughing evoked from the regions of the respiratory passages mentioned above.

EXPERIMENTAL METHOD

The experiments were carried out on cats under dial anesthesia. Potentials were recorded at inspiration (from the diaphragm) and at expiration (from the intracostal muscles); the instrument used was a "Diza" electromyograph. The cough was elicited by mechanical stimulation of the mucous membrane of the nasopharynx and of the bifurcation of the trachea; for this purpose a nylon thread was introduced through a small aperture in the trachea. The intrapleural pressure was recorded. In certain cases the nasopharyngeal region was stimulated through the mouth or nose.

Potentials of the respiratory muscles were recorded in more than 100 cases during experimentally induced coughing.

EXPERIMENTAL RESULTS

During coughing evoked by mechanical stimulation of the nasopharynx the electrical activity of the inspiratory and expiratory muscles altered. The greatest change was in the inspiratory muscles (Fig. 1

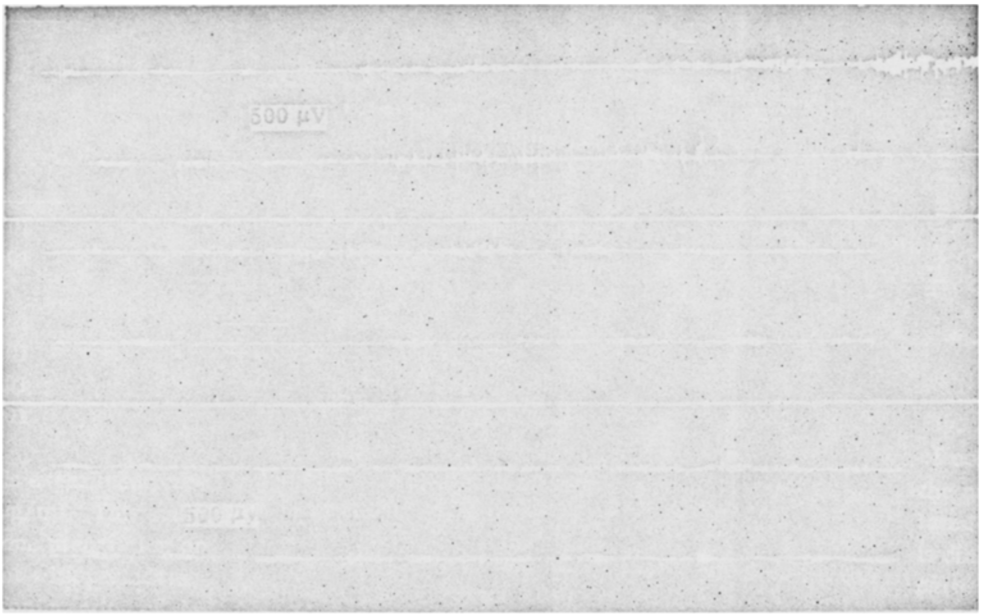

Fig. 1. Intrapleural pressure (above – [illegible]), and EMG of (1) the expiratory and (2) the [illegible] muscles of cat No. 2. [illegible] indicates the moment at which a [illegible] was introduced into the trachea. [illegible] indicate the moments at which [illegible] (cough).

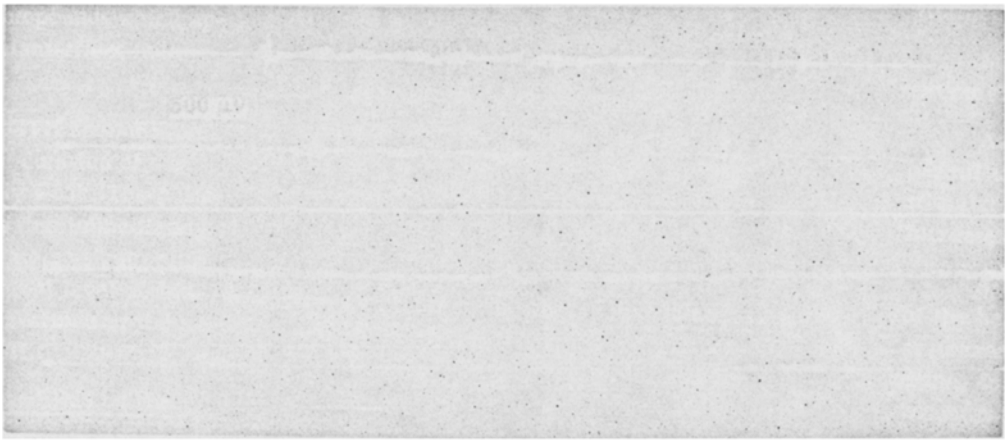

Fig. 2. [illegible] of cat No. [illegible] at the [illegible] of the [illegible]

Unlike the c[illegible] of electrical a[illegible] coughing, evoked by [illegible] amplitude and [illegible] In this case [illegible] of the [illegible]

[illegible]

[illegible] Electrical activity [illegible] in 10–1[illegible]

The results obtained indicate that a cough evoked by mechanical stimulation of the mucous membrane of the nasopharynx is associated with a characteristic pattern of electrical impulses in the respiratory muscles. These facts confirm our previous findings and indicate that in response to stimulation of the upper part of the respiratory passages the mechanoreceptors of the cat respond by a particular type of cough. In coughing evoked by stimulation of the nasopharynx the principal effect is an increase of electrical activity in the inspiratory muscles; in coughing caused by stimulation at the bifurcation of the trachea the opposite situation occurs and the increase of activity occurs in the expiratory muscles.

As our experiments have shown the changes shown in the pneumogram or changes of intrapleural pressure do not always reflect the functional condition of the respiratory center. For example expiratory impulses did not cease at the times when active changes of intrapleural pressure no longer occurred (see Fig. 1, B). These electromyographic findings confirm the idea that the increased inspiration evoked by stimulation of the upper respiratory passages is not a cough in the accepted sense of the word (a cough is characterized by an increased expiration), but is a special inspiratory reflex. It is still not clear why in these cases expiratory activity does not lead to complete collapse of the thoracic cage. A possible reason is that during the time of "pharyngeal" and "laryngeal" coughing activity develops simultaneously in both the inspiratory and expiratory muscles. The less vigorous flow of expiratory impulses is insufficient to overcome the powerful inspiratory activity, and therefore complete expiration does not take place during the cough.

In our previous studies [3, 5, 8] we found that a cough evoked by mechanical stimulation of the nasopharynx resembles the effect found in whooping cough. The question then arises as to whether disturbances of reciprocal coordination of the respiratory center developed during coughing induced by stimulation of the nasopharynx are the cause of the respiratory disturbance and cyanosis in whooping cough.

We must also note the development in most cases of an expiratory apnea which occurs after the cough had ceased (independently of from which region it was elicited). The maintained flow of expiratory impulses during apnea appeared to be due to a maintained excitation of the expiratory center [1].

SUMMARY

Acute experiments were carried out on cats. Coughing was induced mechanically by the application of a nylon thread to the mucosa of the nasopharynx and the laryngeal area or to the bifurcation of the trachea and bronchi Electrical activity of the inspiratory and expiratory muscles became much more intense during the cough. Inspiratory activity was predominant during a cough induced by mechanical stimulation of the nasopharynx or of the larynx. The reciprocal relationship between inspiration and expiration was disturbed. In this type of cough the electrical activity of the expiratory muscles was increased at a time when the intrapleural pressure failed to indicate active respiration. When the cough was caused by mechanical stimulation of the mucosa at the bifurcation of the bronchi action potentials of large amplitude and high frequency occurred in long groups of discharges, in which expiratory activity prevailed. Under such conditions the normal relationship between inspiration and expiration were maintained.

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