If rats holding on to a fine-mesh net, stretched tightly on a metal ring, are dropped together with this ring, during the fall they continue to hold on to the net. No tumbling reaction takes place and the animals fall on their back (Fig. 3A). If, however, the net is not stretched tight on a metal ring initially, but is fixed with threads, and if in the initial phase of the fall, its tension is reduced, the net crumples and the rats readily tumble and land on their paws (Fig. 3B).

In all the experimental situations described above, when the tumbling reaction was inhibited, the rats actively and tightly held on to the support. That this was so can be seen from the next variant of the experiment. The Porolon tube or net stretched on the ring were dropped together with the animal on a thin cord (shorter than the path of the animal's free fall), which suddenly arrested their fall. However, the animals held on to the support in their initial position and continued to hang above the safety net for a short time longer, without jumping down.

Labyrinthectomized animals were used in a series of control experiments. In the experiments with the tightly stretched net and also in the experiments with the crumpled net, these rats fell on their back.

It can be concluded from the results that the presence of contact with a support, even under free fall conditions, inhibits the statokinetic reactions which usually ensure normal landing of the animal.

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INTERCONNECTIONS BETWEEN NUCLEI OF THE RESPIRATORY CENTER

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KEY WORDS: respiratory center; respiratory neuron; inspiratory and expiratory sites; gigantocellular nucleus, nucleus solitarius, nucleus ambiguus.

The morphological and functional structure of the respiratory center (RC) is very complex and its neuronal composition heterogeneous. RC is formed from nuclei and separate groups of respiratory and reticular neurons, which are located at different sites in the medulla and make contact with neurons of other functional systems, performing nonrespiratory functions. Meanwhile RC works remarkably accurately and is responsible for various energy-producing and plastic processes in the body. The discovery of interconnections between its component formations is a particularly important task [1-12]. However, in most investigations of RC its responses to various changes in the internal and external environment have been examined, but not interaction between its component nuclei.

In the investigation described below interconnections of neurons of the gigantocellular nucleus (GN) with neurons of the nucleus solitarius and nucleus ambiguus were studied.

EXPERIMENTAL METHOD

Experiments were carried out on 64 mature cats anesthetized with pentobarbital (45 mg/kg, intraperitoneally). The methods of stimulating structures of RC and of recording the EMG of the respiratory muscles and electrical activity of the neurons were described previously [3]. Sites whose stimulation evoked an inspiratory ("inspiratory sites" – IS) or an expiratory ("expiratory sites" – ES) effect in the region of GN were stimulated. It was assumed that integration of afferent impulses [4] arriving in the medial zone of RC took place in the stimulated sites, followed by their transformation into respiratory impulses, to be transmitted to

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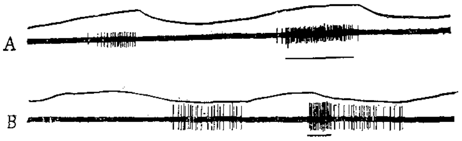

Fig. 1. Changes in activity of late IN (A) and of EN (B) during stimulation of GN. Top trace is pneumogram; bottom trace spike discharge of respiratory neurons; short horizontal line below is stimulation marker.

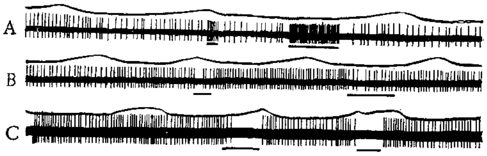

Fig. 2. Changes in activity of RN during stimulation of NG. Legend as to Fig. 1.

efferent respiratory neurons. Such neurons exist in the nucleus solitarius (NS) and nucleus ambiguus (NA). Responses of 181 neurons in NS and NA during stimulation of IS and ES of GN and of 224 reticular neurons (RN) and 9 respiratory neurons of IS and ES of GN during stimulation of NS and NA were recorded.

EXPERIMENTAL RESULTS

Respiratory neurons recorded were of different types: inspiratory (IN), expiratory (EN) – early, complete, late, and discharging continuously with an increase in frequency during inspiration or expiration. IS and ES of GN were stimulated during inspiration and expiration. Irrespective of their functional features, 159 neurons responded to stimulation. When IS were stimulated during inspiration, the frequency of sites generated by IN was increased. When they were stimulated during expiration, the effect was replaced by premature inspiration and resumption of spike activity of IN. Responses of EN to stimulation of ES during expiration and inspiration were similar to those described above. Meanwhile responses of a different character were observed, although in fewer cases: stimulation of IS led to a decrease in the discharge frequency in volleys of IN, and stimulation of ES gave the same effect in EN. Data on the most characteristic responses of respiratory neurons are shown in Fig. 1.

The response of a late IN of NS to stimulation of IS of GN is shown in Fig. 1A (experiment on May 2, 1976), and the response of EN to stimulation of ES of GN is shown in Fig. 1B (experiment on November 16, 1976). In both cases the frequency of spike generation was considerably increased.

Observations on responses of RN and respiratory neurons to stimulation of NS and NA are interesting. The points of stimulation of NS were located 4 mm rostrally to the obex, 3 mm laterally to the midline, and 3 mm deep from the dorsal surface of the brain. Stimulation of this site regularly evoked expiration and stopped inspiration [4]. Of 57 RN of IS, electrical activity was completely arrested in 14, spike activity was reduced in 30, increased in 10, and unchanged in 3 neurons.

In 41 RN of ES, electrical activity completely ceased in 16 during similar stimulation, it was reduced in 15, increased in 4, and unchanged in 5. Typical results are shown in Fig. 2. All three records were obtained in an experiment on December 16, 1977. Stimulation of NS, applied twice, evoked a considerable increase in firing rate of RN (Fig. 2A). Under the influence of stimulation of the same site, the discharge frequency of another RN was reduced (Fig. 2B). In a third RN electrical activity ceased altogether during stimulation (Fig. 2C).

Similar responses of RN of ES and IS were observed in other experiments also, in which NS was stimulated at a point located 3 mm rostrally to the obex, 3 mm laterally to the raphe, and 3 mm deep from the dorsal surface of the brain. Stimulation of this site regularly evoked inspiration and stopped expiration [4]. Of 17 RN of ES, the electrical activity of 11 was completely stopped, that of 3 was reduced, and of 3 increased. Of 46 RN of IS, spike activity ceased altogether in 4 during stimulation of this point of NS, it was considerably

Fig. 3. Changes in activity of continuously firing neurons with increase in discharge frequency during inspiration (A) and in activity of IN (B) during stimulation of NS. Legend as to Fig. 1.

reduced in 32, increased in 6, and unchanged in 4. No significant difference was thus found in the responses of RN of ES and IS in GN.

Stimulation of NA at a point located 3 mm rostrally to the obex, 3.5 mm laterally to the raphe, and at a depth of 5 mm from the dorsal surface of the brain regularly evoked expiration. Of 36 RN of IS, spike activity was completely arrested in 8, reduced in 17, increased in 7, and unchanged in 4 RN of GN. In response to stimulation of the same site, electrical activity was completely abolished in 8 of 27 RN of ES, reduced in 15, and increased in 4. Responses of RN of IS and ES in GN to stimulation of NS and NA were thus qualitatively similar, with predominance of the inhibitory effect to a considerable degree.

In the medial zone of RC, respiratory neurons have been identified by only a few workers [1, 3, 8]. We recorded three IN and three continuously discharging neurons (with an increase in frequency during inspiration) in IS of GN and two IN and one continuously discharging neuron, with an increase in firing rate at the boundary between different phases of the respiratory cycle in ES. In all neurons the discharge frequency was reduced during stimulation of NS and NA, but to a varied degree (Fig. 3). The inhibitory action of stimulation of NS on electrical activity of IN and of a continuously discharging neuron, with an increase in firing rate during inspiration, can be clearly seen in all records (Fig. 3A was obtained in an experiment on December 20, 1977, Fig. 3B in an experiment on March 6, 1979). The same effect also was obtained during observations on responses of respiratory neurons of ES to stimulation of NS.

These observations on responses of 181 respiratory neurons of NS and NA to stimulation of IS and ES of GN and on responses of 224 RN and 9 respiratory neurons of IS and ES of GN to stimulation of NS and NA thus showed that stimulation of the same sites evoked different changes in discharges of neurons: an increase, decrease, or complete cessation of electrical activity, or no response. These results indicate that the type of interaction may differ between respiratory neurons with different functions. At the same time, there is a predominant form of interaction. Stimulation of IS and ES of GN, i.e., sites of integration of respiratory impulses, predominantly increases electrical activity of neurons in NS and NA. Stimulation of NS and NA, on the other hand, predominantly reduces or abolishes electrical activity of RN and respiratory neurons in IS and ES of GN. Predominance of the stimulating action of IS and ES of GN indicates the leading role of sites of integration of respiratory impulses in the activity of RC, and because of the predominantly inhibitory action of impulses from NS and NA on neurons of IS and ES of GN, the action of the latter on the effector apparatus of RC is regulated. The presence of the connections described above may lie at the basis of the formation of cyclic rhythms of excitation in RC.

The presence of neurons not responding to stimulation, however, may indicate that these neurons are linked in their activity with other neuronal formations and not with those which were stimulated.

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DYNAMICS OF RECOVERY OF THE BACKGROUND GASTRIC pH AFTER ACTIVE GASTRIC SECRETION IN RESPONSE TO A FOOD STIMULUS

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KEY WORDS: stomach; secretion.

When studying the acid-forming and acid-neutralizing function of the stomach during natural digestion in experiments on dogs, in which the type of hydrochloric acid secretion as we know is interrupted, it is of definite interest to study the dynamics of the intragastric pH not only in a fasting state and in the period of active secretion evoked by a food stimulus, but also in the period of recovery of the background pH, which may shed considerable light on the acid-neutralizing function of the stomach.

It has become possible to study this problem since measurement of the intragastric pH by means of a pH-meter was introduced into experimental research practice, so that the changes in intragastric pH could be recorded automatically during the whole period of natural digestion, under both normal and pathological conditions [2-9].

The writer studied the dynamics of recovery of the background pH level in the stomach after active secretion due to a food stimulus.

EXPERIMENTAL METHOD

Experiments were carried out on 5 mature dogs weighing 15-18 kg with Basov's fistulas of the fundal part of the stomach. The animals were used 18-20 h after the last meal, when their intragastric pH was 6.7-7.2. The intragastric pH was recorded by the method described by the writer previously [1], using the ÉPP-09m automatic writer, with a paper winding speed of 1 cm/min and a sweep of not less than 0.5 pH units/cm. The pH was first recorded for 30 min in the fasting state, then after the animal had received a food stimulus (50 g white bread and 200 ml water, warmed to 37°C). To characterize the acid-neutralizing potential of the stomach and the intensity of acid neutralization in it, an acid test was used: 10 ml of acid gastric juice was injected into the stomach through the fistula during the period of recovery of the background pH level, without interrupting the recording of the pH, which continued until the pH level had been restored.

EXPERIMENTAL RESULTS

Analysis of 53 records of the intragastric pH changes showed that in fasting dogs the mean pH in the stomach was 7.2 ± 0.2. After administration of the food stimulus to the animals, as a result of secretion of hydrochloric acid by the gastric glands the gastric contents became acidified, and this was reflected on the pH-gram by a shift of the curve to the acid side which continued for 137 ± 4.1 min; after the pH had reached 2.3 ± 0.3 it became stabilized for 149 ± 7.8 min. In the period of acidification of the gastric contents, rhythmic pH-waves with a frequency of 4.7-4.9/min, reflecting the portion-rhythmic mechanism of acid secretion [3], could be clearly distinguished; these waves disappeared at the beginning of the period of pH stabilization and did not reappear until its end.

At the end of the period of pH stabilization the beginning of restoration of the pH level was clearly observed, and stable values of 6.5-7.0 were attained after 83 ± 6.7 min. Under these circumstances pH-waves of a unique shape were recorded on the pH-gram for a period of 1.5-2.0 min (Fig. 1), with pointed and, in

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