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EFFECT OF STIMULATION OF THE HYPOTHALAMUS ON THE MOTOR-SECRETORY ACTIVITY OF THE EMPTY STOMACH, IN EXTENSIVE EXPERIMENTS ON DOGS

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The effect of stimulation of the hypothalamus on the periodic activity of the fasting stomach has been relatively little studied. Most of the work done was in conditions of short experiments, and the results obtained were contradictory. We have been unable to find any references in the literature to the effect of hypothalamic stimulation on gastric secretion in extensive experiments.

Some of the published work has been on animals in which the hypothalamus had been destroyed. N. N. Burdenko and B. N. Mogilnitzki [7] found that destruction of the hypothalamus in dogs was followed by an increase in the amount and the acidity of the gastric juice. Beattie [8] found that stimulation of the lateral wall of the hypophyseal infundibulum of cats under light barbiturate narcosis was followed by increased peristalsis and gastric secretion.

I. I. Burachevsky [1] studied the periodic activity of the empty stomach after damaging the tuber cinereum. He found no significant difference following this operation, as compared with normal animals.

G. M. Davydov [2] found that lesions of the region of the tuber cinereum caused increased gastric secretion in dogs.

G. Bodechtel and O. Kaufmann [9] observed increased peristalsis after stimulating the anterior part of the hypothalamus, whereas E. Gelgorn [3] found the opposite effect.

Rusishvili (1949) found that lesions of the hypothalamic region of dogs caused disturbances in the periodic activity of the stomach and in the spontaneous secretion of gastric juice. I. A. Chereshnev [5] showed that stimulation of the hypothalamus of dogs delayed evacuation of gastric contents into the duodenum.

G. and B. Uvnas [10] found that stimulation of the frontal lobes, basal nuclei, and hypothalamus of cats (acute experiments) was followed after 30-40 seconds by contraction of the stomach.

From all these data it might be concluded that stimulation of the anterior parts of the hypothalamus causes motor and secretory activity of the stomach, which are inhibited by stimulation of the posterior parts. We have attempted, using improved methods and in extensive experiments, to investigate the effect of hypothalamic stimulation in dogs on the motor-secretory activity of the empty stomach.

* In Russian.

EXPERIMENTAL METHODS

The experiments were performed on fasting dogs with a permanent Basov gastric fistula. We examined the motor and secretory activities of the dogs 6-8 days after the operation. After recording the background activities over a period of 30 days we inserted an indwelling electrode, for the purpose of stimulating the hypothalamus in extensive experiments. The electrodes, mounted on an arcuate piece of Plexiglass, were placed around the infundibulum, so that one pair was located at the anterior, and the other at the posterior, part of the hypothalamus. The technique of implanting the electrodes was worked out by us together with P. G. Bogach [6]. Stimulation of the hypothalamus was achieved by means of a sonic generator, Type GZ-1, with a frequency of 20 to 200cps, and an amplitude of 15-20 mv.

Stomach movements were recorded on a kymograph, using air-water transmission from a rubber bag, and a Marey capsule. Gastric juice was collected in a graduated cylinder, and its free and combined acid content and digestive power (according to Metta) are determined.

During 1-2 hours before each experiment we recorded the periodic activities of the stomach without hypothalamic stimulation, and collected gastric juice. After determining the background conditions we proceeded to stimulate the hypothalamus.

EXPERIMENTAL RESULTS

The experiments were performed on two dogs.

Bobik, a male farmyard dog weighing 12 kg, was operated for a Basov fistula on May 30, 1955. Observations were begun 13 days after the operation and lasted for 30 days.

Four polar electrodes were placed on the hypothalamus on July 1, 1955. The experiments began again on the 6th day after the operation, and lasted until October 18, 1955.

During the first two experiments we recorded stomach contractions in the absence of hypothalamic stimulation. We found that "acid" movements took place continuously during the whole experiment. Later on, the periodic activity of the stomach became of the normal type, not differing from that observed before the operation. We then proceeded with the experiments involving stimulation of the hypothalamus.

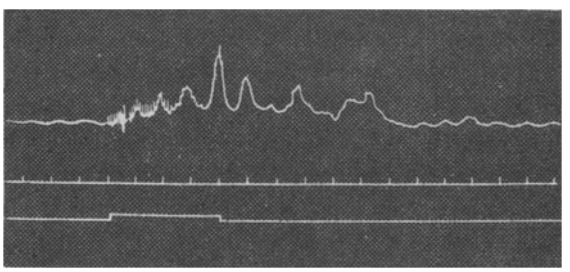

Fig. 1. Heightening of tonus, and appearance of gastric contractions due to stimulation of the hypothalamus (anterior parts) during a phase of gastric inactivity, for the dog Sultan. Explanation of tracings (from above down): recording of stomach movements, time signals (15 sec.), and stimulation signal (15 cps, 15 A).

In all cases, stimulation of the posterior hypothalamus of Bobik against a background of gastric activity caused lowering of tonus and inhibition of periodic contractions, both in the pyloric part and in the fundus of the stomach; in addition, we observed widening of the palpebral fissures, contractions of the pupils, and panting. The dog raised his head and sniffed the air.

During a quiescent phase of gastric activity, stimulation by the posterior electrodes did not cause any motor effects. Stimulation by the anterior electrodes during a period of inactivity raised the tonus of the stomach, and

was followed, after a latent period of 10-15 seconds, by gastric contractions. At the same time we observed narrowing of the palpebral fissures and the pupils and acceleration of the rate of breathing. The dog started to lick himself. Stimulation by the anterior electrodes while the stomach was active caused slight raising of tonus, with increased amplitude of the individual contractions.

Before the electrodes were implanted, the gastric juice collected over a 4-5 hour period amounted to about 8 ml, with a free acid content of 0-10, a total acidity of 2-20, and a digestive power of 0 to 1 mm.

In the first two experiments performed after implanting the electrodes we collected up to 70 ml of gastric juice over the same time, with a free acid content of 50 to 120, a total acidity of 100 to 140, and a digestive power of 2 to 6 mm. On the third day after the operation gastric secretion had returned to preoperational levels.

With hypothalamic stimulation we collected, over 4-5 hours time, 3 to 20 ml of gastric juice, with a free hydrochloric acid content of 20 to 50, total acidity of 30 to 105, and a digestive power of 1 to 3 mm of protein.

The stomach contractions and secretion observed in experiments in which we did not stimulate the hypothalamus were of the same order as before implantation of the electrodes.

Our second experimental dog, Sultan, (a watchdog, weight 23 kg, male) was given a gastric fistula on June 15, 1955. After 7 days we began to take recordings, which lasted for a month, to July 16, when 4 polar electrodes were implanted in the hypothalamic region. After 14 days we renewed our experiments, which lasted until October 24, 1955.

No perceptible effect resulted from stimulation from the anterior and posterior electrodes while the stomach was working. Stimulation during a quiescent period caused contractions, with a latent period of 15-35 seconds (duration of stimulation 1 minute; see Figure 1).

In all, we performed 300 such stimulations during our experiments. We always found copious secretion of gastric juice, with heightened free and total acidity, and raised digestive power. These effects followed both single stimulations and stimulations repeated at 30 minute intervals during the whole experiment. The results of two experiments are represented in Figures 2 and 3.

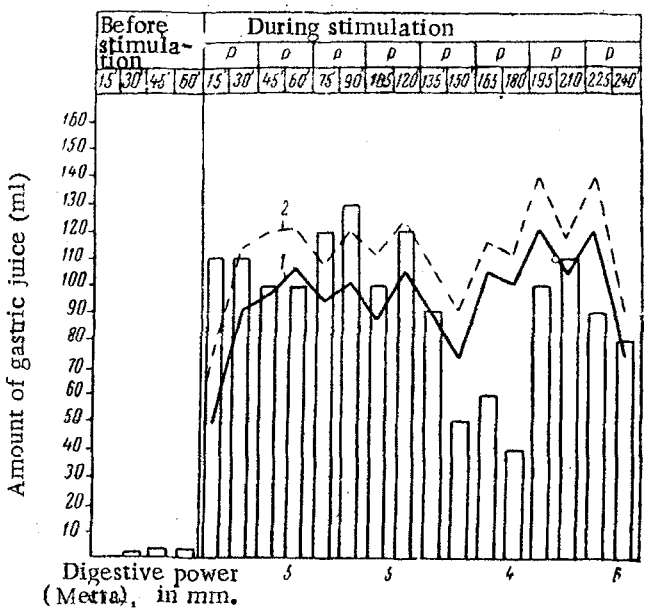

Fig. 2. Alterations in gastric secretion due to stimulation of the hypothalamus for 1 minute with a current frequency 30 cps, amplitude 15 mv, at 30 minute intervals. 1) Free hydrochloric acid, in Ewald units; 2) total acidity in Ewald units; average digestive power of a 1 hour portion of gastric juice (Metta), in mm of protein digested in 24 hours (figures below). Experiment on Sultan, July 30, 1955.

Other effects noticed during stimulation from the anterior electrodes, in the dog Sultan, were defecation, urination, and narrowing of the pupils, and the dog licked himself. Stimulation from the anterior electrodes caused dilatation of the pupils, with convergent squint, and the dog sniffed the air.

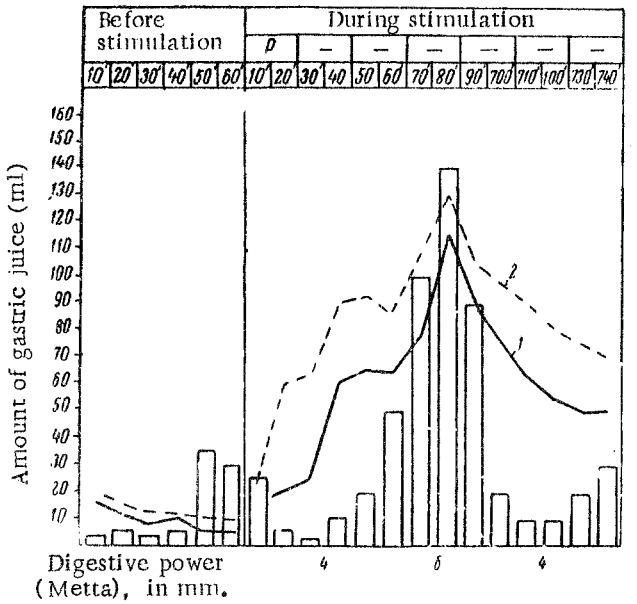

Fig. 3. Alterations in gastric secretion with a single stimulation of the hypothalamus (current frequency 50 cps, amplitude 15 mv, duration 1 minute). 1) Free hydrochloric acid, in Ewald units; 2) total acidity in Ewald units; columns: ml of gastric juice per 10 minutes; average digestive power of a 40 minute portion of gastric juice, in mm of a protein column digested in 24 hours (Metta test; figures below). Experiment on Sultan, September 2, 1955.

Before implantation of the electrodes secretion of gastric juice over 4-5 hours amounted to 2 to 10 ml, of a free acid content of 0 to 15, total acidity 2 to 20, and digestive power of 0 to 1 mm.

During stimulation of either the anterior or the posterior hypothalamus the amount of juice collected over the same time was 40 to 150 ml, with a free hydrochloric acid content of 30 to 144, a total acidity of 40 to 160, and a digestive power of 2 to 7 mm.

We found that the maximum effect was achieved when the hypothalamus was stimulated with a current of frequency 30 to 80 cps, and amplitude 15-20 mv.

Thus we see that stimulation of the hypothalamic region, in extensive experiments on dogs, causes alterations in the motor activity of the fasting stomach; appearance of untimely contractions of the stomach during a quiescent period, when the anterior part of the hypothalamus is stimulated, and inhibition of rhythmic contractions during a phase of gastric activity when the posterior part is stimulated. Stimulation from both the anteriorly and the posteriorly placed electrodes raises the secretion of gastric juice, of high acidity and considerable digestive power, and also causes defecation, urination, panting, and dilatation of the pupils.

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EFFECT OF NATURAL AND DRUG-INDUCED SLEEP ON GASTRIC SECRETION IN DOGS

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Drug-induced sleep has been widely applied in therapeutics over the past few years, in particular in the treatment of gastric ulcer. It is known that the disturbances in gastric secretion encountered in ulcerative disease play a certain part in its pathogenesis and in its recurrence. Clinical data on the effect of drug-induced sleep on gastric secretion in ulcer patients are very contradictory, owing to the differences between the test methods used, and because of the use of diverse hypnotics, with different modes of action.

Not enough work has been done on the theoretical basis of the indications or counter-indications for the application of drug-induced sleep to the treatment of functional disturbances of the gastrointestinal tract.

The object of our research was to investigate the effects of natural and drug-induced sleep on the secretory activities of the gastric glands.

EXPERIMENTAL METHODS

The hypnotics used were Barbamyl and chloral hydrate. The research was conducted under the conditions of extensive experiments. The experiments were performed on 10 dogs with Pavlov and Klemensievich-Heidenhain gastric pouches, and with gastroesophagotomies. Barbamyl was introduced rectally at a dosage of 0.04 g per kg body weight, and chloral hydrate at a dosage level of 0.3-0.4 g per kg body weight. In view of the intense local irritation caused by chloral hydrate solution we dissolved it in starch solution. At the given dosage levels, Barbamyl induced sleep lasted for 7-8 hours, and chloral hydrate sleep for 3-4 hours. Immediately after administration of the hypnotic, and before it had had time to act, the dogs were given a carefully measured amount of gastric stimulant (hematogen, raw meat, rye bread).

The experiments involving the use of hypnotics were preceded by experiments designed to determine the normal secretory response of the gastric glands to the stimulants, in wakefulness and in natural sleep. The latter experiments were performed at night, after gastric stimulation in a darkened room, as near as possible soundproof.

* In Russian.