ELECTROPHYSIOLOGICAL RECORDING OF MOTOR ACTIVITY OF DUODENUM UNDER ACTION OF FOOD STIMULI OF DIFFERENT NATURE

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In a previous paper [4], we described a new electrophysiological method of studying the rhythmic activity of the duodenum in the empty state and during digestion.

In the present work, this method was used for a study of the nature of the motor activity of this part of the gastrointestinal tract when food stimuli of different nature were used. This question has not been adequately clarified in the literature. The x-ray method, widely employed with different food stimuli for the investigation of the motor activity of the duodenum, has provided a means of determining mainly the evacuatory function [5,7,8].

Visual observations of the movements of the duodenum during digestion have been made on a loop of the gut brought out under the skin [1,2].

A graphic characteristic of this activity has been obtained by registration with a balloon-type kymograph [3]. However, these investigations did not give a detailed picture of the motor activity of the small intestine during the whole digestive period after the introduction of food stimuli of different nature.

Our aim was to obtain a full and detailed characterization of the movements of the duodenum when various food stimuli were used.

Experimental Methods and Results

For recording the motor activity, we used an electrode implanted in the duodenal wall [4]. The biocurrents were recorded by means of an EGS-1 apparatus with unipolar tapping of the biocurrents.

This paper contains the information obtained from experiments on five dogs in which the motor function of the duodenum was recorded electrographically after the animals had been fed with food stimuli of different nature – finely shredded meat (200 g), bread (200 g), and milk (200 ml). In every case, these stimuli were given in the "rest" period, 12-15 min after termination of the "work" period. Dogs with empty stomachs, 18-20 hr after being fed, were taken for the experiments.

In the investigations with these food stimuli, we observed changes in the amplitude of the electrical activity during digestion, and these changes are shown in the electroenterograms (Figs. 1a,b,c).

A comparison of the electroenterograms shows that the frequency of the electrical oscillations was constant for all three foods; on the average, it corresponded to a rhythm of peristaltic activity at a rate of 5-6 oscillations per minute, and pendular oscillations at a rate of 12-15 per minute. The variation of the amplitudes of the

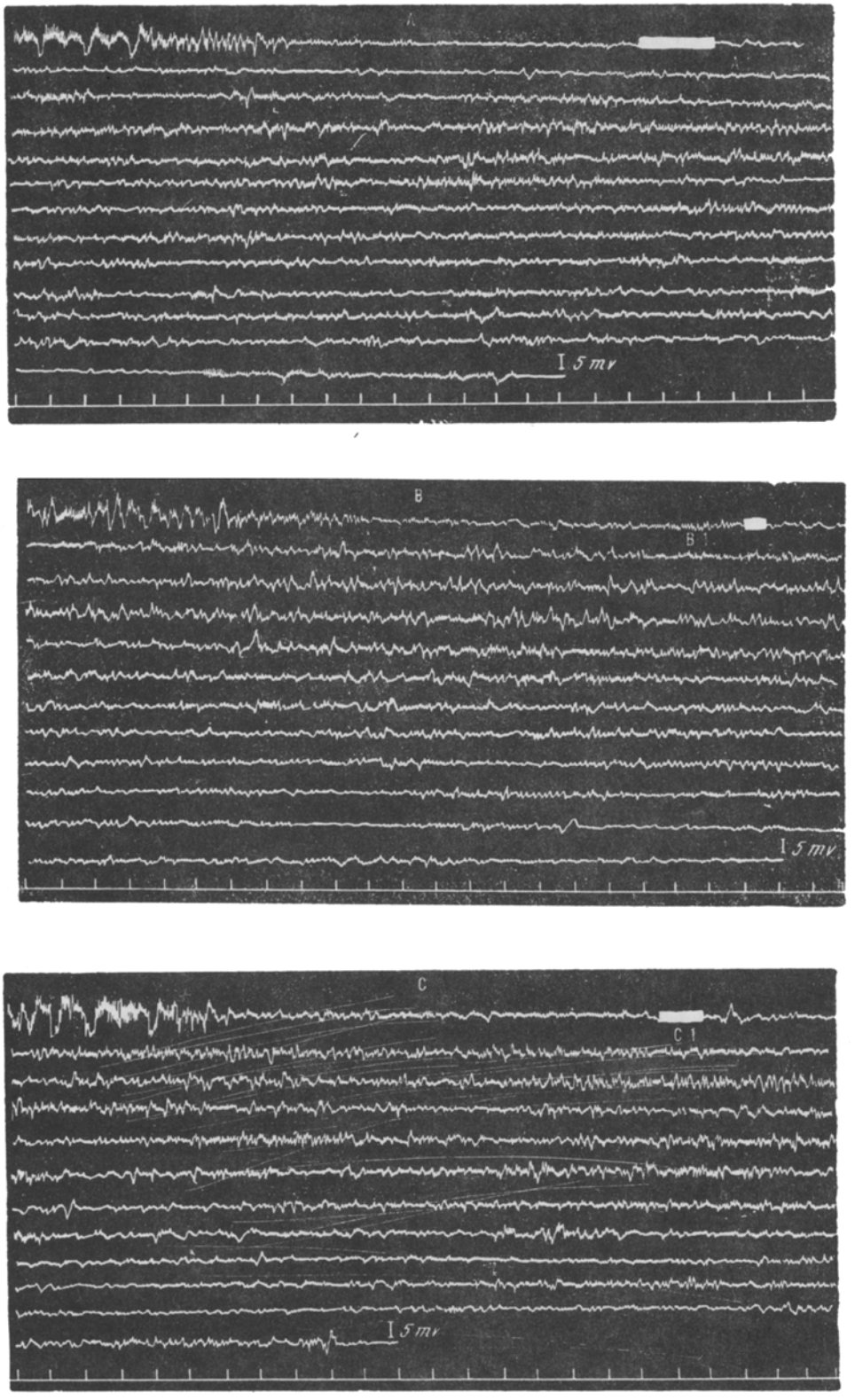

Fig. 1. Electrograms of motor activity of duodenum during digestion. The food stimuli: a) 200 g bread; b) 200 g meat; c) 200 ml milk were given in the 10th min of the "rest" period. At end of trace) calibration (5 mv); bottom line) 1-min time marks. Series of experiments on dog Tsezar (December, 1956). A1) 200 g bread fed; B1) 200 g meat fed; C1) 200 ml milk fed.

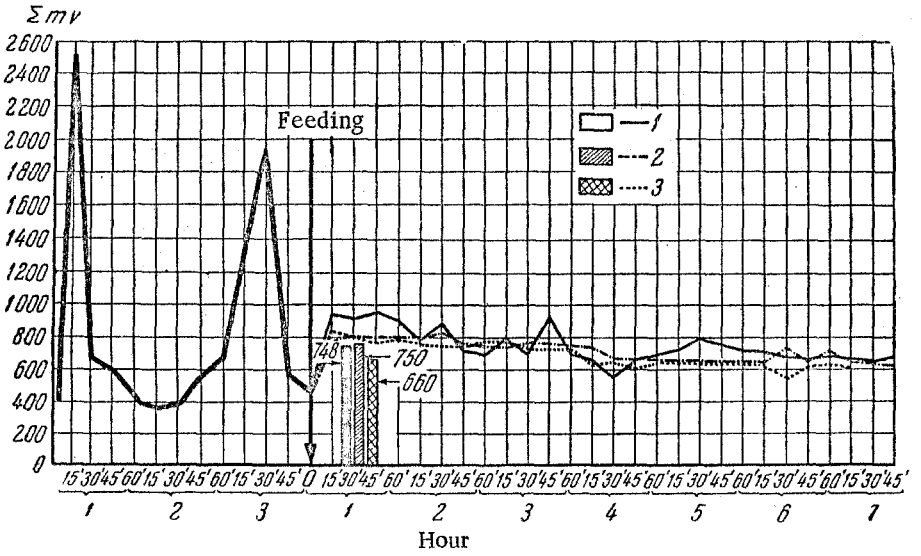

Fig. 2. Dynamics of changes of electrical activity of duodenum motor, summed over 15-min intervals in the "work" period, in the "rest" period (indications for first 3 hr), and after feeding with food stimuli of different nature in subsequent hours. The columns underneath denote the sum total values of the amplitudes of electrical activity for the digestion period for the stimuli of different kind.

individual contractions seemed to imitate the variable rhythm. Moreover, the outward picture of the changes in electrical activity was of an inconstant nature owing to the nonperiodic appearance of slow, large-amplitude oscillations of the tonic type; these oscillations are typical of the motor activity of the intestinal wall in physiological hunger, and of the onset of peristaltic contractions on which rhythmic pendular contractions are superimposed. Thus, during digestion, there is no definite, strict alternation of the basic types of motion of the duodenum.

Most affected by the qualitative composition of the food were the strength and depth of the peristaltic and pendular contractions; the amplitude of the electrical oscillations varied accordingly. The absolute values of the amplitudes of the electrical oscillations attained the order of millivolts. The mean absolute values of the amplitudes of the electrical oscillations in this series of experiments after the dogs had been fed on 200 g of bread, varied from 0.3 to 1.3 mv, and the values of the amplitudes corresponding to the pendular motions lay between 0.1 and 0.6 mv. When the animals were fed with meat, the mean absolute values of the amplitudes of the electrical oscillations corresponding to the peristaltic activity varied from 0.3 to 1.1 mv, and those corresponding to the pendular motions varied from 0.1 to 0.5 mv.

In the case of feeding with milk, the mean absolute values of the amplitudes of the electrical oscillations corresponding to the peristaltic activity varied from 0.3 to 0.8 mv, and those corresponding to the pendular motions from 0.1 to 0.4 mv.

On all the electroenterograms, irrespective of the food stimuli employed, we can distinctly see the inconstancy of the amplitudes of the electrical oscillations and, hence, of the strength of the rhythmic contractions of the duodenum. The alternation of the groups of large-amplitude oscillations, corresponding to the peristaltic and pendular contractions, was also variable in time. On the whole, however, the electrical activity of the rhythmic contractions of the duodenum during digestion was greater than in the period of relative "rest," and less than in the "work" period in conditions of physiological hunger.

A clearer idea of the changes in the electrical activity of the rhythmic contractions of the duodenum is given by Fig. 2. Fifteen-minute time intervals are plotted on the x axis, and the sums of the amplitudes of the electrical oscillations recorded in these 15-min intervals are plotted on the y axis. Figure 2 illustrates the changes in the electrical activity of the rhythmical contractions of the duodenum in the "work" period and in the period of relative "rest."

As Fig. 2 shows, the electrical activity in the "work" period is almost ten times greater than that in the "rest" period. Figure 2 also shows diagrams (designated by columns) of the changes of electrical activity during digestion, summed for the food stimuli of different nature.

We see that the mean values of the total electrical activity for bread and meat hardly differ at all from one another, whereas, for milk, this value is a little lower.

Thus, the electrical activity of the duodenal walls with the different food stimuli which we used did not reveal any appreciable differences, thus differing from the results recorded earlier by M. A. Sobakin in similar experiments on electrogastrography [6]. This result is possibly due to the fact that the food arrives in the duodenum after its mechanical treatment, i.e., as chyme; the food passes from the stomach to the intestine in approximately equal batches. Hence, their action on the mechanoceptors of the duodenum will be more or less constant. Along with the diagrams on Fig. 2, we show a full graphic characterization of the course of the changes in the electrical activity of the duodenum during 15-min periods in the process of digestion. In contrast to physiological hunger, the rhythmic activity of the duodenum during digestion is of a more or less uniform nature, with no clearly expressed "rest" and "work" periods.

The conducted investigations have shown that when food stimuli of different nature are used, the frequency of the rhythm of electrical oscillations does not vary, and for pendular movements is equal to 12-15 oscillations per minute, and for peristaltic movements it is equal to 5-6 contractions per minute. The amplitudes of the electrical oscillations during digestion are variable; however, the sum total of the amplitudes of the electrical activity during the period of digestion for the stimuli which we used (bread, meat, milk) did not vary much.

SUMMARY

The author presents experimental material obtained on five chronically operated dogs. A method of biocurrent registration from the electrodes implanted into the duodenal wall was used. The general characteristics of the duodenal motor function was thus obtained during the whole period of digestion of various foods, such as finely cut meat (200 g), bread (200 g), and milk (200 ml).

The greatest influence, exercised by the qualitative composition of food, was produced upon the strength of the peristaltic and pendulumlike contractions; the amplitude of electric oscillations altered correspondingly.

The change of the groups (with enlarged amplitude) corresponding to the peristaltic and pendulumlike motions, is inconstant and independent of the food stimuli used. With the mentioned irritants, the sum-total value of the electrical activity amplitudes changes but slightly during digestion. The frequency of the electric oscillations rhythm remained unchanged under the effect of the stimuli used, and equalled 12-15 oscillations per minute for the pendulumlike motion, and 5-6 contractions per minute for peristalsis.

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