THE EFFECT OF THE ESOPHAGUS ON INTESTINAL MOVEMENTS

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In contrast to the large number of reflexes which inhibit intestinal movements, and which can be obtained from certain well-defined portions of the gut, as well as by stimulation of certain afferent nerves, there are in the literature only a few references to stimulation of intestinal movements. In particular there are no references to the effect on intestinal movements of stimuli affecting the receptors of the esophagus.

Pearcey and van Liere observed inhibition of gastric contractions on distention of the esophagus, as well as a reduced tone of the cardiac and pyloric sphincters.

After dilatation of the esophagus Pearcey and van Liere found an inhibition of gastric contractions, a reduction in tone of the cardiac and pyloric sphincters, and an increase in tone of the ileocecal sphincter.

A. I. Ivanov [7] concluded from his short-term experiments on cats, that stimulation of the interoceptors of the esophagus is without effect on the motility of the intestine. I. P. Dolgachev [6] found an increased peristalsis of the large intestine after distention of the abdominal portion of the esophagus.

The aim of the present investigation was to find the effect of repeated stimulation of the esophogeal receptors on intestinal motility.

EXPERIMENTAL METHODS

The experiments were performed 18-20 hours after the last meal, on two esophagotomized dogs Malchik and Bimba, with gastric and jejunal fistulae. Stimulation of the esophagus was effected by inflating a thin-walled balloon 4-7 cm. in length, located in the middle or lower third of the esophagus. The balloon was connected to an apparatus giving a steady flow of air. It was also joined by means of a 3-way connection with a Marey capsule for registration of esophageal movements on a kymograph, and with a mercury manometer for control of pressure in the balloon. Stimulation was applied for 2-3 mins. Gastric and intestinal movements were recorded by means of balloons, using a hydraulic transmission, and a Marey capsule on the kymograph. The stimulus to the esophagus was given at various phases of the activity of the stomach and intestine. Sixty experiments were performed on the 2 dogs, during which time 448 tests of the effect of esophageal stimulation were made.

EXPERIMENTAL RESULTS

Stimulation of the mechanoreceptors of the esophagus by inflating a baloon to 40-50 ml during peristalsis of the intestine had no effect on its motility (Fig. 1); (this degree of inflation represented a pressure of 2 to 10 mm of mercury during relaxation of the esophagus, and 8-30 mm during contraction); it had an inhibiting effect on contractions of the cardiac portion of the stomach. Inflation of the baloon to 75 ml and to 100-150 ml evoked powerful contractions of the esophagus. There was little difference in the pressures obtained during the contractions, the values being 30-60 mm and 50-60 mm of mercury respectively. During relaxation, the pressures

and volumes were as follows: 75 ml - 5-20 mm; 100 ml -10-30 mm; 150 ml - 20-40 mm. There was never any inhibition of intestinal movement. The contractions of the fundus could be inhibited just as in the case of a balloon of volume 40-50 ml. The supply of air to the balloon caused no pain to the animal, for when a certain stimulus intensity was exceeded, vomitting occurred and we immediately released air from the balloon.

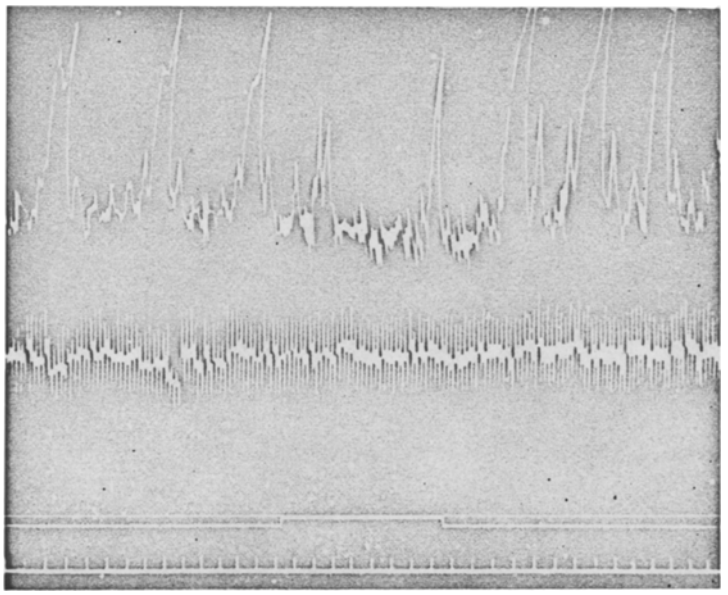

Fig. 1. Absence of inhibition of spontaneous contractions of the small intestine on stimulation of the mechanoreceptors of the esophagus, and inhibition of stomach movements. Curves (from above downwards): stomach movements, movements of the jejunum, stimulus trace (inflation of esophagus to 50 ml, pressure 8-28 mm), time (15 second intervals).

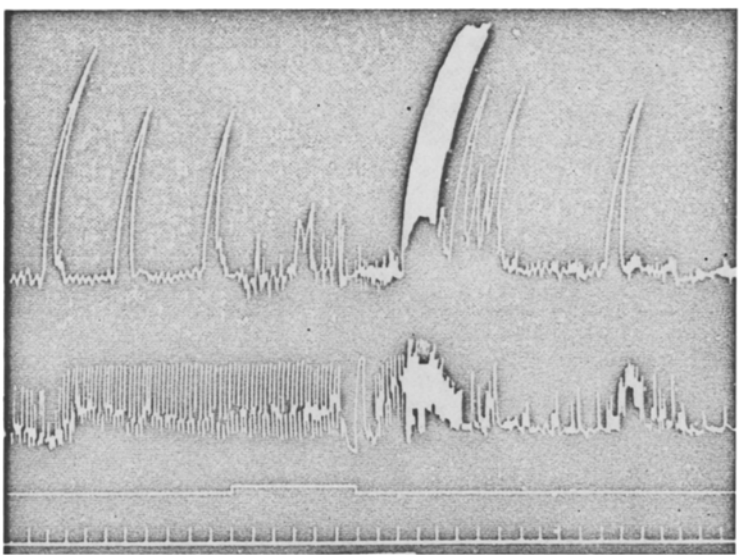

Fig. 2. No inhibition of intestinal movement at the end of the period of rhythmic activity of the jejunum, and inhibition of stomach movements. Vomitting after the stimulus. Curves as in Figure 1.

In some of our experiments stimulation of the esophagus during a period of intestinal activity resulted in tonic or peristaltic waves in the empty intestine. Stimulation of the esophagus during the terminal phase of the movement, called by O. P. Kufarev [8] the terminal rhythmic phase, (Murakami and Uchijamu's tetanic phase [10]), has no effect on the rhythmical contractions of the intestine, whatever the strength of the stimulus. A more powerful stimulus leads as before to vomitting.

In most cases a short stimulus of 1-3 minutes, with a balloon volume of 40-50 ml and a pressure of 2-10 or 8-25 mm according to the contraction of the esophagus, when the intestine was at rest, stimulated intestinal movement (Fig. 3). At the moment of inflation of the balloon, the tone of the stomach was either somewhat lowered, or unchanged. This shows that the movements induced in the small intestine do not arise from waves passing from the esophagus along the stomach.

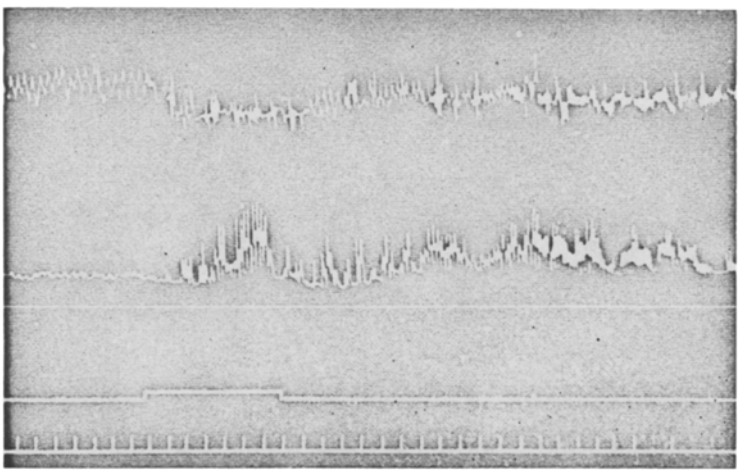

Fig. 3. Excitation of movement in the small intestine through stimulation of the mechanoreceptors of the esophagus during period of rest of intestine. Tone of stomach reduced during stimulation of esophagus. Curves as in Figure 1.

The magnitude and latent period of the response of the intestine to esophageal stimulation depends on the timing of the stimulus; at the beginning of a resting period the response is weak, with a long latent period of 1-2 minutes; if the balloon is inflated to 40-50 ml 5-10 minutes after the beginning of a resting period, the response is still weaker or absent, but if the stimulus is applied later, the response is greater and the latent period is shortened to 30-60 seconds. As the moment at which the esophagus receives the stimulus approaches the period at which movement would begin spontaneously, the response increases in amplitude and duration, and the latent period is reduced. Stimulation with 40-50 ml just before an active period is due, brings on contractions which last for a considerable time and which represent a normal period of activity.

Thus the reaction of the small intestine to stimulation of the esophagus, is the same as that which we previously observed to originate from the stomach [4]. On stimulating the esophagus with 75-100 ml during a period of intestinal rest, the same reaction as before occurs, except that the latent period is shorter, and the response is greater. If the stimulus is very strong it causes vomitting, just as in the case when it is applied during a period of activity.

If the stimulation is applied many times per day, an adaptation occurs to the particular strength of stimulus used, and the response is reduced. Increase of stimulus strength again evokes a clear-cut reaction.

The results afford clear evidence of a stimulant effect exerted by the esophagus on the movement of the small intestine when an adequate stimulus is applied, for a dog is capable of swallowing a lump of food of greater volume than the inflated balloon which we used. We cannot therefore agree with A. I. Ivanov who concluded from the evidence obtained in short experiments, that no changes in intestinal movements occur during the passage of food along the esophagus.

It is well-known that intestinal movements are considerably reduced for a considerable period after opening the abdominal cavity. This is particularly true of the intestine of the cat, in which the chief movement is a rhythmical one which divides the gut up into segments [9]. In the operations performed by A. I. Ivanov, considerable damage was caused to the stomach and intestine, which must certainly have affected intestinal motility. We must also remember that these experiments were performed on anesthetized animals, and this may be the reason why he [7] failed to observe the stimulant action of the esophagus on intestinal motility. In his experiments stimulation of the mechanoreceptors of the esophagus produced no inhibitory effect on the intestine, and this agrees with our results. Since stimulation of the esophagus exerts its action on the intestine at a time when the gastric tone has been reduced also by esophogeal action, or else has remained unchanged, we deduce that there must exist some reflex not yet described in the literature, which mediates this effect. Additional evidence is obtained from our results showing a stimulant action of the esophagus on intestinal motility in cases where the intestinal wall was cut above the place from which the movements were recorded.

From these results and those of the previous investigations [1-5], we may conclude that the increase in intestinal movements that takes place on feeding in normal animals, occurs as a result of the summation of the following reactions: 1) conditioned reflex stimulation from the eye and nose reacting to the sight and smell of the food, before feeding, 2) conditioned reflex stimulation initiated by the act of eating [5], 3) reflex action from the esophagus, 4) reflex action from the stomach. Also, on entry of chyme into the intestine, the degree of movement of the small intestine is to a large extent determined by the action of its constituents on the duodenum and other parts of the intestine.

SUMMARY

Extensive observations of two esophagotomized dogs with fistulae of the stomach and jejunum have shown, that stimulation of the esophagus by an introduced ballon elicits reflex movements of the jejunum. The character of reflex activity depends on the intensity of stimulation and the functional state of the motor apparatus of the stomach and intestine at the moment of esophageal stimulation.

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* In Russian.