

REFLEX EFFECT ON THE STOMACH OF VIBRATIONS PROCEEDING FROM THE HEART*

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The existence of cardiac reception has now been finally confirmed. Animal experiments have shown the existence of reflexes from the myo- and pericardium, causing retardation or arrest of heart-beat, respiratory changes [3, 7, 11], and also initiation of reflexes affecting skeletal muscles [6, 12]. The present paper deals with reflex action of the heart on the stomach, evoked by mechanical (vibratory) stimulation of the heart.

In our earlier studies of the effects of vibratory stimulation of the heart and stomach [8-10] we encountered the following phenomenon: application of the vibrator to the heart of a frog not only affected the activity of the heart, but also affected the stomach, the motor activity of which was modified. In order to study this effect in greater detail, we performed a series of special experiments on frogs, involving application of a vibrator to the heart, with simultaneous observation of the motor activities of the stomach.

EXPERIMENTAL METHODS AND RESULTS

Our experiments were performed on *Rana temporaria*. After transection above the level of the medulla oblongata we destroyed the brain. Kymograph recordings were made of contractions of the heart and stomach in situ. Stimulation was effected by means of an electromagnetic vibrator, of amplitude 0.3 mm and frequency 100 vibration per second; the rod of the vibrator was applied closely to the heart. The duration of action of the stimulator was from 1 to 3 minutes.

The reflex effects on the stomach observed in 67 experiments in which the vibrator was applied to the heart are shown in the Table.

Changes in Gastric Motor Activity due to the Action of a Vibrator on the Heart

Nature of changes in gastric motor activities	Number of experiments	Percentage of total number of experiments
Increased frequency of peristaltic waves and increase in their amplitude	15	23
Increased frequency of peristaltic waves without change in amplitude	25	38
No change in frequency, but increase in amplitude	5	7
Appearance of marked peristalsis, which was absent before application of the vibrator	9	13
No change in peristalsis, but heightening of gastric tonus	11	16
Retarded peristalsis	2	3

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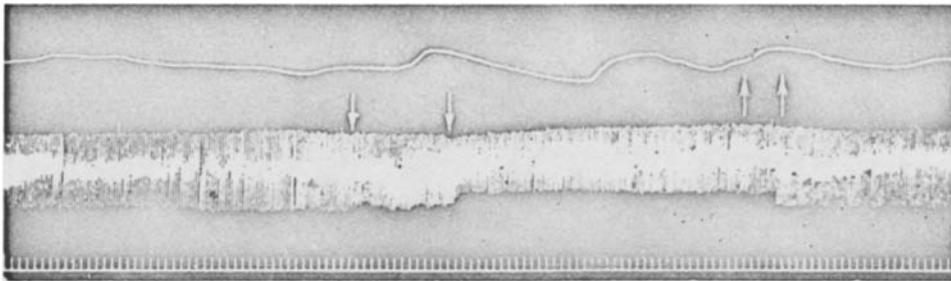


Fig. 1. Heightened gastric peristalsis due to the action of vibration on the heart.
Explanation of tracings (from above down): recording of gastric contractions, recording of heart contractions, time marker (5 seconds); ↓ contact of the vibrator with the heart; ↓ beginning of vibration; ↑ cessation of vibration.

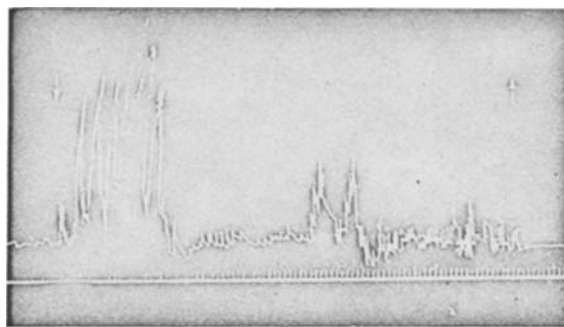


Fig. 2. Contractions of the fasting stomach of a dog subjected to the action of a vibrator placed over the heart.
 The arrows indicate when the vibrator was switched on and off; time marker below (5 seconds).

As is seen from the table, in 82% of all the experiments, stimulation of the heart by the vibrator caused heightened peristalsis of the stomach (Fig. 1), manifested as more frequent or more energetic contractions of the stomach muscles. The latent period of the gastric reaction amounted to 5-10 seconds after application of the vibrator to the heart, but in some experiments it amounted to more than 30 seconds.

In 65% of the experiments there was a rise in gastric tonus, and no perceptible change in 35% of the experiments. The heightening of gastric tonus persisted for 15-20 minutes or more after removal of the vibrator.

We stimulated the heart in 9 experiments in which gastric peristalsis was totally absent (as shown by the kymograms). In all these cases, a lively peristalsis appeared after application of the vibrator, and continued to increase in intensity after its removal. These experiments afforded particularly clear evidence of the reflex action of the heart on the stomach.

In certain of the experiments we observed displacement of the entire stomach after applying the vibrator. This can only be due to a reflex from the heart acting on skeletal muscles (a visceromotor reflex).

Since the heart was located in the vicinity of the stomach during the *in situ* experiments, the possibility existed that the vibrations might reach the stomach via the intervening tissues. If this were to be the case, we would not be justified in concluding that the changes in gastric activity observed after applying the vibrator to the heart were of reflex origin. In order to elucidate this question, we performed an additional 40 experiments on the effect on the stomach of vibration applied to the heart, on animals in which we had destroyed different parts of the central nervous system, beginning with the cerebral cortex, and ending up with the spinal cord, observing the effect on the motor activity of the stomach. The results of these experiments were as follows:

1) when the brain was destroyed above the level of the medulla oblongata, and also when the spinal cord was additionally destroyed below the level of the first cervical vertebra, leaving the medulla oblongata intact, the effect of vibration applied to the heart was, in 78% of the experiments, to stimulate peristalsis of the stomach, which was unaffected in the remaining 22%;

2) with destruction of both the brain and the medulla, i.e., spinal frogs, in no case did application of vibration to the heart affect gastric peristalsis;

3) after destruction of the entire central nervous system (including the spinal cord) application of the vibrator to the heart also had no effect on gastric motor activity.

It thus appears that the heightening of gastric peristalsis observed when a vibratory stimulus is applied to the heart takes place only when the medulla oblongata is intact; after its destruction, stimulation of the heart does not affect gastric motor activity. It may hence be concluded that the stimulation of gastric motor activity observed in our experiments cannot be ascribed to mechanical transmission of vibration from the heart to the stomach through the surrounding tissues, but must be of reflex nature. This reflex must be effected via the medulla oblongata.

Our experiments on poikilotherms were next extended to dogs provided with a chronic gastric fistula. The experiments began with the recording on a kymograph, using V. N. Boldyrev's method [2], of periodic hunger contractions of the stomach, giving records of the duration and the characteristics of the periods of activity and rest. The vibrator was then applied to the cardiac region of the dog, for periods of 2 to 10 minutes. The vibrator (frequency 100 cps, amplitude of vibrations 0.3 mm) was fastened to the left side of the chest, over the heart, before the experiment was begun. The vibrator was switched on at different phases of the periodic activity of the stomach, viz., at rest, and at the beginning and end of periods of activity.

The results of 30 experiments showed that the stomach reaction varied according to its initial functional state. We were never able to evoke contractions when the stomach was in a fully quiescent phase. Nor did stimulation of the heart applied during an active phase have any significant effect on the motor activity of the stomach. However, stimulation of the heart 4-8 minutes after cessation of a periodic contraction phase caused renewal of contractions in 9 out of 10 experiments (Fig. 2).

In order to establish that this reaction of the stomach was of reflex origin, and that the reflex proceeded from the heart, and not from the skin, we performed additional experiments on the same dog, in which we placed the vibrator on the right side of the chest, at a point corresponding with respect to its spinal innervation to the previous location over the heart. These experiments did not give rise to any well-defined reflex reactions of the stomach. We may hence conclude that the stomach reaction observed by us when the vibrator was placed over the heart was caused by a reflex from the heart, and not from the skin.

The experiments on dogs thus confirm the results obtained with poikilotherms; the reflex from the heart may also be demonstrated in homeotherms, which is of definite interest for the study of the physiology of interoception. This reflex reaction should be more pronounced in pathological conditions of the heart, and this has been confirmed by clinical observation [1, 4, 5], showing that diseases or lesions of the heart cause dyspepsia, and sometimes present the clinical picture of gastric ulcer, cholecystitis, "acute abdomen," etc.

SUMMARY

The effect of heart stimulation by vibrations (with the aid of electromagnetic vibrator) on the motor function of the stomach was studied in experiments on animals (frogs and dogs).

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