IMPORTANCE OF STRUCTURES OF THE LESSER CURVATURE IN THE SPREAD OF PERISTALTIC WAVES OVER THE STOMACH

P. G. Bogach and S. D. Groisman

UDC 612.327.014.2

Total transection of the stomach or division of two-thirds of the organ on the lesser curvature side led to prolonged (more than 30 days) blocking of the passage of peristaltic waves from the fundus to the pylorus. After complete transection of the stomach below the incisura angularis, passage of peristaltic waves across the line of division was restored to normal after 10-20 days. Restitution of stomach movements after division of four-fifths of the stomach on the greater curvature side took place after one week. It is concluded that structures in the region of the lesser curvature play a special role in the spread of peristaltic waves over the stomach.

* * *

Disturbances of motor activity of the stomach arising after transection of the organ have long attracted the attention of clinicians and physiologists. However, the data on this subject are conflicting. In some investigations [9, 12, 16, 18] the passage of peristaltic waves across the line of section showed little change, while in others movements in the fundus and pylorus were dissociated [8, 11, 13-15]. These disagreements between results are probably attributable to differences in the times elapsing between the operation of transection of the stomach and the beginning of the observations.

The investigation described below was carried out to study the motor activity of the fundal and pyloric divisions of the stomach, which was undertaken for 6 months after transverse incisions had been made through the stomach at different levels, followed by reanastomosis.

EXPERIMENTAL METHOD

Experiments were carried out on 16 dogs two of which acted as controls. A fistula was made into the fundal and pyloric divisions of the stomach of all the dogs. In 14 dogs, at the same time as the fistulas were made, the stomach was divided and immediately reanastomosed. The following types of transections were carried out: 1) transection of the stomach at the level of the incisura angularis or slightly below it (4 dogs), 2) transection of the stomach 5-10 cm above the incisura (2 dogs), 3) division of four-fifths of the stomach on the greater curvature side at the level of the junction between fundus and pylorus (2 dogs), and 4) division of one-third of the stomach at the same level on the lesser curvature side (2 dogs).

Stomach movements were recorded by a balloon-graphic method. A balloon introduced into the fundal division was inflated with 25-30 ml air, and a balloon in the pyloris division with 3-4 ml. Periodic movements of the stomach and movements in response to food were recorded.

EXPERIMENTAL RESULTS AND DISCUSSION

No fundamental differences in the character of the changes in periodic and peristaltic movements of the stomach depending on the location of transection of the stomach were found. The only differences were in the times of recovery of the normal spread of peristaltic waves over the stomach. After transection of the stomach below the incisura, pyloric movements were restored in 10-20 days, and after transection below the incisura in 30-50 days. Stomach movements were restored after a relatively long period (about 30 days) in cases when one-third of the circumference of the stomach was divided on the lesser curvature side, compared with only one week after division of four-fifths of the stomach on the greater curvature side. Res-

Department of the Physiology of Digestion, Institute of Physiology, T. G. Shevchenko Kiev University
(Presented by Academician V. N. Chernigovskii). Translated from Byulleten' Éksperiment'noi Biologii i Meditsiny, Vol. 66, No. 12, pp. 16-19, December, 1968. Original article submitted July 10, 1966.

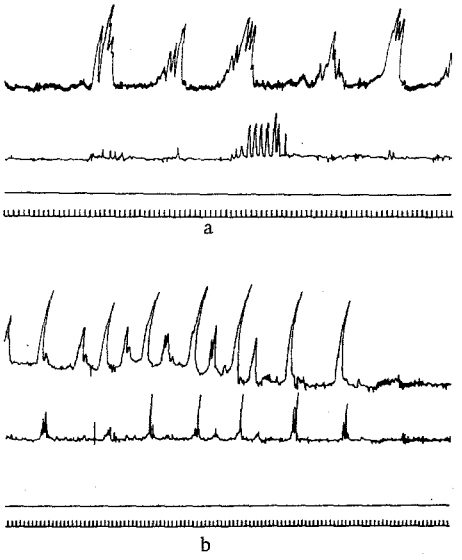

Fig. 1. Periodic movements of fundal and pyloric parts of the stomach showing 1st (a) and 2nd (b) types of disturbances 10 days after transection of the stomach above the incisura angularis. From top to bottom: movements of fundus, movements of pylorus, marker of stimulation, time marker (15 min).

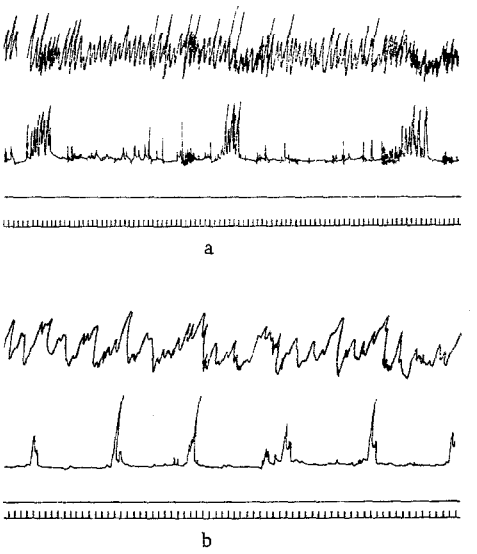

Fig. 2. Movements of the fundus and pylorus in response to food (a) 15 days after transection of the stomach above the incisura angularis (disturbances of first type). The same 9 days after transection of the stomach below the incisura, showing disturbances of the second type (b).

toration of gastric peristalsis in dogs after complete transection of the stomach above the incisura was relative in character, because 6 months after the operation a block to peristalsis sometimes remained at the line of section.

Two types of disturbances of periodic movements were found in the pyloric division of the stomach. In the first type, an absolute majority of contractions of the fundus was blocked at the line of section (Fig. 1a). In the pyloric division very slight contractions sometimes corresponded to them. However, series of powerful contractions consisting of 4-8 waves appeared at the same time in the pyloric division. In each individual series the frequency of contraction was 4-5 per min, i.e., that usually found in the pyloric part of the stomach. Series of contractions appeared during both working and resting periods of the fundus, but in the latter case they were less frequent and consisted of fewer contractions. Gradual passage of waves from the fundus to the pylorus was restored and the periodic movements of the pyloric portion of the stomach returned to normal.

In the second type of disturbances most of the type A contractions crossed from the fundus to the pylorus during the first days after transection of the stomach (Fig. 1b), but the character of the pyloric movements was different from that observed in dogs with an intact stomach. Each wave in the fundal portion corresponded to one, or less commonly, two pyloric contractions, whereas under normal conditions, depending on the pauses between contractions of the fundal portion, each corresponds to 3-7 contractions of the pylorus [3, 5, 6]. Autonomous series of contractions of the pylorus were absent in these dogs. With time the periodic movements of the pyloric division also returned to normal in this group of dogs. With both types of disturbances of movements of the pyloric division the amplitude of its contractions remained normal.

After transection and reanastomosis of the stomach a clear block to the passage of peristaltic contractions from fundus to pylorus was observed in all dogs. However, the definite differences in periodic gastric movements present in different dogs left a clear impression on the peristaltic movements of the stomach. In dogs with the first type of disturbances, while rhythmic contractions occurred in the fundus at a frequency of 4-6/min, isolated series of contractions very reminiscent of those found in these dogs during pyloric movements appeared in the pyloric division (Fig. 2a). The appearance of each series of pyloric contractions corresponded to a decrease in tone of the fundal portion. In dogs with the second type of dis-

turbance, marked changes were found in the character of contractions in the fundus and pylorus (Fig. 2b). In the fundus of these animals, strong contractions at a frequency of 2-3/min were predominant, resembling type II contractions described previously [2]. In the pyloric division, under these conditions, separate contractions appeared at intervals of 3-7 min, usually corresponding to the appearance of the strongest contractions in the fundus.

Movements of the stomach in response to food recovered gradually in both groups of dogs, passing through a series of phases during which rhythmic contraction of low amplitude developed in the intervals between series of contractions or single contractions of the pyloric division. In some experiments, despite active pyloric contractions, the small contractions of the fundus were blocked at the line of section until pyloric motor activity was fully restored to normal.

The results described indicate that in the intact stomach the source of peristaltic waves is its proximal portion, although the pyloric portion possesses some degree of autonomy in this respect. Contractions of the pyloric division, if its connection with the fundus is disturbed, differ in the recovery period from those of the normal stomach. The blocking of peristaltic waves at the line of section cannot be attributed to deterioration of the general condition of the pyloric muscles because the amplitude of single contractions or series of contractions arising in the pylorus was normal. These observations are in agreement with the concept of the existence of a pacemaker for peristalsis in the proximal part of the stomach [10]. In contrast to the pacemaker in the duodenum, laying down the frequency of regular contractions of the proximal division of the small intestine [1], the gastric pacemaker acts as a source of peristaltic waves. It should also be emphasized that the disturbance of pyloric movements developing after transection of the stomach was mainly temporary. The considerable increase in the time required for recovery of gastric movements after transections above the incisura angularis is evidently due to the fact that these transections involved the oblique layer of muscles extending along the lesser curvature only as far as the incisura. The special role of the lesser curvature in the spread of peristaltic waves is also indicated by the fact that division of the part of the stomach including the lesser curvature above the incisura delayed recovery of gastric contractions almost as much as complete transection of the stomach.

The definite differences in character of the block to gastric peristalsis discovered in different dogs are most probably associated with differences in the degree of denervation of the pyloric part of the stomach. The similarity in the character of pyloric movements in disturbances of the first type and movements of isolated gastric pouches made from the pylorus and fundus [4, 7, 17, 18] suggests that in the case under discussion the extramural innervation of the pyloric portion of the stomach was disturbed.

LITERATURE CITED

1. P. G. Bogach and S. D. Groisman, Vopr. Pitaniya, No. 2, 56 (1959).
2. P. G. Bogach, Mechanisms of Nervous Regulation of Motor Function of the Small Intestine [in Russian], Kiev (1961).
3. S. D. Groisman, Effect of Differences in Consistency and Chemical Composition of Food on Gastric Peristalsis. Author's Abstract of Candidate Dissertation [in Russian], Kiev (1960).
4. S. D. Groisman, in: Proceedings of a Scientific Conference on "Functional Relationships Between Various Systems of the Body Under Normal and Pathological Conditions" [in Russian], Ivanovo (1962), p. 159.
5. V. F. Mostun, Relationships between Fasting Motor Activity of Various Parts of the Alimentary Tract. Candidate Dissertation [in Russian], Moscow (1956).
6. I. A. Édel'man, Movements of the Stomach and Passage of Contents from the Stomach into the Intestine. Dissertation [in Russian], St. Petersburg (1906).
7. Z. Bercovitz, Am. J. Physiol., 72, 109 (1925).
8. E. Borchers, Arch. Klin. Chir., 122, 198 (1923).
9. C. Göcke, Bruns. Beit. Klin. Chir., 99, 294 (1916).
10. A. Keith, Lancet, 2, 371 (1915).
11. E. Klein, Arch. Surg., 12, 583 (1926).
12. H. Kloiber, Bruns. Beit. Klin. Chir., 120, 247 (1920).
13. B. Lilja, Acta Radiol. (Stockholm), 39, 353 (1953).
14. B. Lilja, Acta Radiol. (Stockholm), 41, 225 (1954).
15. B. Lilja, Motor Activity of the Stomach, Stockholm (1959).

16. H. Meyer and W. Schmidt, in: Ergebnisse der Medizinischen Strahlenforschung, Vol. 4, Leipzig (1930), p. 481.
17. J. Quigley and R. Templeton, Am. J. Physiol., 91, 475 (1929).
18. R. Robins and T. Boyd, Am. J. Physiol., 67, 166 (1923).
19. A. Thal, J. Perry, and O. Wagensteen, Surgery, 41, 576 (1957).