THE EFFECT OF VAGAL SECTION ON GASTRIC EXCRETION

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The work of the stomach is not limited to digestion. Besides secreting, absorbing, and contracting, it also excretes. Though many investigations of gastric excretion have been carried out [2, 4, 7, 8, 11, 12, 13 and others], the controlling mechanism has never been determined. A reduction in the excretion of neutral red by a Pavlov pouch was observed by R. O. Faitel'berg [14] after section of the left vagus in dogs, and by P. I. Zherebtsov [3] after bilateral vagotomy in rabbits. L. R. Nisevich [10] found that a Heidenhain pouch excreted less urea than did a Pavlov pouch, and E. A. Brodskaya [1] found an increased concentration of urea and creatinin in dogs in whom cystitis had been induced experimentally, and a reduced rate of secretion of neutral red from a Heidenhain pouch.

We have attempted to study various aspects of the regulation of gastric excretion before and after vagotomy.

METHOD

Gastric excretion was studied in 2 dogs having a Basov gastric fistula, by means of chromoscopy. Intramuscular injections of 4 ml (40 mg) of an aqueous solution of neutral red were given. Vagotomy was performed after the control experiments. The vagi were sectioned at two levels, using I. P. Pavlov's method: the right vago-sympathetic trunk was sectioned in the thoracic cavity, leaving undamaged the branches to the heart and the recurrent laryngeal nerve, and the left trunk was divided in the neck 6-7 days later.

The animals survived section of the right vagus without any aftereffects. Recovery was less successful after section of the vagus on the opposite side, and respiration was markedly slowed; in the dog Al'ma, it fell from 18-20 to 10-12 per minute, and in Faithful from 22 to 12 per minute. The pulse rate was raised so high (to 200-230 beats per minute) that it was difficult to count. However, by the second day it had slowed down to 130-150, and by the day after, to 100-110 beats per minute – i.e., it had nearly returned to its original level. The respiration remained unchanged at 8-10 per minute. The temperature measured in the rectum was normal, but the animal did not tolerate temperature changes well, particularly low temperatures.

A special diet was given, because vagotomy may cause death through poisoning by food decay products. On the diet supplied, they remained in a satisfactory condition throughout the experiment.

RESULTS

Section of one vagus had no effect on the excretion of neutral red into the stomach. In the first two days after bilateral vagal section there was marked increase in excretion, as shown by a raised concentration of the dye and a longer excretory period (paralytic stage).

The results of all our experiments were in agreement, and we will therefore report the separate observations. In the dog Al'ma, while the vagi were intact, it was shown that when the dye was injected, it appeared in the pouch contents after 10-20 minutes; the maximal concentration was 2 mg%, and it was excreted for 3 hours 30 minutes. During this time the average amount excreted was from 280 to 340 γ of the dye. On the second day after vagotomy, the same amount of neutral red was excreted, beginning at the tenth minute, and its concentration increased to 4 mg%; the excretion lasted 5 hours. During this period, twice as much dye (676 γ) was excreted as before the vagotomy, and almost $1\frac{1}{2}$ times as much gastric juice was secreted (Fig. 1).

In the second dog, Faithful, before vagotomy, the injected neutral red, as a rule, appeared after 10 minutes; the maximum concentration was reached in 45-60 minutes, after which it was gradually reduced. Excretion continued, on average, for 4 hours 15 minutes. During this time from 320 to 360 γ of the dye were excreted.

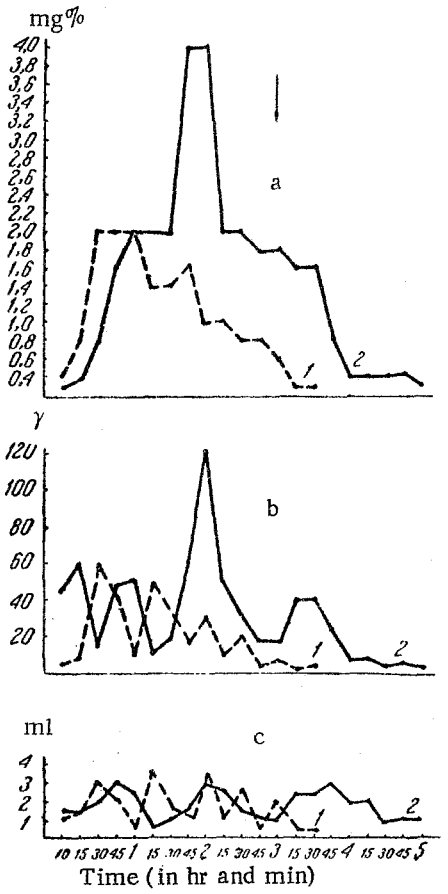

Fig. 1. Effect of bilateral vagotomy on the excretion of neutral red into the stomach (1 day after vagal section). Dog: Al'ma. a) Concentration of neutral red (in mg%); b) amount of dye excreted (in γ); c) amount of gastric juice (in ml); 1) before section; 2) after section. The arrow indicates the injection of 40 mg of neutral red.

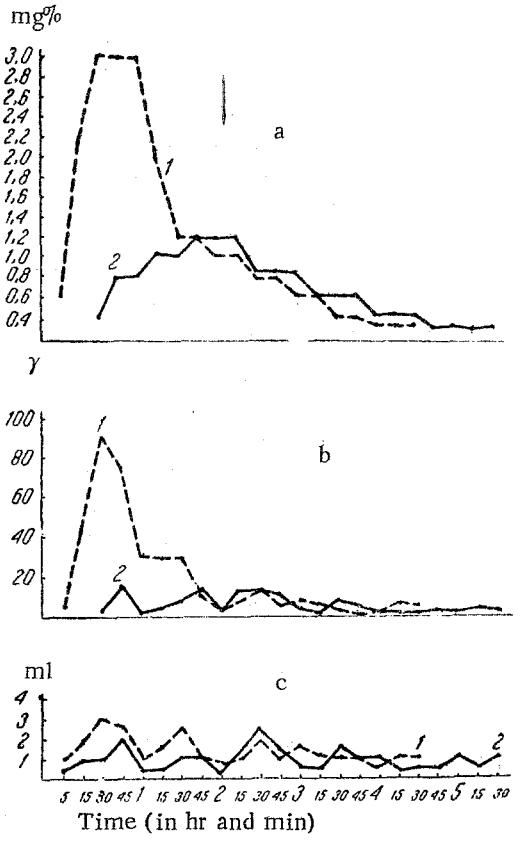

Fig. 2. Effect of bilateral vagotomy on the excretion of neutral red into the stomach (on the 6th day after vagal section). Dog: Faithful. a) Concentration of neutral red (in mg%); b) amount of dye excreted (in γ); c) amount of gastric juice (in ml); 1) before section; 2) after section. The arrow indicates the injection of 40 mg of neutral red.

On the second day after vagotomy, 704γ of dye were excreted, and 43.5 ml of gastric juice secreted, representing an approximately twofold increase in both amounts. Subsequently, there was a marked depression of excretion. In most of the experiments the dye did not appear until 30-45 minutes after the injection, and in some cases the delay was as long as 1½-2 hours. In all the experiments there was a marked reduction in the concentration of the dye, whose maximal concentration did not exceed 1.2 mg%, while the period of excretion was lengthened up to one hour, and in some experiments, up to 1½ hours or more.

In experiments on Al'ma, on the fourth day after vagotomy, the dye did not appear in the gastric juice until 40 minutes after it had been injected; after 1 hour and 25 minutes the maximum concentration of 1 mg% was reached. Excretion continued for 4 hours 45 minutes. During this time, only 108γ of dye were excreted into 16.5 ml of gastric juice, and by the 12th day, the amount had fallen to 97 γ.

Similar results with small variations were obtained on Faithful. We were able to observe gastric excretion for two months after the vagotomy. On different experimental days, there was a considerable delay in the appearance of the dye, and the latent period increased up to 20-45 minutes or more; its concentration did not exceed 1.2 mg%, and the excretory period lasted up to 5 hours 30 minutes (Fig. 2).

We will give the results of the experiments which were the most representative. For instance, on the 14th day after vagotomy, no dye appeared for 1½ hours; subsequently, the gastric contents were stained a pale pink, but the concentration was so low that it was not possible to obtain a reading on the colorimeter. The same con-

centration remained during the whole period of observation, for 5 hours 30 minutes. During this time about 16 ml of gastric juice was secreted.

Similar results were obtained on the 18th day. The dye then appeared after two hours, but was not present in every sample collected subsequently at 15 minute intervals; the concentration was very low. The liberation of the dye continued for 5 hours 45 minutes. In the remaining experiments, the amount of dye excreted on different days varied from 70 to 130 γ.

In some experiments, during the period when the dye concentration in the gastric contents was becoming reduced, some broth was introduced into the stomach through the fistula. Pavlov showed that the broth acts as a chemical stimulant, increasing the work of the gastric glands. Despite the increased gastric secretion, the concentration of dye in the juice was no greater than in the other experiments.

Thus our observations showed that in dogs, after section of both vagi there is a severe impairment of gastric excretion. We may conclude that, as judged by the excretion of dye, gastric excretory function is depressed.

There was no return of gastric excretion during the whole two month period of investigation. Besides the phenomena described, there was also a considerable depression of gastric secretion, but that does not mean that excretion is subordinate to secretion. The fact that the two functions alter in the same direction may indicate a common nervous control.

The facts described above evidently cannot be explained in terms of the condition of the gastric glands themselves, though the effects may be due to morphological changes in the gastric mucosa. The theory that seems to us most plausible is that after vagal section considerable changes occur in the gastric mucosa and its innervation.

In studying the intramural nervous plexus of the stomach, after sectioning both vagi in the neck, we found various pathological conditions both in the ganglion cells and their outgrowths, as well as in the nerve fibers. The most definite changes occurred two weeks after the operation. The dependence on nervous control of various gastric functions, including excretion, is a clear example of the unity of the physiological processes.

SUMMARY

Gastric excretion was studied in two vagotomized dogs in which a Basov gastric fistula had been established. The animals received 4 ml of a 1% aqueous solution of neutral red. The excretion of the dye was not affected by cutting the vagus on one side. When both vagus nerves were divided, there was a marked reduction in excretion. No recovery occurred during the whole two month period of investigation. It is concluded that gastric excretion is under nervous control.

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