THE EFFECT OF EXTENSIVE RESECTION OF THE PROXIMAL AND DISTAL PORTIONS OF THE SMALL INTESTINE ON CANINE GASTRIC SECRETION

B. I. Sabsai

Digestion (Head, Professor S. I. Filippovich), Institute of Normal and Pathological Physiology (Director, Active Member AMN SSSR V. V. Parin), AMN SSSR, Moscow
(Presented by Active Member AMN SSSR V. V. Parin)
Translated from Byulleten' Eksperimental'noi Biologii i Meditsiny, Vol. 55, No. 4, pp. 32-36, April, 1963
Original article submitted March 10, 1962

Resection of the small intestine is quite frequently performed in a number of diseasesof organs of the abdominal cavity. Extensive resection of more than 1 meter length causes widespread functional and morphological changes, chiefly in the gastro-intestinal tract.

The object of the present work has been to study the gastric secretion after extensive resection of the jejunum and ileum.

Some authors [4, 10] have experimented on dogs by inserting a number of fistulae; they found an increased secretion of gastric juice produced in response to a food stimulus, an increased acidity, and a delayed emptying. G. Ya. Odishvili [7] found that in two dogs there was an increase and in two a decrease of gastric secretion and acidity. However, some investigators had at their disposal only dogs in which fistulae had been established (G. Ya. Odishvili had one dog with a Pavlov pouch); they were not in a position to make an adequate study of gastric secretion. Petri [14], using a probe, found that in two dogs the acidity of the gastric juice was reduced between the second and sixth month after extensive resection of the small intestine. At various times after operation, it has been found that patients show either an increased [15] or a decreased acidity [2, 11]. O. A. Dolina [6] found normal acidity in 7 out of 13 patients, and in the others the acidity was increased or decreased G. L. Aleksandrovich [1] found the same effects.

However we must note that a single determination of gastric acidity does not give a complete picture of gastric secretion, particularly if no previous determinations have been made. It is important to note that after extensive intestinal resection a clinical or laboratory study of the secretion of gastric enzymes was seldom made.

Our studies were made on dogs with Pavlov or Heidenhain pouches, or with a Basov fistula. The animals were kept on a normal diet and were fed once per day. The experiments were carried out 18-20 h after the animals had been fed. Normal secretion was established in response to stimuli as follows: 200 g of meat and 200 ml of a 20% solution of hematogen, 2 min sham-feeding with 100 g meat, a subcutaneous injection of 0.5-1 mg histamine, or the injection into the rectum of 100 ml 10% alcohol. We measured the amount of gastric juice liberated during 15 min or 1 h, and determined its acidity and proteolytic activity. Acidity was determined by titration with a 0.02 N NaOH solution, and the digestive power (pepsin content) was made by our modification [9] of Hunt's calorimetric method; the result was expressed in pepsin units (p.u.). After a baseline value of gastric secretion had been obtained, 50-70% of the small intestine was resected. Resection of the proximal portion started 10-15 cm from the junction of the duodenum and jejunum, while the end of the distal resection was at the ileo-cecal angle. The length of the removed and residual portions were measured at operation before resection. The experiments were carried out 2-3 weeks after the operation. Observations were continued up to 11 months.

EXPERIMENTAL RESULTS

Extensive resection of the proximal portion of the small intestine caused considerable changes in gastric secretion. In the dog Seryi in which a Pavlov pouch had been established, after resection of 146 cm of intestine the amount of gastric juice secreted in response to meat rose on an average from 28.9 to 69.9 ml, an increase of 142%. Despite the

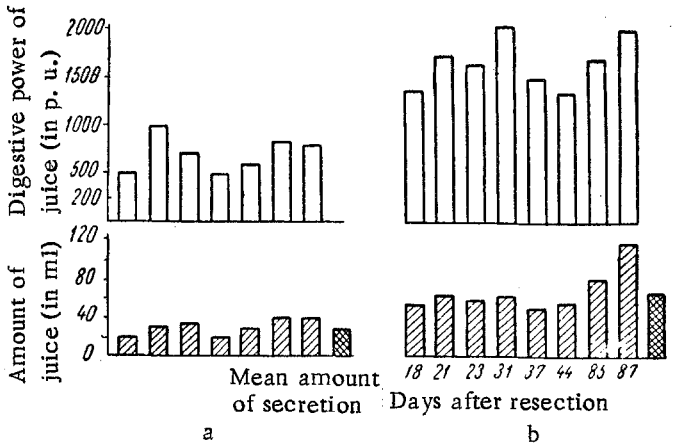

Fig. 1. Gastric secretion in Seryi in response to 200 g of raw meat (a) before and (b) after resection of the proximal end of the small intestine.

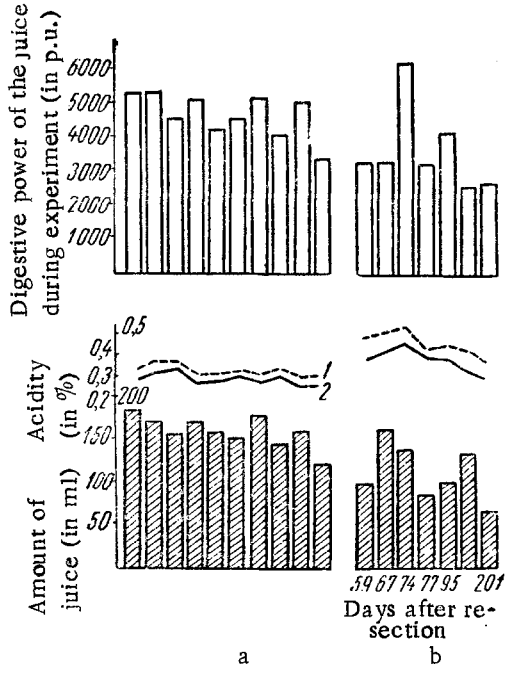

Fig. 2. Gastric secretion in the dog Egoza in response to sham feeding with 100 g meat (a) before and (b) after resection of the distal end of the small intestine.

small increase in the amount of pepsin per ml, the total amount obtained in the experiment rose from 726 to 1691 p.u., i.e., an increase of 133% (Fig. 1). In the same dog, in response to the humoral stimulus hematogen, secretion increased from 18.5 to 27.4 ml (by 48%), the enzyme concentration rose from 10.3 to 24.1 p.u./ml (increase of 134%), while in the total juice obtained during the experiment the amount of enzyme increased from 191.8 to 640.7 p.u., an increase of nearly 3.5 times. In the dog Prima with a Heidenhain pouch, after resection of 128 cm of small intestine the amount of gastric juice and the quantity of pepsin in it secreted in response to hematogen also rose. The increased acidity observed in both dogs was most marked in Seryi.

Studies were made on three dogs (Pirate, Laska, and Lord), in which Basov gastric fistulas had been established; it was shown that after removal of 50-70% of the small intestine the gastric secretion in response to sham feeding or to histamine or alcohol considerably exceeded the preoperational level; the actual lengths of intestine removed were 112, 137, and 118 cm, respectively. The acidity and amount of pepsin/ml of gastric juice showed no appreciable change, but the amount of free HCl and pepsin in the total juice obtained increased considerably. The latent period showed no appreciable change.

Therefore after extensive resection of the proximal portion of the small intestine, in no dog was there any increase in the amount of gastric juice, free HCl, or pepsin secreted in response to the stimulus.

We found rather different conditions after extensive resection of the distal end of the small intestine. In Egoza, in which a Basov fistula was established, extirpation of 188 cm of the distal end of the small intestine caused the amount of gastric juice secreted to fall from 161 to 114 ml (a reduction of 29%). Despite the small (17%) increase from 29 to 33 p.u. in the amount of pepsin/ml, the amount obtained in the juice during the experiment fell from 4800 to 3663 p.u. (a reduction of 24%). The secretion of free hydrochloric acid and total acidity increased by 22-35% (Fig. 2). In the same dog the response to alcohol caused a reduction in the digestive power of the gastric juice, though the amount remained within the range of initial values and the acidity was increased.

In Rusty, which had a Heidenhain pouch, for the first two months after extirpation of 158 cm of the distal end of the small intestine the amount of juice secreted rose on an average from 8.8 to 9.8 ml (by 11%) in response to stimulation with hematogen; the amount of pepsin in the juice rose from 296 to 351 p.u. (by 18%), and subsequently the amount of juice fell to the original value. The amount of pepsin/ml of juice and the amount in the total juice collected and the acidity were somewhat increased for the first eight months of observation (Fig. 3).

In the dog Snow, which had a Heidenhain pouch, resection of 128 cm of the distal end of the small intestine caused a reduction from 10.7 to 6.4 ml (a fall of 41%) in the amount of juice secreted in response to hematogen. Despite the fact that the amount of pepsin/ml of gastric juice rose from 18 to 23 p. u. (an increase of 28%), the total amount obtained during the experiment fell from 176 to 141 p. u. (by 20%). The acidity remained within normal limits. In Rusty and Snow the latent period increased by 60-80%.

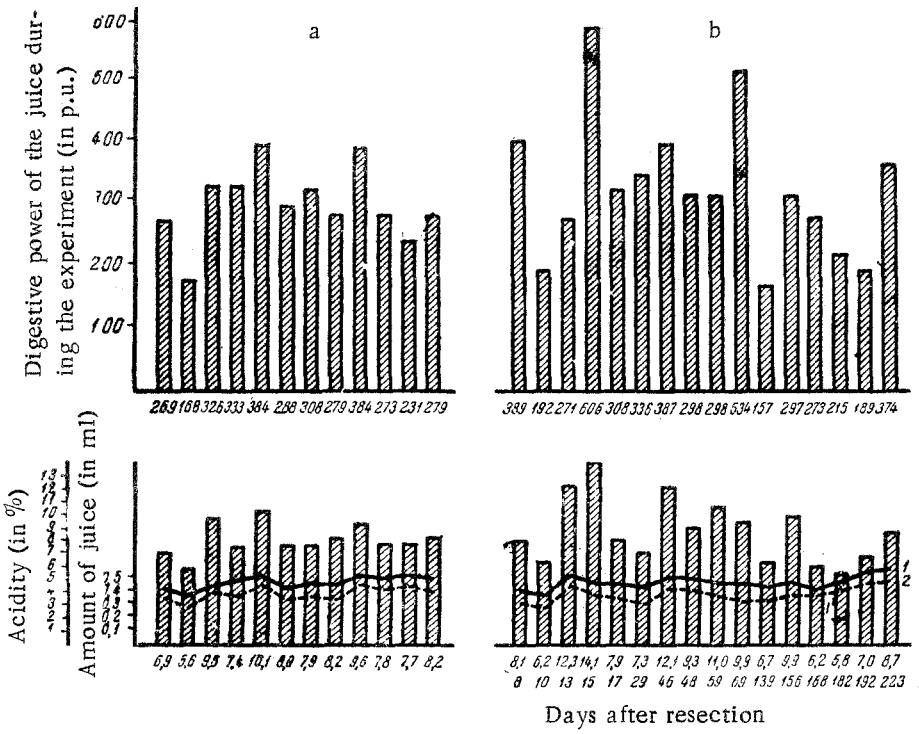

Fig. 3. Gastric secretion in the dog Rusty when given 200 ml of a 20% solution of hematogen (a) before and (b) after resection of the distal end of the small intestine. Indications as in Fig. 2.

The general condition of the dogs was satisfactory. After the operation their weight fell somewhat, but subsequently remained stable. After an initial diarrhea, formed stools were produced. There was no noticeable change in their response to food, and no changes in the blood cells were observed.

These facts indicate that extensive resection of the small intestine causes changes in gastric secretion. After removal of the proximal portion the amount of gastric juice secreted in response to a stimulus was increased, as was also the amount of free hydrochloric acid secreted and the digestive power of the juice. These changes may be attributed to compensatory processes which make for a more complete digestion of the food after a considerable proportion of the digestive tract has been eliminated.

A delayed emptying of the stomach which follows extensive resection of the proximal small intestine may also play some part in enhancing the secretion of gastric juice [5].

Also, the fact that these changes develop in both the first and the second phases of gastric secretion shows that nervous and humoral factors are involved. The results obtained from the action of different stimuli indicate that changes occur both in the central regulatory mechanisms governing gastric secretion and in the functional condition of the secretory apparatus itself (gastric cells and the associated intramural nervous system).

Many authors have shown experimentally that there are reflex connections between the different parts of the intestine and gastric secretion and motility [3, 8]. We may therefore infer that the gastric secretory changes are associated with a change in the reflex relationships between the stomach, jejunum, and ileum, (particularly the ileocecal region).

There is also the possibility of the existence of a humoral mechanism responsible for the gastric secretory changes we have described. It has been reported that gastric secretion is inhibited by a humoral agent (enterogastrone) which enters the blood stream, being liberated when food substances and their breakdown products come in contact with the mucosa of the upper portion of the small intestine [12, 13]. Possibly the enhanced gastric secretion following extensive resection of the proximal portion of the small intestine is due to elimination of the inhibitory influence of enterogastrone.

The differences in the secretory response of the gastric glands after extensive resection of the small intestine are to be attributed to functional and morphological features of the jejunum and ileum and to their reflex connections with the stomach.

We propose next to make an experimental analysis of the mechanism of the changes of gastric secretion following extensive resection of the small intestine.

SUMMARY

Experiments were carried out on dogs with Pavlov or Heidenhain pouches and Basov fistulas. Gastric secretion was studied after resection of 60-70% of the proximal or distal regions of the small intestine. Extensive resection caused gastric changes in both the initial conditioned reflex and subsequent neurochemical phase of gastric secretion indicating the involvement of both nervous and humoral factors. After excision of the superior part of the small intestine there was an increased gastric secretion in response to food, and the acidity and digestive power were also enhanced. In some dogs removal of the distal portion caused some reduction of gastric secretion and an increased acidity and pepsin concentration. These differences were evidently related to the functional and morphological features of the jejunum and ileum and to the nature of their reflex connections with the stomach.

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