

PATHOLOGICAL PHYSIOLOGY AND GENERAL PATHOLOGY

THE SECRETORY FUNCTION OF THE SMALL INTESTINE IN DOGS AFTER RESECTION OF THE STOMACH

COMMUNICATION I. PERIODIC SECRETION

M. S. Martsevich

From the Laboratory of the Physiology and Pathology of Digestion (Head — Prof. S. I. Filippovich) of the Institute of Normal and Pathological Physiology (Director — Active Member AMN SSSR V. N. Chernigovskii) of the AMN SSSR, Moscow

(Received March 27, 1958. Presented by Active Member Acad. Med. Sci. USSR, V. N. Chernigovskii)

The secretory activity of the small intestine after partial resection of the stomach has received inadequate study, in spite of its practical importance.

Of the few papers in the literature dealing with this subject, the majority are devoted to the study of the motor function of the small intestine. Investigations of its secretory activity have been mainly clinical. S. Ya. Mikhlin and L. M. Levitskii [4], for instance, studied the enzyme-secreting function of the small intestine in patients after resection of the stomach for cancer. They found that secretion of intestinal enzymes is increased after this operation, whereas the enzyme content of the pancreatic juice — trypsin and amylase — remains within normal limits and the lipase content is reduced.

A. A. Kardeeva [2] carried out similar investigations in patients after resection of the stomach for gastric ulcer. This author also observed an increase in the intestinal enzymes (enterokinase and phosphatase) after resection of the stomach.

Yu. K. Kvashin [3] observed a fall in certain pancreatic and intestinal enzymes (enterokinase, lipase and trypsin), and an increase in the phosphatase in patients after gastrectomy for cancer of the stomach, in the first few months after operation. At the end of the first year after gastrectomy the secretion of enterokinase and lipase, according to Kvashin's findings, increases and the trypsin content returns to normal.

Certain discrepancies in the results that were obtained were presumed to be due to the fact that none of the above-cited authors were able to examine pure intestinal or pancreatic juice.

Of the experimental work published recently, we are aware of only the researches of S. A. Selezneva [5] and A. I. Aivazyan [1].

The work of S. A. Selezneva was devoted to the study of the motor and secretory activity of the stomach and intestine after resection of various portions of the stomach. In examination of the secretion of the small intestine, only the total quantity of intestinal juice (the periodic secretion and the secretion in response to mechanical stimulation) and the residual solid content of the juice were determined. No changes in the secretion of intestinal juice after resection of the stomach were observed by this author.

A. I. Aivazyan [1] also found no essential changes in the secretion of intestinal juice after resection of $\frac{2}{3}$ of the stomach. No details of the enzyme content were given in this paper.

In connection with investigations carried out by a group of workers from the Laboratory of the Physiology and Pathology of Digestion on the mechanisms of compensation of the functions of the digestive apparatus after exclusion of various portions of the gastrointestinal tract, we made an experimental study of the secretory activity of the small intestine after partial resection of the stomach.

In the present communication we give the results of an investigation of the periodic secretion of the intestine after resection of two thirds of the stomach.

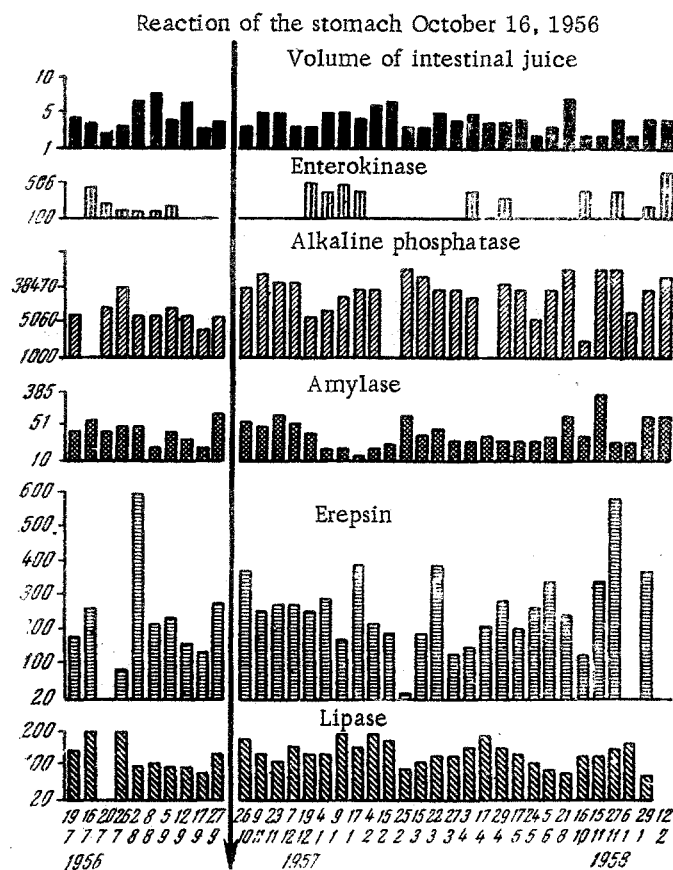


Fig. 1. Changes in the volume of intestinal juice and contained enzymes: enterokinase, alkaline phosphatase, amylase, erepsin and lipase in the dog Laima before and after resection of the stomach.

↓) Moment of resection of the stomach. Below, on the horizontal axis are given the dates of the experiments. On the left, on the vertical axis are given the quantities of the enzymes in conventional units.

EXPERIMENTAL METHOD

The investigations were carried out on dogs in which an isolated segment of the upper part of the small intestine had been fashioned by the Thiry method.

As indices of the secretory activity of the small intestine we selected the secretion of intestinal juice in an experimental period of 4 hours, the ratio of solids to fluid portion and the content of 5 enzymes in the juice: alkaline phosphatase, enterokinase, erepsin, lipase and amylase.

The proportions of solid and liquid parts were determined by centrifugation and subsequent resuspension. The enzymes were estimated in a homogenate by methods devised or improved by the Institute of Nutrition of the AMN SSSR [6, 7].

The results given in this communication were obtained with 4 dogs.

All the dogs, both before and after operation, were kept on a mixed, balanced diet. Food was given 2-3 times a day, in a finely chopped form.

The dogs were systematically weighed throughout the period of observation.

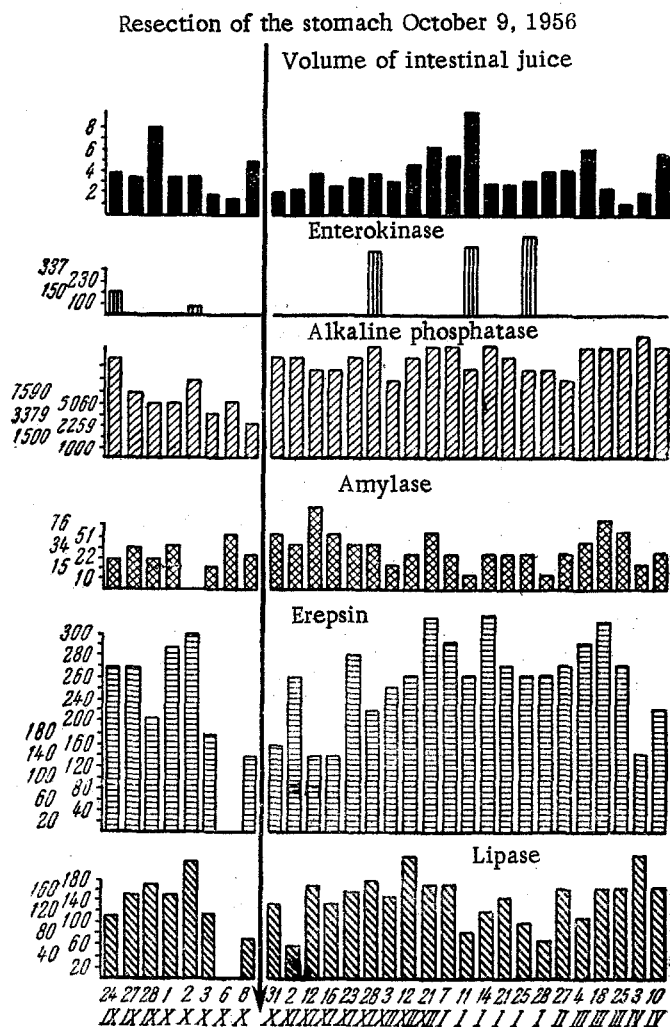


Fig. 2. Changes in the volume of intestinal juice and contained enzymes in the dog Dunai.

EXPERIMENTAL RESULTS

From the investigations which we made the following results were obtained.

The dog Laima was examined 1 year 4 months after resection of the stomach. The dog withstood the operation well. In the course of the first 2 months the weight of this dog fell by 2 kg, and it was then maintained at this level with slight variations on either side.

The results which we obtained during investigation of the secretion of intestinal juice in the dog Laima are shown in Fig. 1. The volume of intestinal juice obtained in the course of an experimental period of 4 hours did not change appreciably after resection of the stomach, i.e. the fluctuations which were observed from day to day after the operation did not exceed those which were present before the resection of the stomach. Nor did we observe any change in the proportions of solid and fluid parts of the juice.

In this particular dog, so far as the concentration of enzymes in the intestinal juice was concerned, we obtained a significant increase in the alkaline phosphatase, which began in the first month after resection of the stomach and has continued until the present time. The same feature was observed with regard to the enterokinase.

The concentration of erepsin and lipase also increased slightly. In the first 2 months after operation a slight increase in the amylase concentration could also be observed.

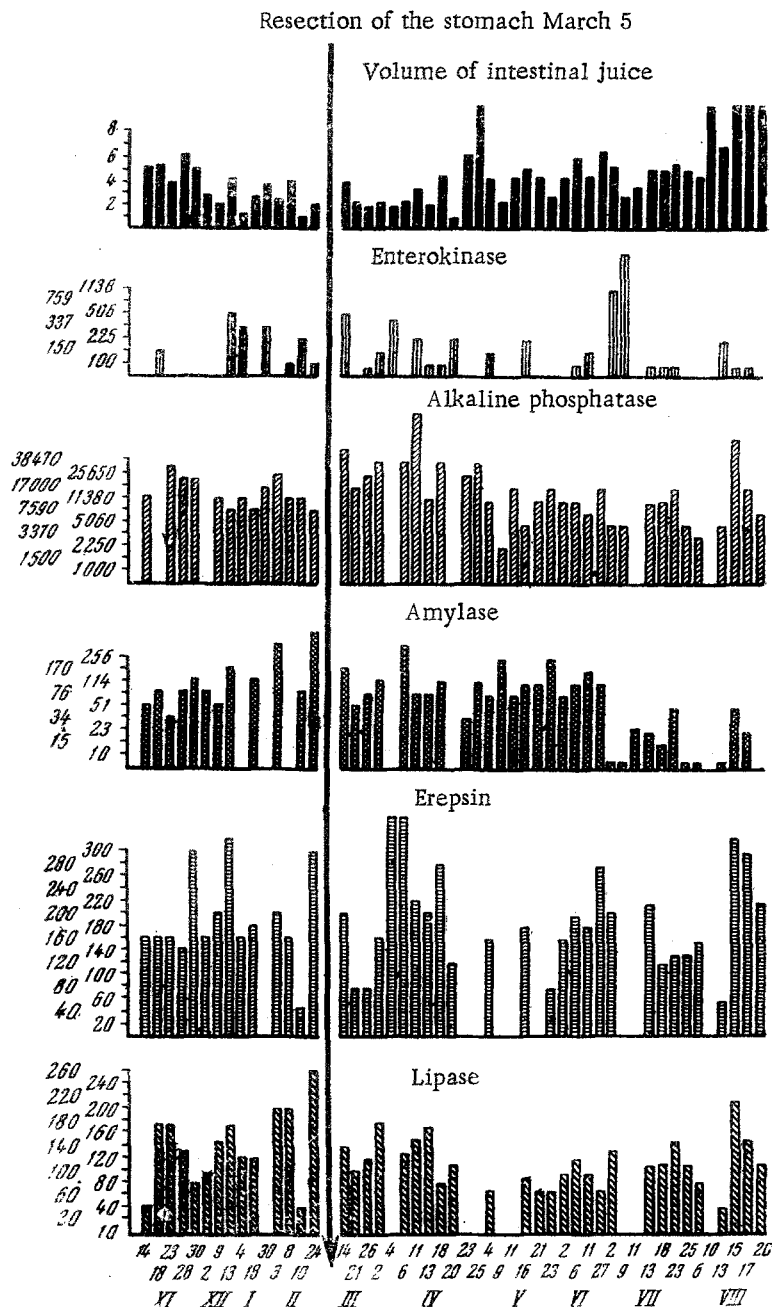


Fig. 3. Changes in the content of intestinal juice and its enzymes in the dog Mirta.

We also obtained similar results with the dog Dunai, which we were able to keep under observation for 8 months after operation. A significant increase in the concentration of phosphatase and enterokinase was observed, together with a small increase in the concentration of amylase in the first 2 months after the operation and, starting with the 2nd month, in that of erepsin. The variations in the concentration of lipase in the intestinal juice of the dog Dunai did not exceed those present before operation (Fig. 2).

In the third dog Anitra we also observed an increase in the concentration of phosphatase, but only in the first 2 months.

At later periods the variations in the phosphatase concentration did not exceed those before operation. A significant increase was observed in the amylase content, beginning with the 3rd month after resection of the stomach and continuing until the death of the dog. The content of the remaining enzymes investigated in the dog Anitra (lipase and erepsin) did not change significantly, according to our findings.

It must be pointed out that in the dog Anitra not two thirds of the stomach was resected, as in the other dogs, but four fifths. After the operation the dog lived for 12 months. The excitation of this dog towards food was sharply reduced. Beginning on the 8th month after resection of the stomach, the dog's weight began to fall progressively, and at the end of the 12th month, the dog died with manifestations of severe cachexia.

The fourth dog — Mirta — survived for $5\frac{1}{2}$ months after resection of the stomach. From the first few days after the operation, the dog's weight fell progressively until the moment of its death. After operation jaundice was observed. The excitation of this dog towards food was reduced.

The volume of intestinal juice and its enzyme content were not appreciably altered, apart from a slight increase in the concentration of phosphatase in the course of the first month after operation (Fig. 3). During the 10 days before the dog's death, when its condition was grave, the volume of intestinal juice increased.

It can be concluded from the investigation that after partial resection of the stomach there is a tendency for the enzyme activity of the "periodic" juice of the small intestine to increase. The degree of increase of concentration of the enzymes after operation is expressed differently in respect of the various enzymes and the individual dogs.

The sharpest increase affected the phosphatase; in 3 of the 4 dogs examined, the increase in its concentration was significant and lasting (for 1 year 4 months); in the fourth dog — Mirta — an increase in the phosphatase was observed only in the first $1\frac{1}{2}$ months. We observed an increase in the concentration of enterokinase in 2 of the 3 dogs examined (not in Mirta). We observed an increase in the concentration of erepsin after operation in 2 dogs; in the other two there was no change. The lipase concentration in the intestinal juice after removal of the stomach rose slightly in 2 dogs and in the other two its variations were within normal limits.

It may be pointed out that the greatest increase in enzyme activity of the intestinal juice was revealed in the dog whose general condition remained good for a long period of time after the operation (Laima). Conversely, in the dog Mirta, whose condition after resection of the stomach was serious, and which died $5\frac{1}{2}$ months later with signs of cachexia, we found no appreciable changes.

It may be thought that the increase, after resection of the stomach, of mainly those enzymes of the intestinal juice which are concerned with the breakdown of protein is directly connected with the severe disturbance of digestion of proteins in the higher portions of the digestive tract, and is, therefore, compensatory in character.

SUMMARY

Data concerning the secretory and enzyme-secretory function of the small intestine after resection of $\frac{2}{3}$ of the stomach in dogs was studied. The amount of the intestinal juice in periodical secretion, the ratio of the fluid to the solid part and the content of the 5 enzymes—enterokinase, basic phosphatase, erepsin, lipase and amylase—were examined.

It was demonstrated that there is a tendency to increased enzymatic activity of the intestinal juice after partial removal of the stomach. The most considerable increase was exhibited by phosphatase and enterokinase. The increase was more pronounced in the dogs, the general condition of which, after the operation, was good.

It is believed that the main increase of the activity occurring in the enzymes which take part in the protein

cleavage is in direct relationship with the acute disturbance of the process of protein digestion in the upper part of the digestive tract and is, therefore, compensatory in character.

LITERATURE CITED

- [1] A. I. Aivazyan, Proceedings of the Second All-Union Conference of Pathophysiologist, 7-8, (Kiev, 1956) [In Russian].
- [2] A. A. Kardeeva, Disturbance of the Function of the Intestine in a Patient after Resection of the Stomach for Peptic Ulcer. Dissertation, (Moscow, 1953). [In Russian].
- [3] Yu. K. Kvashin, Problems of the Reactivity of the Body and the Pathology and Clinical Features of Certain Diseases, 62-72, (Moscow, 1956). [In Russian].
- [4] S. Ya. Mikhlin and L. M. Levitskii, Voprosy Pitaniya, 14, 2, 34-35 (1955).
- [5] S. A. Seleznev, The Motor and Secretory Function of the Stomach and Intestine after Resection of Various Portions of the Stomach. Dissertation, (Leningrad, 1955). [In Russian].
- [6] L. S. Fomina, S. Ya. Mikhlin and G. K. Shlygin, Biokhimiya, 2, 134-138 (1952).
- [7] G. K. Shlygin, Biokhimiya, 6, 509-516 (1950).