

MOTOR AND EVACUATORY FUNCTION OF THE DIGESTIVE TRACT AFTER EXTENSIVE RESECTION OF THE SMALL INTESTINE OF DOGS

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A study of compensation in the digestive system after removal of certain portions of the gut is of both theoretical and practical importance. Nevertheless, until recently but little work had been done on the effect of extensive resection of the small intestine on gastric motility, nor had observations been made on the significance of such changes as representing compensatory or adaptive reactions.

Most published clinical reports (both Russian and foreign) concern individual cases of resection of part of the small intestine, and only indirect or even more remote results of the operation are described [1,3,5-8,10,12,13,16].

Some authors have observed a reduced rate of evacuation from the stomach after partial resection of the small intestine [4, 19, 20], or else a gradual slowing down of the movement of food along the gut [9, 17, 18].

Very few experimental results bearing on this problem have been published. B. D. Stasov [14] and P. P. Bryukhanov [1] observed a reduced rate of emptying of the stomach after partial resection of the small intestine in dogs in which multiple fistuli had been established. G. Ya. Odishvili [11] observed a considerable reduction of the motor and evacuatory function of the stomach, and T. V. Tkeshelashvili [15] found the same effect in the remaining portion of the small intestine, followed by recovery 1-2 months after the operation.

However, the investigation of the evacuatory function of the stomach as performed by the authors named above was made with the fistular method, which cannot give an accurate picture of the changes caused.

The present work concerns a study of the motor and evacuatory function of the digestive tract after extensive resection of the small intestine, and includes an investigation of the significance of this function as a compensatory and adaptive reaction of the digestive system.

METHOD

The experiments were carried out on 6 dogs. The food stimulus consisted of 100 g of minced meat, 100 ml of milk diluted with 50 ml of water, or 150 ml of milk jelly, all mixed with 30-50 g of barium sulfate.

An x-ray method was used to study gastric and intestinal motor and evacuatory function, and the following quantities were noted: 1) the onset of evacuation from the stomach, 2) the time at which the stomach was completely emptied; 3) time for the passage of the "first" portions of food to pass along the small intestine (from the time at which it left the stomach to its entry into the large intestine); 4) time for the passage of the "last" portion of food along the small intestine (from the time at which it left the stomach until the small intestine had been completely emptied); 5) total period for which the food remained in the stomach and in the small intestine (from the start of feeding until complete emptying of the small intestine).

From dogs numbers 1, 2, and 3, 40-50% of the small intestine (distal portion) was removed, and in dog No. 4, 50% of the small intestine (proximal portion).

Dogs Nos. 5 and 6 were equipped with fistulas of the ileum near the ileocecal region (25 cm proximal to it) and, in addition, dog No. 5 had a Basov fistula of the fundus of the stomach.

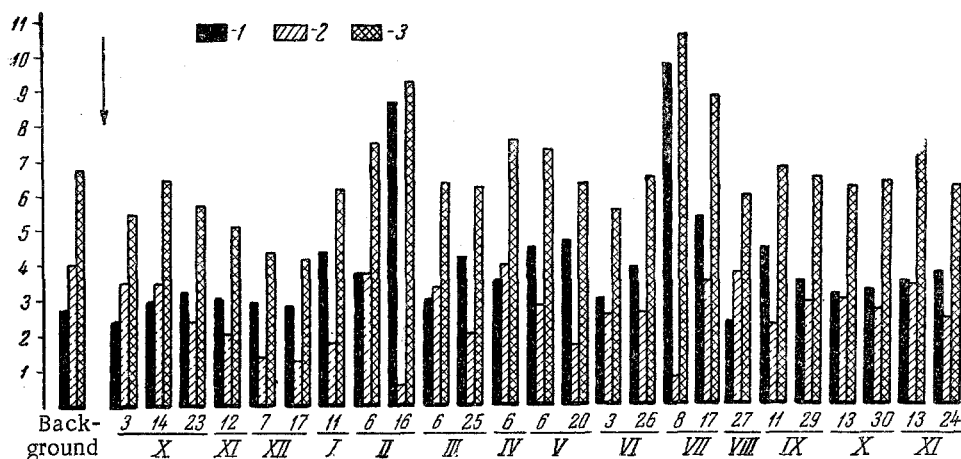


Fig. 1. Emptying of the stomach and the small intestine after partial resection of the small intestine in dog No. 1, fed with milk. 1. Time of emptying of the stomach; 2) time of emptying of small intestine; 3) total time spent by food in the stomach and small intestine. Arrow indicates the moment of resection of the small intestine. Abscissa, dates of the experiments; ordinate, time (in hours).

RESULTS

In the control experiments, when the animals were fed with 100 g of minced meat, the stomach took from 6 h 10 min to 7 h 20 min to empty, and when the dogs were fed with milk jelly, the time taken was from 3 h 40 min to 3 h 45 min.

After extensive resection of the small intestine,* in numerous experiments in all the dogs it was observed that emptying of the stomach was observed when it contained either milk or milk jelly, or more dense food (minced meat).

As can be seen from Fig. 1, in dog No. 1, in the first five months after the operation, emptying of milk from the stomach took the same time as it did in the control experiments. From the 6th month on, emptying of the stomach was slowed in almost all the experiments.

In the last 6 months of observation ($1\frac{1}{2}$ to 2 years after the operation), emptying of the stomach was scarcely delayed at all, or was normal. Emptying of the small intestine was as a rule approximately normal, but if it was taken into account that the length had been reduced by 40%, then the movement of the food along the remaining part was clearly slower. An increased time for the small intestine to empty was observed as early as the first few months after the operation. Experiments in which the food had been retained for a long time in the stomach were exceptions. In these experiments, the movement of the "last" portions of food along the intestine were accelerated.

The experiments showed that the longer the food remained in the stomach, the more rapidly it passed along the small intestine, and, conversely, the more rapidly the stomach was emptied the longer the food was retained in the small intestine (this relationship was observed also in experiments on dogs after partial gastric resection).*

Similar results were obtained on dog No. 1 when studying the other food stimulus — meat.

In experiments on dog No. 2, after resection of 50% of the small intestine, the delayed emptying of the stomach occurred as early as one month after the operation, and the time for the food to pass along the small intestine was also delayed in most cases.

In experiments on dog No. 4, the delayed evacuation of milk from the stomach was observed to occur in the

*The first experiments were carried out not less than 3 weeks after the operation. Observations were continued for from 10 months to $2\frac{1}{2}$ years.

**The results of the investigation of the results of motility and emptying of the digestive tract after partial gastric resection in dogs have been published by us in the Transactions of the Scientific Conference on Problems of the Physiology and Pathology of Digestion (Ivanova, 1960), pp. 131-135, and in Reports of the Fourteenth Scientific Session of the Institute of Nutrition AMN SSSR (1960), p. 36.

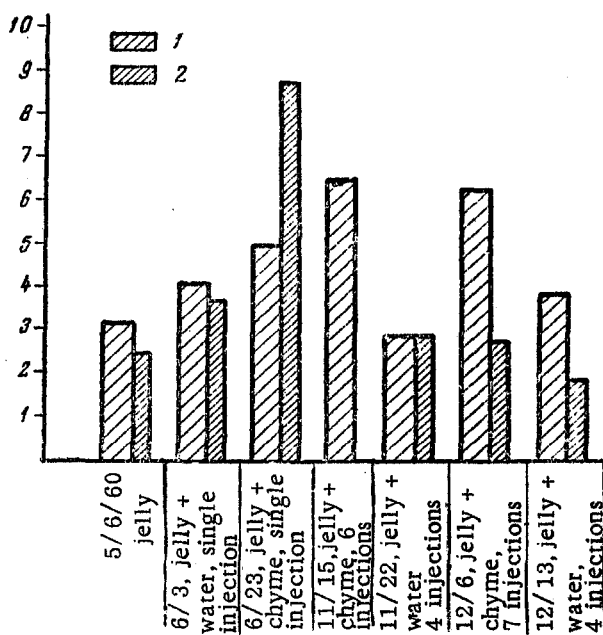


Fig. 2. Emptying of food from the stomach and from the small intestine when chyme or distilled water was introduced into the ileocecal region at the time of feeding. 1) Time required for the stomach to empty; 2) time for food to leave the small intestine. Along the horizontal line, date and conditions of the experiment; vertical line, time (in hours).

slower emptying of the stomach and a slower movement of the food along the remaining part of the small intestine.

In our previous investigations into the motility and emptying of the gastrointestinal tract after partial gastric resection, we found that, as a rule, food left the stomach more quickly.

It must be supposed that one of the causes for the delayed emptying of the stomach after extensive resection of the small intestine was the change in the reflex influences from the ileocecal region to the pyloric sphincter, a change induced by a marked alteration in the properties of the chyme. In order to test this hypothesis, we carried out experiments on two dogs equipped with ileocecal fistulas. Through the fistula, 10 ml of chyme were introduced together with the food, consisting of 150 ml of milk jelly and 30 g of barium sulfate; alternatively, the chyme was given every hour (5-7 times per experiment). It was obtained from a fistula in the upper part of the jejunum of a dog with partial gastric resection, i.e., it was incompletely digested.

As can be seen from Fig. 2, in these experiments the food remained in the stomach for a longer time than with normal feeding, and for longer than it did in experiments in which the same amount of water was introduced into the ileo-cecal region.

Thus, our experiments in which chyme was injected into the ileocecal region showed that the stomach must receive from the mucous membrane of the lower part of the small intestine a considerable number of afferent impulses, which form part of the reflex regulation of gastric motility and emptying. A delay in the emptying of the stomach after extensive resection of the small intestine is to a large extent due to a change in these reflex influences.

The delayed emptying of the food from the small intestine under these conditions appears to be associated with a delay in the passage of the incompletely digested food through the ileocecal sphincter into the large intestine.

SUMMARY

A study of gastric and intestinal motility and emptying was made before and after resection of 40-50% of the intestine (either the distal or the proximal portion was removed). X-ray studies were made. One of the adaptive factors of the digestive tract to the new digestive conditions imposed by the resection was a slower movement of food along the remaining portion of the small intestine.

first few days after the operation; in the first 5 months there was a very slight delay in the evacuation of meat from the stomach, but not in all experiments. Six months after the operation in nearly all the experiments there was a marked increase in the time required for meat to leave the stomach. The time for the "first" and "last" portions of food to leave the intestine was, in most cases, increased, except when the food was held for an unusually long time in the stomach.

In experiments on dog No. 3, as a rule there was no delay in the emptying of the stomach; evacuation of food from the small intestine was delayed as early as 3 weeks after the operation.

Besides studying motility and emptying of the gut, we also made systematic observations on the general condition, appetite, and weight of the dogs. In all of them the operation of resection of half of the small intestine was well tolerated. They remained in good condition for the whole period of observation, their response to food was normal, and apart from a small loss immediately after the operation, which was restored in 2-3 months, their weight remained unchanged.

Thus, one of the adaptations of the digestive tract to the new conditions of development established after removal of part of the small intestine was a

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
