THE ABSORPTIVE FUNCTION OF THE SMALL INTESTINE AFTER SUBTOTAL RESECTION OF THE STOMACH

COMMUNICATION I. CHANGES IN THE ABSORPTION OF GLUCOSE AND WATER BY THE SMALL INTESTINE AFTER PARTIAL RESECTION OF THE STOMACH

L. A. Shekun

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

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This article is part of a complex study being conducted at this laboratory on the problem of compensating functional disturbances of the digestive system caused by various injuries to the latter, particularly by the resection of various portions of the digestive apparatus [1, 5, 12].

Our task was to study the effect of partial resection of the stomach on the absorptive function of the small intestine in dogs. Despite its great importance to theoretical and practical medicine, this question has been inadequately investigated.

The existing research on this problem for the most part concerns the effect of stomach resection on the assimilation of food substances; the authors judge the absorptive powers of the small intestine according to the assimilability of these food substances [6, 13, 14].

EXPERIMENTAL METHODS

We studied the dynamics of the disturbance and restoration of the absorptive power of the small intestine with subtotal resection of the stomach in chronic experiments on 5 dogs. The diet and general maintenance conditions were the same for all the experimental animals. The dogs were given full-value food in pulverized form at the same times every day 2-3 times per 24 hours. The appetite and general condition were systematically observed, and the dogs were weighed once or twice a week.

The operation isolating an intestinal loop and extirpating the stomach (Finsterer's modification of Billroth's operation No. 2) was performed on the experimental dogs by N. Sh. Amirov.

The effect of stomach resection upon absorption was studied by two different methods. The dynamics of normal glucose absorption and of glucose absorption at different intervals after the resection was studied on two dogs (Naidenysh and Laima) by introducing glucose into the digestive tract (in a dose of 2 g per 1 kg of animal weight) and determining the dynamics of its concentration in the blood. Blood was taken from the vena saphena parva on an empty stomach and then 15, 30, 45, 60, 90 and 120 minutes after ingestion of the glucose. The blood sugar was determined by the Hagedorn-Jensen method.

The absorptive function of the small intestine was studied on an empty stomach on four dogs (Laima, Trezor, Lokhmach, Sulak) with sections of the upper portion of the small intestine isolated according to Thiry and Thiry-Vella. Water and 0.5-1% solutions of glucose were used as the experimental substances. Fifteen ml of the experimental solution was introduced for a period of 7 minutes into the isolated intestinal loop (15-20 cm). The temperature of the experimental substance and of the water used for washing the intestine was constant at 37°.

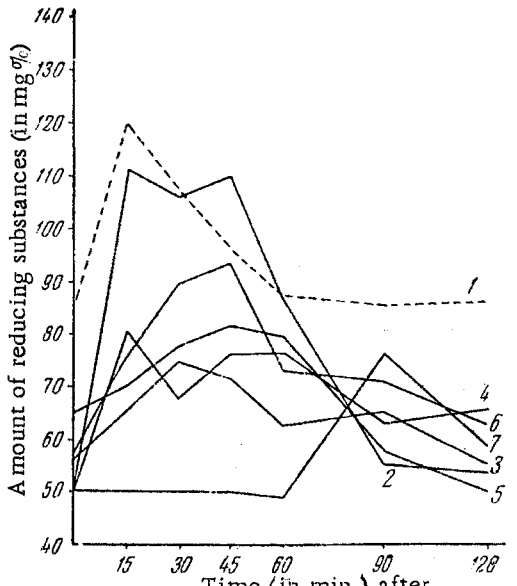

Fig. 1. Glycemic curves of the dog Naidenysh, normally and after resection of the stomach (experiment from May 8, 1956 to March 24, 1958).

1) norm; 2, 3, 4, 5, 6, 7) at different intervals after resection of the stomach (experiment begun May 8, 1956). Ordinate axis represents sugar, in mg%; abscissa axis represents time, in minutes.

The glucose content of the experimental fluids was also determined by the Hagedorn-Jensen method. The amount of absorption was determined from the amount of experimental substance absorbed from the isolated intestinal loop during the 7-minute period and was expressed in percent of the amount of substance administered. By comparing the amount of glucose and water absorption and character of the variations observed in these indices at various intervals after resection of the stomach with the fluctuations in absorption observed in the background experiments, we could estimate the changes in the absorption of these substances caused by resection of the stomach.

EXPERIMENTAL RESULTS

The first of the methods we used to study the character of glucose absorption after resection of the stomach showed that the glycemic curve and the blood sugar level changed considerably after the resection, but these changes were not the same in the two dogs. In Naidenysh, for example, there were more acute disturbances in the blood sugar content and in the character of the glycemic curve. After resection and on an empty stomach, the blood sugar level had decreased sharply. The normal blood sugar in this dog being 80-90 mg%; after the resection, the content decreased during the first month to 50 mg% and remained at 50-60 mg% for 7 months. One to one and a half years after resection, the blood sugar as determined on an empty stomach rose to 90-95 mg%, then decreased sharply again to 50 mg%. Sugar-loading after resection caused, in a large mjaority of cases, a slower increase of the curve to the maximum. A year and 10 months after the resection, glucose was only observed in the blood 90 minutes after its per os administration, the glucose content increasing to 77 mg% (Fig. 1, curve 7).

In the dog Laima, the glycemic curve changed after resection of the stomach, but not in the same way as in the dog Naidenysh. The normal blood sugar content on an empty stomach was 70-80 mg% in Laima; the blood sugar level did not fall after resection of the stomach, but remained at the original level for 1 year and 5 months. Even after sugar-loading, Laima's glycemic curve remained relatively high and was not as pathologic in character as that of Naidenysh (Fig. 2).

Resection of the stomach was well tolerated by the two dogs, Naidenysh and Laima. However, the first week after the operation, Naidenysh sustained a weight loss of 3300 g and another of 1200 g during the second week. Although Naidenysh's general condition was satisfactory, great fluctuations in weight and food excitability were subsequently observed in this dog. During the 23-month observation period, he lost 9350 g, or 42% of his original weight. No sharp decrease in weight was observed in Laima. The dog lost 2 kg during the first two months after the resection, but thereafter none of the sharp variations in weight and food excitability which were observed in Naidenysh were observed in Laima. During the 17-month observation period, Laima lost 3 g, or 19% of her original weight.

According to the well-documented literary data, considerable variations in the blood sugar level and in the character of the glycemic curve are known to take place after resection of the stomach.

It is known that, after resection of the stomach, when food enters directly into the jejunum not only carbohydrate absorption is disturbed, but also the metabolic functions of the liver, especially the glycogenic. It is therefore impossible to conclusively determine the absorptive ability of the small intestine according to the sugar level in the peripheral blood. Therefore, we went on to study absorption in isolated loops of the jejunum.

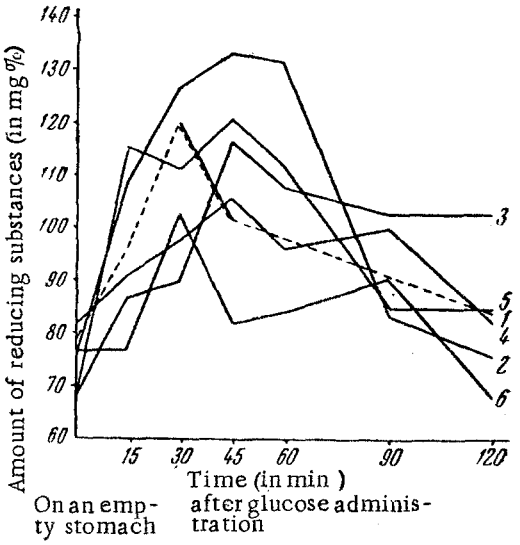

Fig. 2. Glycemic curves of the dog Laima, normally and after resection of the stomach (experiment from October 16, 1956 to March 26, 1958). 1) norm; 2, 3, 4, 5, 6) at different intervals after resection of the stomach (October 16, 1956).

Many investigations [2, 3, 4, 7, 8, 9, 10, 11] have demonstrated the possibility of studying the absorptive function of the small intestine normally and under various pathologic conditions on isolated sections of the jejunum.

Data illustrating the effect of stomach resection on glucose and water absorption by an isolated intestinal section is given in Figure 3.

As Figure 3 shows, stomach resection caused, in the dog Laima, the degree of glucose absorption to decrease during the first month to 25-30% (original level – 50-60%); this index then increased to 60-70% and thereafter remained within normal limits. In this dog, as Figure 3 shows, resection of the stomach increased the absorption of water to 40% during the first month (original level – 20-30%); water absorption then remained high for a long time, 75-85% with occasional drops to 40%.

From Figure 3, one can see that in Trezor (II), glucose absorption was 60-80% before resection. Glucose absorption was within normal limits on the 13th day after resection (75%). Three weeks after the operation, it decreased to 30-50%. Then it became almost normal for a month. Normal water absorption in Trezor was 15-20% (Fig. 3). On the 17th day after the operation, water absorption had increased to 35-45%; it then remained at this level.

Glucose absorption was 50-70% in the dog Lokhmach before the operation. This index decreased to 25-30% for two months after the resection, then increased and settled within the normal range.

Normal water absorption in Lokhmach was 25-40%. This increased to 60-65% during the first month after the resection and then to 65-75%, where it remained for four months. Subsequently, it decreased to 40-50%, approximating the original level.

In the dog Sulak, glucose and water absorption remained low both before and after resection of the stomach, especially after the operation. The normal glucose absorption in this dog was 10-20%; it decreased to 5-7% after resection of the stomach and remained at this level for two months, after which it rose to 15%. Water absorption in Sulak was 10-20% before the operation. One month and 16 days after the resection, it increased to 20-35%, where it remained for 7 months. After this, sharp variations in the amount of water absorption were observed – it would increase to 60%, decrease to 8% and then rise again to 30-35%. It should be mentioned that Sulak sustained a weight loss of 4 kg during the first month after resection of the stomach. Variations in weight and food excitability were subsequently observed in this dog. Beginning the tenth month after the operation, food excitability declined sharply; the dog often refused to eat and after $11\frac{1}{2}$ months was killed in an extremely emaciated condition, having lost 50% of his original weight.

As the data presented show, the changes in the dynamics of glucose and water absorption caused by resection of the stomach were expressed to different degrees in the different experimental dogs.

Therefore, the experiments conducted on isolated intestinal loops showed that stomach resection caused the amount of glucose absorption to decrease during the first month after the operation and that this index then increased and fluctuated within normal limits (with observations lasting from 3 months to $1\frac{1}{2}$ years). Water absorption was considerably increased by the operation and remained so for a long time.

When the character of the glycemic curve after the per os administration of glucose is compared with glucose absorption in an isolated intestinal section (dog Laima), it is evident that the glycemic curve shows more pronounced changes after resection of the stomach; this seems to be connected with the fact that, as we have already mentioned, the glycemic curve reflects more than the glucose-absorbing function of the intestine.

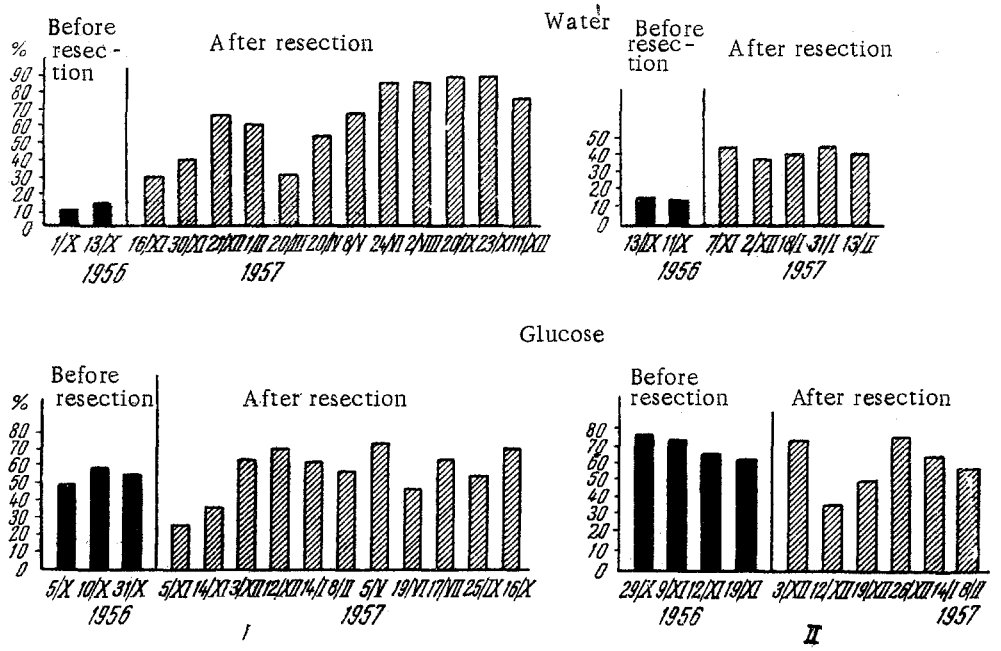

Fig. 3. Glucose and water absorption in the dogs Laima (I) and Trezor (II). Ordinate axis represents the amount of glucose and water absorption in percent of the quantity administered; the abscissa axis represents the days of the experiments (date).

At the same time, our experimental data showed the absorption of glucose and water, the blood sugar level and the character of the glycemic curve depend on the general condition of the dog after the resection of the stomach.

SUMMARY

The author describes the effect of partial resection of the stomach on the absorptive ability of the small intestine. Experiments were performed on dogs by 2 methods. The dynamics of glucose absorption were studied in normal conditions and at various time periods after resection of the stomach. Experiments were conducted by the administration of glucose into the digestive tract and subsequent study of the glycemic curve. The absorption function of the "fasting" small intestine was examined in 4 dogs with the isolated section of the superior portion of the small intestine by Thiry's and Thiry-Vella's methods. 0.5-1% glucose and water were given as "test meals". Experiments conducted by the first method demonstrated that after stomach resection, the blood sugar level (before meals) and the character of glycemic curve show considerable changes, but the changes are different in these two dogs. Experiments carried out on isolated intestinal sections show that as a result of stomach resection, the glucose absorption decreases during the first month after the operation, then rises and stays within the normal limits. The dogs were observed for from 3 months to 1½ years. Absorption of water is greatly increased after resection and remains in this condition for a long time. The absorption of glucose and water, as well as the blood sugar level and the character of glycemic curve, depends on the general condition of the animal after stomach resection.

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