

THE ABSORPTIVE POWER OF THE DIGESTIVE TRACT AT VARIOUS TIMES AFTER PARTIAL RESECTION OF THE SMALL INTESTINE

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Many experimental and clinical studies have shown that after partial resection of the small intestine various changes in the activity of the digestive tract may occur, in particular a change in the absorptive power, which may be either enhanced or reduced. Many authors have regarded an increase in the absorptive power as a compensation for the disturbed function of the digestive tract.

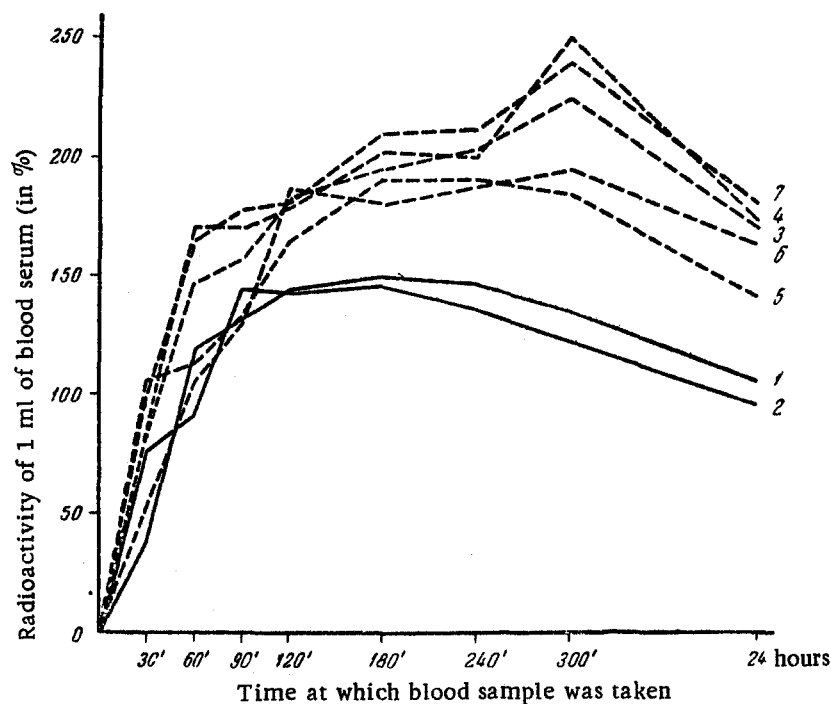


Fig. 1. Absorption of methionine- S^{35} from the digestive tract in the dog Dik. 1, 2) Control experiment; 3) 1 month; 4) 1 month, 17 days; 5) 4 months; 6) 7 months, 15 days; 7) 13 months after the operation.

Most investigators have estimated the absorptive power of the digestive tract in terms of its uptake of food substances, or from the chemical composition of the chyme obtained from different sections of the intestine [1-4, 8-14]. Most of the studies were made by observations continued for a comparatively short period after operation. It has been reported that after partial resection of the small intestine there is frequently a protein insufficiency [1,10,13].

In the present investigation, a study was made of the uptake of methionine- S^{35} from the digestive tract, and of its rate of disappearance from the blood and its rate of uptake into the serum proteins at different times after partial

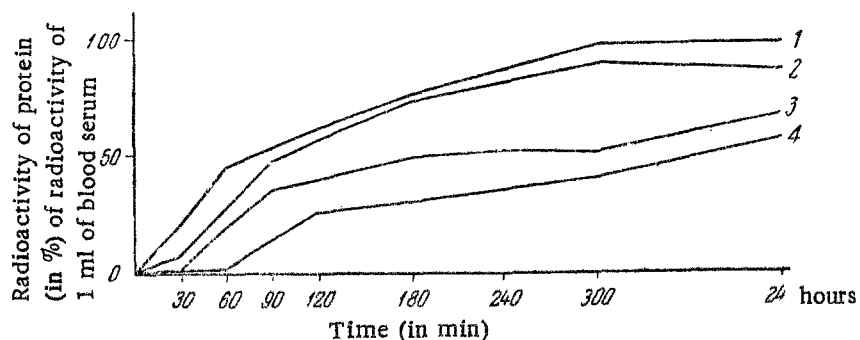


Fig. 2. Rate of uptake of methionine- S^{35} into blood proteins, in the dog Dik. 1) 1 month, 17 days; 2) 4 months; 3) 7 months, 15 days; 4) 13 months after the operation.

resection of the small intestine. Over a period of many years we have accumulated a large amount of experimental material [5,6], which has shown that a study of the rate of uptake of sodium phosphate ($Na_2HP^{32}O_4$) is a useful test for investigating the absorptive power of the digestive tract and the functional condition of the liver. Therefore, in order to describe further the absorptive power of the digestive tract after partial resection of the small intestine, we have used radioactive sodium phosphate.

METHOD

Resection of the upper portion of the small intestine was carried out in 3 dogs. In Kutsii and Buyan, 150 cm of the upper portion of the small intestine was removed, and in Dik, 102 cm. Control experiments were carried out before operation on the dogs Kutsii and Dik, and on 3 intact dogs.

Methionine- S^{35} (150-200 impulses per g weight of animal) was given on an empty stomach 18 hours after feeding. The total volume of fluid introduced was 150 ml (50 ml of milk and 100 ml of water). Samples of blood were taken at accurately measured time intervals (after 15, 30, 60, 90, 120, 180, 240, 300 min, and after 24 h) from the small saphenous veins, while the animal was standing. The blood was centrifuged, and 0.2 ml of the serum was placed on an aluminum target, which was dried in air. To study the rate of uptake of methionine by serum proteins, in parallel tests, the protein was precipitated with a 10% trichloroacetic acid solution, and the precipitate formed washed with 3-5% trichloroacetic acid. The protein precipitate was dissolved in a 10% ammonium solution, and transferred quantitatively to a perspex target. At the same time, a standard methionine- S^{35} solution was made by adding to it 0.2 ml of serum or of dissolved protein. The radioactivity of the samples was measured on a type B instrument having an end-window counter. The radioactivity of 1 ml of the serum was then expressed as a percentage of the radioactivity of the methionine injected per g body weight.

Experiments with the injection of $Na_2HP^{32}O_4$ were carried out on the same dogs under similar conditions. In the serum, measurements were made of the total phosphorus and of its radioactivity. The specific activity of the blood serum was determined by the method described previously [5].

RESULTS

Figure 1 (dog Dik) shows the results of 5 experiments and 2 controls carried out at various times after partial resection of the small intestine. In the control experiments, after methionine- S^{35} had been given, the increase in the radioactivity of the blood occurred after 60-120 min, and attained a level of 120-140%.

In the experiments carried out after partial resection of the small intestine, the radioactivity of the blood was higher than in the control experiments; in many cases, the maximum radioactivity was observed after 300 min. Twenty-four hours after the methionine injection, the radioactivity fell, but remained above the mean level of the control experiments.

The rate of uptake of methionine into serum proteins fell steadily during the time after the operation. The amount of methionine incorporated in the blood proteins remained reduced also on the day after the methionine injection (Fig. 2).

Similar results were obtained on the dogs Kuts and Buyan.

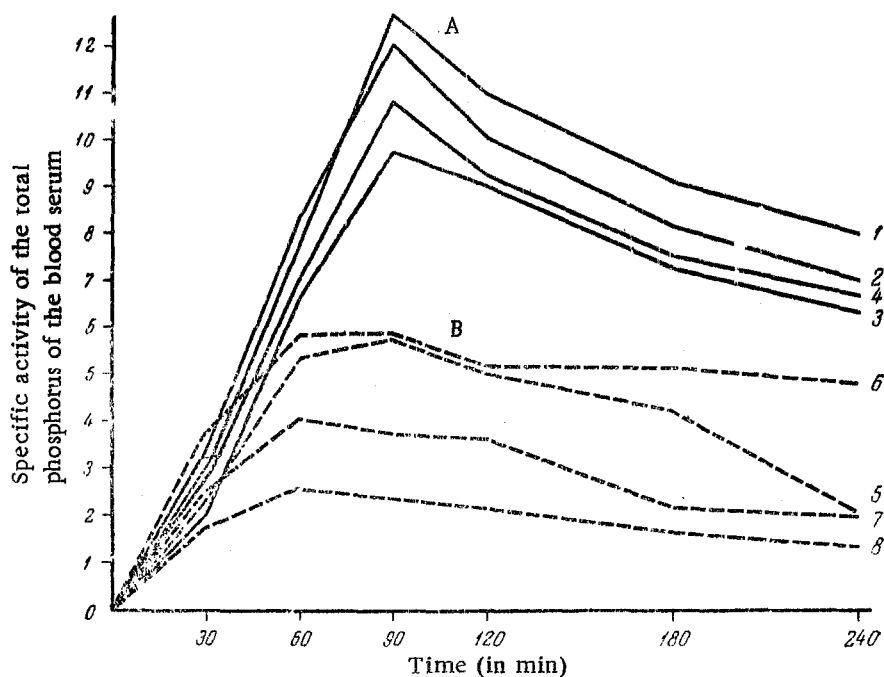


Fig. 3. Absorption of sodium phosphate ($\text{Na}_2\text{HP}^{32}\text{O}_4$) from the digestive tract. A. 1-4) Control experiments on intact dogs. B. Experiments on the dog Dik: 5) 1 month; 6) 5 months; 7) 8 months; 8) 14 months after the operation.

The observed changes in the methionine metabolism after partial resection of the small intestine depend both on the increased absorption of this substance from the gut and on its impaired utilization by the body (the latter influence being evidently the more important). These mechanisms are indicated by the high level of radioactivity of the blood during the whole of the experiment and during the days after it had been given, and by the reduced rate of uptake of methionine by serum proteins, indicating a reduced synthesis of plasma proteins.

The following results were obtained during a study of the rate of uptake of $\text{Na}_2\text{HP}^{32}\text{O}_4$ in the digestive tract after partial resection of the small intestine. In the first experiments, carried out 1 month after the operation, the absorption and utilization of radioactive sodium phosphate differed from the values in the controls. The indices of the specific activity of total serum phosphorus were low, and the slope of the curves was small. At later times, after the operation, the specific activity of the blood serum fell further (Fig. 3); it was close to the specific activity of the blood serum which we found [6] in dogs with pathological liver changes.

Post-mortem examination of the dogs with resection of the intestine established the following points. The liver was enlarged and hyperemic. In Dik and Kuts the stomach was increased in volume and atonic; in Buyan, the atony of the stomach was less marked. In all 3 dogs the remaining part of the small intestine was thickened, and the mucous membrane was hyperemic. There are several reports [7, 13, 14] of pathological liver changes after removal of one or another part of the small intestine. Further investigation will reveal the extent of the morphological liver changes in the experimental dogs. Possibly, the degree of the gastric atony which we found influenced the absorptive power of the digestive tract.

Evidently the changes in the methionine and sodium phosphate metabolism which we observed did not directly affect the general condition of the animals, because, throughout the whole of the experiment, appetite and weight were maintained.

The experiments showed that after resection of 50% of the small intestine (upper part) there was a change in the rate of absorption and utilization of methionine and sodium phosphate. These changes increased with length of time after the operation (observations were continued for 14 months).

The described disturbances of absorption from the gut may be the cause of the complications observed in human subjects after resection of the small intestine.

SUMMARY

A study was made in dogs of the effect produced by resection of the superior portion (amounting to 50%) of the small intestine on the absorption from the digestive tract of methionine S^{35} and on its rate of utilization by the blood, and on the rate at which it was incorporated into the serum proteins. In similar experiments, a study was made of the changes of $Na_2HP^{32}O_4$ absorption from the digestive tract, and of its utilization by the body. Considerable changes were observed in the rate of absorption and utilization of methionine and sodium phosphate. The changes increased with time. Observations were continued for 14 months.

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