A FUNCTIONAL CONNECTION BETWEEN THE THYROID GLAND AND THE STOMACH

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Although numerous investigations [1, 3, 4, 9 and others] have dealt with the functional connection between the endocrine and digestive systems, insufficient work has been done.

Experiments have as a rule consisted in observing a particular function of a digestive organ (especially the stomach) and its relationship to disturbed function of the endocrine system, including the thyroid gland. For example, many authors have studied the motor activity of the gastrointestinal tract in relation to disturbance of function or removal of the thyroid [2, 8, 13 and others]; some workers have studied the secretory function of the stomach [10, 11, 12, 16 and others]. The variation in the results are probably to be attributed to the fact that experimental conditions have not been the same.

We think that to obtain a complete picture of the relationship between the functional condition of the stomach and the glands of internal secretion a simultaneous study is required of the secretory, motor, and evacuatory gastric functions.

A. G. Kratinov [5] has shown that in different dogs, a single function of the gastrointestinal tract may change in quite opposite ways in response to the same stimulus. Results obtained by R. I.Levina [6] show considerable individual differences of evacuatory function, and a great variability in the responses of a given set of animals. A. E. Levin and N. I. Shtel'makh [7,15] have pointed out that when thyroid function is impaired the response of the gastric glands to a food stimulus are of a parabiotic type.

Following up these results we have come to the conclusion that a study of the physiological condition of the stomach in relation to various changes in the function of the endocrine glands should be made on the same animals. We have then considered the results statistically: gastrointestinal disturbance is found in 70% of patients in which the fundamental illness is an impairment of thyroid function.

EXPERIMENTAL METHOD

For the experiment we used 6 dogs with a Pavlov pouch formed by Solov'eva's method, and equipped with a Basov fistula. The animals were kept on a mixed standard diet soup made from 250 g of meat, 250 g of oatmeal mash, and 250 g of black bread. At first in healthy dogs we measured the normal levels of secretion, motility (digestive motor function and periodic activity of the empty stomach), and emptying of the stomach. When sufficient measurements had been made to determine the initial conditions, two dogs were kept as controls and the remaining four were given 0.5 g/kg of thyroidin. The time for which the thyroidin was taken was 50 days. The effectiveness of the action of the preparation was judged by the loss in weight. As food stimuli we used raw meat (0.5 g), and 200 ml of 10% [illegible]. The acidity of the gastric juice was found by titration with a 0.1 N solution of alkali, and the digestive power [illegible]. Gastric motility was recorded by means of an air and water system. As a [illegible] we used a [illegible], We made our own modifications of the method of recording gastric [illegible] with sufficient degree of accuracy to compare the strength of the gastric contractions on various days of the experiment, even when they were separated by a time interval of several months. Observations on the periodic motility were continued for 6-8 h.

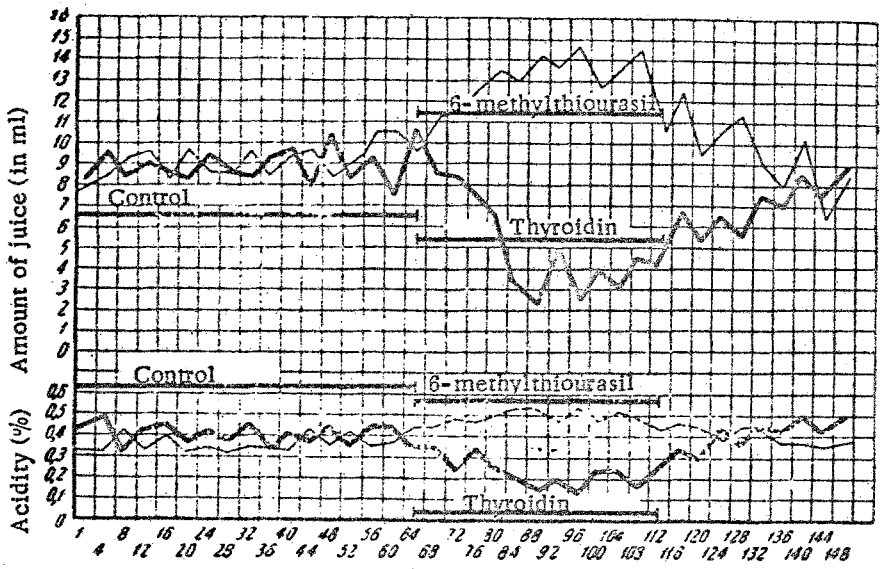

Fig. 1. Secretory function of the gastric glands of the dog "Dzhul'bars" after it had been given 200 ml of 10% hematogen solution. Control experiments, hyperthyroidism, and hypothyroidism.

Gastric emptying was studied by measuring the volume of the remaining contents. The animals were fed with 250 ml of milk jelly, and the "dead space" of the system was 50 ml; thus, the original amount of jelly subject to evacuation was taken as 200 ml.

Ten months after cessation of the thyroidin treatment, when all indications were that the dog had returned to the original condition, between spring and summer a second set of experiments was started in which the dog was given 6-methylthiourasil instead of thyrodin (four times up to 50 days), the daily dose being 50-60 mg/kg. The animals were weighed regularly; thyroid function was measured by means of the isotope I^{131}; in other details the experiments were performed as they had been previously.

EXPERIMENTAL RESULTS

To determine the original level of secretory activity of the gastric glands we determined the secretory response to hematogen, and took the mean results of 9-17 experiments. The values obtained for the different dogs were: 7.2, 9.7, 10.4, 13.6, 13.9, and 14.1 ml. In most of the dogs the total acidity of the gastric juice varied between 0.37 and 0.52%, and the free acid from 0.37 to 0.43%; in dog No. 2 the acidity was reduced, the corresponding figures being 0.15-0.18, and 0.13-0.15%, respectively. The digestive power varied between 3.2 and 5.2 mm of protein bacillus, and the latent period from 5 to 9 min. The periodicity of the empty stomach was well shown in all the dogs, and the transition from phases of relative rest to motility was well marked. The period of rest varied from dog to dog from 79 to 98 min, and the active periods from 18 to 25 min. In control experiments the variation and the duration of the different periods was ±3-17 min for rest, and ±1-5 min for activity.

The rate of evacuation of milk jelly varied from 40 to 105 min.

After thyroidin had been given, from the 3-5th days onwards there was a very definite change in the functions investigated which in some dogs became significant by the 8-10th day (Fig. 1), and in others after the 15-18th day. At this time the body weight began to fall.

During this period the amount of juice liberated fell to one-half or one-third (in one dog to one-fifth) of the original amount liberated in the control experiments. The latent period rose in the different dogs to 13-49 min. Acidity was reduced and never exceeded 0.38%, and there was a relative increase of bound acid; the digestive power showed no change, but a count showed a marked reduction in the number of enzyme units.

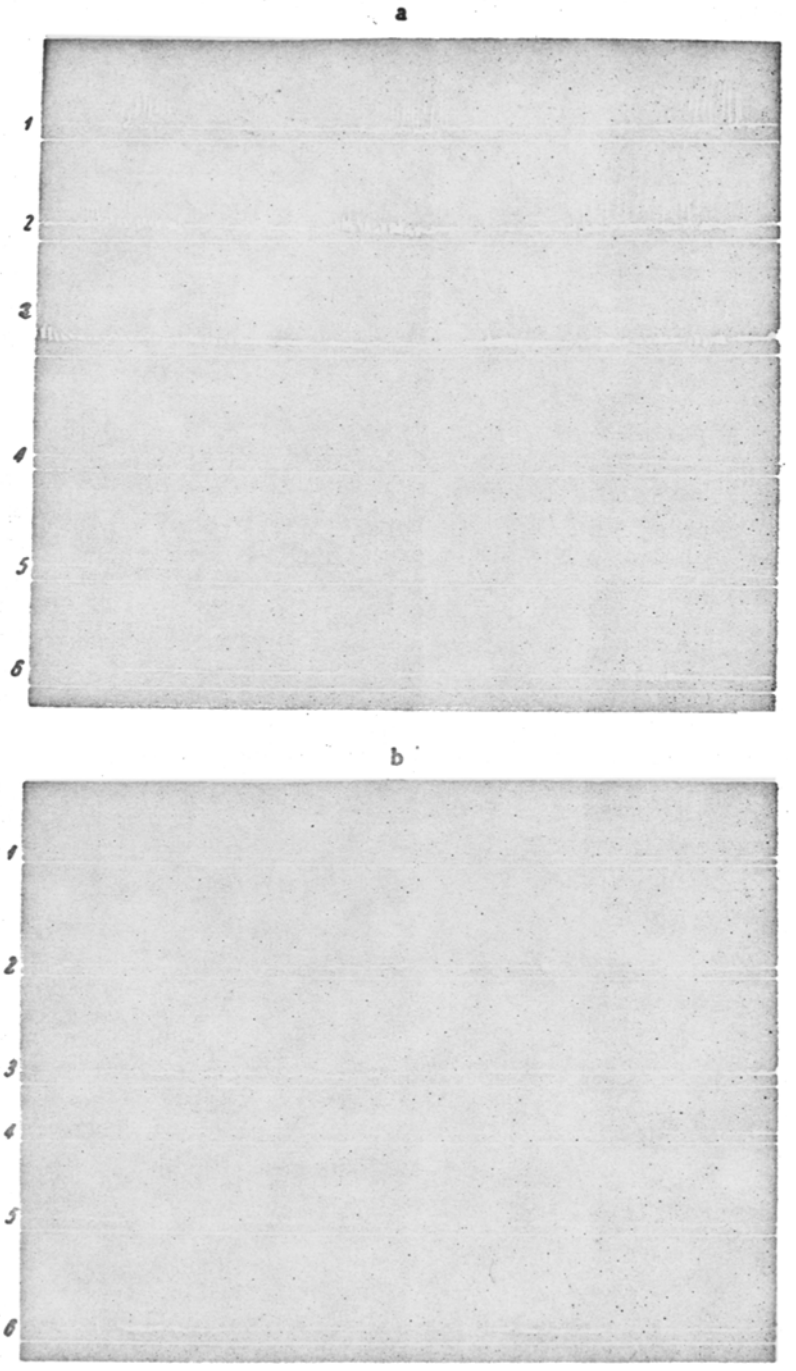

Fig. 2. Change in the periodic activity of the empty stomach during experimental hyper- and hypothyroidism in the dog Pal'ma (A) and Artosha (B). 1) Periodic activity of the empty stomach in the control; 2, 3) in hyperthyroidism; 4, 5, and 6) in hypothyroidism. Time marker (5 min).

There was also a change in the shape of the gastric secretion curve: the rate of secretion was reduced and the curves were shifted to the right.

As thyroid hyperfunction increased so also did gastric motility and emptying rate. It is known that in most cases these two functions alter together. When the thyroid was overactive motility was increased and it emptied

more rapidly. Only in one dog was the evacuation rate increased by as little as 10-15%, in all the others it was emptied twice as fast as normally, or more rapidly still. With regard to the periodic contractions of the empty stomach, this interesting phenomenon did not occur but instead there was an irregular motility which could only be described as chaotic. No trace remained of the regular alternation of periods of rest and motility (Fig. 2, A and B, 1). Very occasionally and for a short time the stomach entered a period of relative rest: most of the time there were gastric contractions of various strengths and rates, and the strength of the individual contractions was many times greater than the strongest contraction recorded in the control experiments (Fig. 2, A and B, 2 and 3).

The functional disturbances we have described as occurring during the period when thyroidin was given continued to increase, though the increase was not continuous: in some of the animals, superimposed on the general disturbance of gastric activity, there were signs of a return to the original condition. This tendency occurred during the second half of the period when the thyroidin was taken. Thus, the mean values of the total amount of gastric juice secreted in the second half of the period was 30-40% of that secreted in the first half. In the periodic activity of the empty stomach there was also an "improvement": there were periods of rest, but they were short and showed no regular alternation; the strength of the gastric contractions was somewhat reduced.

The changes observed to occur when the dogs were given 6-methylthiourasil in the food were the opposite of those which have been described previously. Even during the first days of taking this substance there was an increase of gastric secretion, though it was not so marked as when the thyroidin was taken, amounting to 58-76% of the original value; the latent period was reduced by 1-3 min; the juice secreted was more acid than it had been at the start and had a greater digestive power (the latter effect was particularly noticeable when estimating the digestive power per unit amount of enzyme for the whole mass); evacuation of the stomach contents took place more slowly, taking a 36-52% longer time than in the initial period. The periodic activity of the empty stomach showed a longer period of relative rest, a shorter active period, and a reduced strength of gastric contractions (Fig. 2, A and B, 4, 5, and 6).

When 6-methylthiourasil was taken various changes occurred in the periodic activity of the empty stomach. In some of the dogs a period of relative rest was produced when motility was less than when the preparation was first taken, while in other dogs there was some increase of periodicity, and the active period was prolonged. Here we may consider various methods of compensation for the disturbed function. Two dogs received 6-methylthiourasil for the longer time of 190 days. By the end of this time the rate of gastric emptying was closer to the original rate.

After administration of thyroidin or 6-methylthiourasil had been discontinued, in addition to a return to normal of thyroid function there was also a gradual return of gastric function to its original condition.

In experimental hyperthyroidism the amount of gastric juice secreted was reduced, as was also its acidity and digestive power; digestive movement became stronger and emptying was more rapid; there was also a disturbance of the periodic activity of the empty stomach. In hypothyroidism gastric secretion was enhanced as were also acidity and digestive power, evacuation was slowed, and motility reduced.

In hyperthyroidism insufficient digestion and the accelerated evacuation of the food mass would be expected to lead to poor absorption, and so in turn to loss in weight and a maintained excitation of the feeding center. On the other hand, in thyroid hypofunction the reduced emptying rate of the stomach, the high rate of secretion and the greater digestive power establish conditions more favorable for digestion and for good absorption of food, and facilitate increase in weight; at the same time the reduced motility may cause constipation.

The results or our experiments show that in the different pathological conditions occurring in one particular group of animals the extent of the functional changes is not directly related to the duration of the action of the substances influencing thyroid function. On the other hand there was a functional adaptation to the maintained changes in the conditions of the internal medium. In the two opposite functional thyroid changes, in the same group of animals, at the end of the period during which the preparations were given the alterations in the motility and evacuation rates were less marked than in the middle of this period.

SUMMARY

Experiments were carried out on 6 dogs with a Pavlov pouch and gastric fistula. Studies were made of gastric secretion, motility and evacuation in normal conditions and when hyper- or hypothyroidism had been induced in the animals for a period of 1 year. Thyroid function was altered by thyroidin or methylthiourasil given by mouth. It was found that the gastric functions studied were influenced in two opposite ways. The pathological changes occurring

in hypothyroidism created unfavorable conditions for digestion, and this might lead to diarrhea and loss of weight. In hypothyroidism conditions were favorable, and the animals gained weight; however, decreased gastric motility might lead to constipation.

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