INVESTIGATION OF THE EFFECT OF THYROID EXTRACT ON ACID FORMATION IN THE DOG STOMACH BY RECORDING THE INTRAGASTRIC pH

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The dynamics of acid formation in the stomach of dogs with fistulas into the fundal part of the stomach was investigated by recording the intragastric pH during the outside periods of digestion and before and after administration of thyroid extract. Changes in acid formation in the stomach under the influence of thyroid hormone were found to be biphasic in character.

KEY WORDS: *stomach; pH; thyroid extract.*

The role of thyroid hormones in the regulation of the acid-forming function of the stomach is nowadays not in dispute [2, 6, 10-15], although the data so far obtained are largely contradictory. The authors cited investigated the acid-forming function of the stomach by means of a titration method, but this is known to have several disadvantages. In recent years a method of recording the intragastric pH has been used [1, 7, 8], by means of which changes in pH can be monitored continuously and directly in the stomach over a period of time, including during digestion, after administration of various food stimulants, and during function tests.

The author is aware of only one paper [9] which describes a study of changes in the intragastric pH under the influence of thyroid extract, for which a pH probe was used.

The object of this investigation was to study the dynamics of the intragastric pH under the influence of thyroid extract, by the use of a food stimulus and soda function test.

EXPERIMENTAL METHOD

Experiments were carried out on six dogs with fistulas of the fundal part of the stomach 18-20 h after the last meal. The intragastric pH was recorded graphically by the method described in [3]; the paper winding speed of the automatic writer was 1 cm/min and a deflection of 1 cm corresponded to 0.5 pH unit. The pH was recorded initially for 30 min in a fasting state (special preliminary experiments were carried out in which the pH was recorded for 3 h), and it was again recorded during the 3-4 h after the animal was given a food stimulus (50 g white bread and 200 ml water, warmed to 37°C). To assess the intensity of acid formation in the stomach a soda function test was used: Twenty ml of a 2.5% solution of drinking soda was introduced through the fistula without interrupting the recording of pH. The investigations began before administration of thyroid extract, the animals were then given thyroid extract and continued while the animals were being given thyroid extract in a dose of 35-40 mg/kg daily for 37-38 days.

EXPERIMENTAL RESULTS

On analysis of 102 records of the intragastric pH during the first 3-4 days of administration of thyroid extract to the animals no regular pattern could be observed in the changes of intragastric pH recorded outside and during the period of digestion.

In the next experiments in the course of 10-12 days (the first period) the dynamics of the intragastric pH was similar (see Table 1 and Fig. 1). As Table 1 shows, an acid reaction was recorded in the stomach of all the fasting animals. A pH wave with an amplitude of 0.2-0.3 pH unit and a frequency of 4.7-4.9/min was recorded under these circumstances, but never in the control experiments, in which the pH was within the range 6.9-7.1.

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TABLE 1. Intragastric pH Values Recorded in Dogs Receiving a Food Stimulus and Undergoing Soda Test **before** (control) and **after** Beginning of Thyroid Administration in Periods 1 and 2

Experimental conditions	Period of investigation	Number of experiments	pH		Period of acidification, min	Level of stabilization of pH	Rate of change of pH, pH unit/min
			initial	after feeding or administration of soda solution			
With food stimulus	Control	33	7,0±0,2	7,4±0,2	114±4.7	2,1±0.1	0,046±0,003
	period 1 of experiment	32	2,5±0,1	6,8±0,3	75±0.9	1.8±0.1	0,067±0.006
	P		<0,001	<0,05	<0,001	<0,01	<0,001
	period 2 of experiment	37	6.8±0,2	7,1±0,3	138±5.3	2,4±0.1	0,034±0.003
	P		>0.05	>0,05	<0,001	<0,01	<0.01
With soda test	Control	33	2,1±0,1	7,4±0,3	42±2.6	2.1±0.1	0,123±0,004
	period 1 of experiment	32	1,8±0,1	7,0±0,4	30±2.0	1.8±0.1	0,173±0.006
	P		<0,05	<0,05	<0,001	<0.05	<0,01
	period 2 of experiment	37	2,4±0.1	7,6±0,4	64±3.5	2.3±0.1	0,082±0.004
	P		<0,01	>0,05	<0,001	<0.01	<0,001

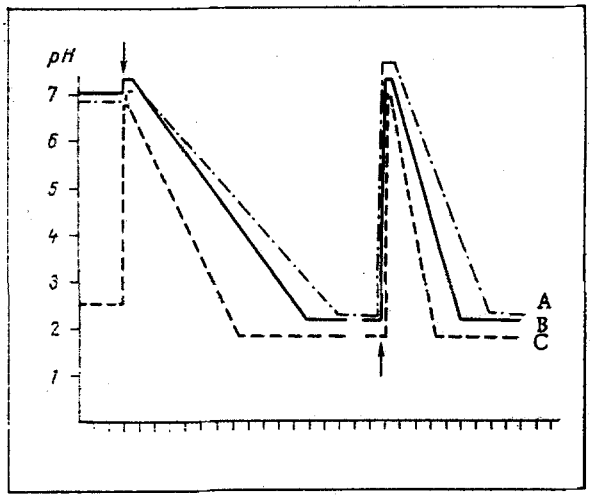

Fig. 1. Dynamics of intragastric pH in dogs during administration of food stimulus and during soda function test in control experiments (B) and during periods 1 (C) and 2 (A) after administration of thyroid to animals. Arrow pointing downward indicates feeding, arrow pointing upward indicates injection of soda solution through fistula. Time marker 10 min.

To study whether the electrode introduced into the stomach and the procedure of preparing the animals for the experiment acted as stimuli for the gastric glands, a series of preliminary experiments (before administration of thyroid extract to the animals) was carried out in which, the initial pH level being between 7.0 and 7.5, the pH was recorded in the fasting state for 3 h or more without the use of any stimuli. These experiments showed that the pH remained substantially unchanged throughout the experiment [4]. Consequently, the results obtained during thyroid administration indicated that in this period acid formation in the stomach was continuous in character. The soda test showed that the intensity of acid formation during this period was low. Comparison of these results with those obtained with the soda test in the period of stimulated secretion (Table 1) indicates that although the reaction of the gastric contents of the dogs during this period was acid, the intensity of acid formation was very low, suggesting a reduction in the acid-neutralizing function of the stomach.

When the animals were given a food stimulus (pH 8.0) the intragastric pH was stabilized at a lower level than in the control experiments and the pH curve deviated much faster to the acid side as a result of acidification of the gastric contents with hydrochloric acid secreted by the gastric glands. During this period the pH record showed pH waves with a frequency of 4.7-4.9/min, with maximal amplitude of 0.5-0.8 pH unit in the middle of the

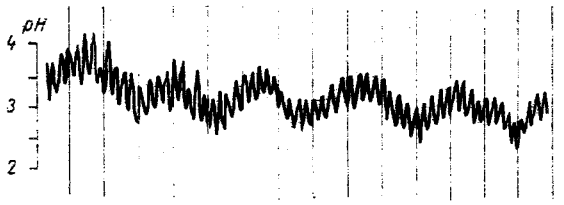

Fig. 2

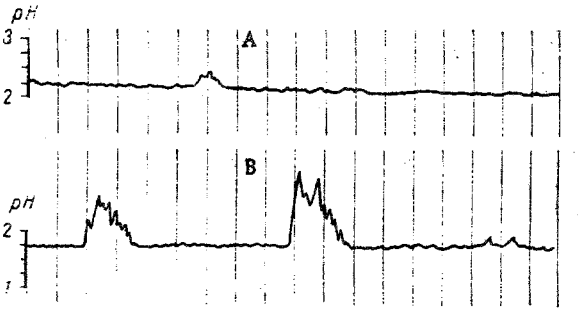

Fig. 3

Fig. 2. Recording of intragastric pH of dog during period of fall of pH 30 min after feeding. Time marker 1 min.

Fig. 3. Recordings of intragastric pH of dogs during stabilization of pH before (A) and in period 1 (B) after administration of thyroid to animals. Waves reflecting regurgitation of duodenal contents into stomach are shown. Time marker 1 min.

period, within the range of 3.5-4.8 pH units (Fig. 2). Toward the end of the period of the decrease in pH the amplitude of the pH waves fell and the waves then disappeared. The rate of decrease of pH was slower, and the duration of the period of the decrease in pH was on average 35.2% shorter than in the experiments before administration of thyroid. The pH curves became stabilized at a lower level than in the control experiments.

In the period of stabilization of the pH curve, pH waves with a duration of 3-5 min and an amplitude of 0.5-1.5 pH unit, and with peaks pointing to the acid side, appeared at intervals of 10-17 min (Fig. 3).

To explain the genesis of these pH waves special experiments were carried out in which samples of gastric contents were taken from the region of the active part of the ion-selective electrode at the time of appearance of the waves. These experiments showed that these samples were mixed with bile. This is proof that the above-mentioned pH waves appeared as a result of the regurgitation of the duodenal contents, with a higher pH value, into the stomach [5].

This phenomenon can evidently be regarded as an adaptive reaction aimed at compensating the reduced acid-neutralizing function of the stomach, for in control experiments before the animals were given thyroid such pH waves were hardly observed at all, or they were extremely rare (once or twice per hour), their amplitude was low (0.2-0.5 pH unit), and they were recorded for a shorter time.

The soda test carried out in the period of stabilization of the pH curve showed an increase in the intensity of acid formation in the stomach during this period.

The results thus indicate that at the beginning of the period of thyroid administration to the animals acid formation in the stomach followed a more intensive course. Later, during the next 18-20 days (period 2) the intragastric pH values before and after administration of the food stimulus were significantly changed and in all experiments without exception they were clearly opposite in character to those in the previous period (Table 1), although clinical manifestations of hyperthyroidism (a decrease in the body weight of the animals, tachycardia, etc.) continued to be pronounced. As Table 1 shows, this period was characterized by lengthening of the period of acidification of the food stimulus and of the soda solution, some increase in the level of pH stabilization, and a decrease in the rate of changes of pH, evidence of a reduction in the intensity of acid formation in the stomach in response to the food stimulus.

After administration of thyroid to the animals ceased the intragastric pH values returned to normal within 7-11 days, and this was accompanied by disappearance of the clinical manifestations of hyperthyroidism.

It can thus be concluded on the basis of these results that changes in acid formation in the stomach in response to a food stimulus become phasic in character under the influence of

thyroid extract. Between three and four days after administration of thyroid to the animals the period of increased acid formation occurs in the stomach, and is followed by a period of inhibition of the intensity of acid formation in response to a food stimulus.

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EFFECT OF NEUROMEDIATORS ON THE ACID–BASE BALANCE

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Acute and chronic experiments on dogs showed correlation between the state of the adrenergic, cholinergic, and serotoninergic systems, on the one hand, and the acid–base balance of the animal on the other hand. An excess of each mediator was accompanied by respiratory alkalosis and a deficiency by mixed respiratory and metabolic acidosis.

KEY WORDS: *acid–base balance; catecholamines; acetylcholine; serotonin.*

Neuromediators are known to play an important role in the regulation of the hemodynamics in general and the nutritive circulation in particular [2, 13, 15]. The role of mediator systems in the regulation of the acid–base balance is particularly interesting. However, information on this problem is extremely limited [3].

The object of the investigation described below was, accordingly, to study the correlation between the acid–base balance (ABB), as an integral indicator of the state of the nutritive circulation, and the level of the most important neuromediators of the blood.

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