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# DYNAMICS OF RECOVERY OF THE BACKGROUND GASTRIC pH AFTER ACTIVE GASTRIC SECRETION IN RESPONSE TO A FOOD STIMULUS

A. I. Kienya

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KEY WORDS: stomach; secretion.

When studying the acid-forming and acid-neutralizing function of the stomach during natural digestion in experiments on dogs, in which the type of hydrochloric acid secretion as we know is interrupted, it is of definite interest to study the dynamics of the intragastric pH not only in a fasting state and in the period of active secretion evoked by a food stimulus, but also in the period of recovery of the background pH, which may shed considerable light on the acid-neutralizing function of the stomach.

It has become possible to study this problem since measurement of the intragastric pH by means of a pH-meter was introduced into experimental research practice, so that the changes in intragastric pH could be recorded automatically during the whole period of natural digestion, under both normal and pathological conditions [2-9].

The writer studied the dynamics of recovery of the background pH level in the stomach after active secretion due to a food stimulus.

## EXPERIMENTAL METHOD

Experiments were carried out on 5 mature dogs weighing 15-18 kg with Basov's fistulas of the fundal part of the stomach. The animals were used 18-20 h after the last meal, when their intragastric pH was 6.7-7.2. The intragastric pH was recorded by the method described by the writer previously [1], using the ÉPP-09m automatic writer, with a paper winding speed of 1 cm/ min and a sweep of not less than 0.5 pH units/cm. The pH was first recorded for 30 min in the fasting state, then after the animal had received a food stimulus (50 g white bread and 200 ml water, warmed to 37°C). To characterize the acid-neutralizing potential of the stomach and the intensity of acid neutralization in it, an acid test was used: 10 ml of acid gastric juice was injected into the stomach through the fistula during the period of recovery of the background pH level, without interrupting the recording of the pH, which continued until the pH level had been restored.

## EXPERIMENTAL RESULTS

Analysis of 53 records of the intragastric pH changes showed that in fasting dogs the mean pH in the stomach was $7.2 \pm 0.2$. After administration of the food stimulus to the animals, as a result of secretion of hydrochloric acid by the gastric glands the gastric contents became acidified, and this was reflected on the pH-gram by a shift of the curve to the acid side which continued for $137 \pm 4.1$ min; after the pH had reached $2.3 \pm 0.3$ it became stabilized for $149 \pm 7.8$ min. In the period of acidification of the gastric contents, rhythmic pH-waves with a frequency of 4.7-4.9/min, reflecting the portion-rhythmic mechanism of acid secretion [3], could be clearly distinguished; these waves disappeared at the beginning of the period of pH stabilization and did not reappear until its end.

At the end of the period of pH stabilization the beginning of restoration of the pH level was clearly observed, and stable values of 6.5-7.0 were attained after $83 \pm 6.7$ min. Under these circumstances pH-waves of a unique shape were recorded on the pH-gram for a period of 1.5-2.0 min (Fig. 1), with pointed and, in

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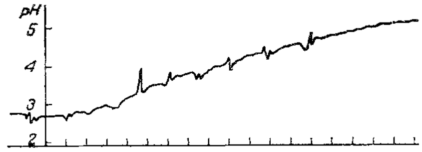


Fig. 1. Intragastric pH-gram during restoration of pH level after active gastric secretion evoked by a food stimulus (time marker 1 min).

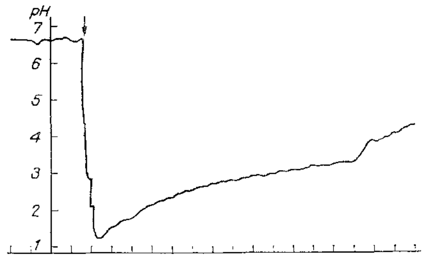


Fig. 2. Intragastric pH-gram during injection of acid gastric juice through the fistula into the stomach, against the background of restoration of the pH level after active secretion evoked by a food stimulus (arrow marks injection of gastric juice into stomach; time marker 1 min).

most cases, reduplicated spurs at the junctions. The appearance of these pH-waves was observed only between the beginning of the period of recovery of pH until the level of 4.5-4.7, above which they disappeared from the pH-gram with a further shift of the pH curve toward the alkaline side. The frequency, shape, and amplitude of these pH-waves were practically identical in all animals. Considering that the reduction of acidity in the stomach is the result of production of an alkaline secretion and neutralization of acid, on the one hand, and of a reduction in acid production, on the other hand, it was of definite interest to study which of these processes is portioned (wave-like on the pH-gram) in character. For this purpose special experiments were carried out with acid gastric juice. The following assumption was made: if production of an alkaline secretion, leading to neutralization of acid in the stomach, takes place in portions, the appearance of pH-waves similar to those described above on the pH-gram must be expected after injection of gastric juice through the fistula into the stomach, against the background of restoration of the pH level.

The results of these experiments showed that (Fig. 2) after injection of acid gastric juice into the stomach while the pH level in the stomach was being restored to 6.5-7.0, a fall in pH was observed to 1.2-1.4. The degree of lowering of pH under these circumstances can evidently be regarded as an indicator of the capacity of the alkaline potential in the stomach at the moment of entry of acid gastric juice into it. A shift of the pH curve toward the alkaline side was then observed as a result of neutralization of the acid gastric juice introduced into the stomach, and this continued for $37 \pm 2.1$ min until the background level was restored.

It is an interesting fact that during restoration of the pH level after introduction of gastric juice into the stomach no rhythmic pH-waves were observed on the pH-gram, indicating the absence of a portioned-rhythm in the production of alkaline secretion.

During analysis of the pH-gram (Fig. 2) it should be noted that restoration of the pH level at the beginning of the period after injection of alkaline juice into the stomach took place comparatively smoothly, but after 13-14 min the rate of shift of pH toward the alkaline side increased sharply, evidently on account of stimulation of mucus and bile [sic] formation in the stomach. However, no evidence of secretion in portions (reflected as pH-waves on the pH-gram) could be observed.

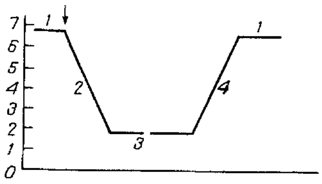


Fig. 3. Scheme of gastric cycle. 1) phase of rest, 2) phase of active HCl secretion under the influence of a food stimulus, 3) phase of stabilized pH level, 4) phase of recovery of background pH level. Arrow indicates administration of food stimulus to animal. Abscissa, time.

Consequently, the appearance of pH-waves in the period of restoration of the background pH level after active gastric secretion evoked by a food stimulus is associated with the secretion of portions of hydrochloric acid by the gastric glands. Disappearance of pH-waves in the region of pH above 4.5-4.7 is evidently due to complete cessation of HCl secretion, whereas the subsequent shift of the pH curve toward the alkaline side without the presence of pH-waves reflects a process of neutralization of acid remaining in the stomach by alkaline secretion, a process which characteristically does not take place in portions.

In the period of restoration of the background pH in the stomach all changes noted on the pH-gram can be interpreted, in the writer's view, as a reflection of a decline in acid formation and stimulation of mucus and bile [sic] formation in the stomach, as a result of the activity of the stomach itself without regurgitation of the duodenal contents into the stomach, as is shown by the absence of specific pH-waves, which arise during that process, on the pH-gram.

As the writer pointed out previously [4], the specific pH-waves reflecting regurgitation of duodenal contents into the stomach were observed only in the period of maximal acidity in the stomach (the period of stabilization of the pH curve). Regurgitation of alkaline secretion from the duodenum into the stomach undoubtedly affects the intragastric pH, but in clinically healthy dogs this process evidently plays an unimportant role, for the pH-waves mentioned above appeared once or twice in the course of 1 h in the period of stabilization of the pH curve and they were of low amplitude and short duration. This process was well marked when the stomach was in a hyperacid state. In that case regurgitation of the duodenal contents into the stomach must be regarded as a compensatory reaction to the reduced acid-neutralizing function of the stomach, such as could be observed, for example, in a hyperthyroid state, during the period of potentiation of the acid-forming function of the stomach [4]. In that case the pH-waves had a larger amplitude, a longer duration, and they appeared more frequently.

The use of the method of recording the intragastric pH, together with an acid test with gastric juice in the recovery period thus provides information on yet another phase reflecting the secretory activity of the dog stomach – the phase of recovery of the background pH level after active acid formation evoked by a food stimulus. Under these circumstances it was found that the production of acid-neutralizing secretion does not take place in portions during the period of restoration of the pH level, whereas the decline of the acid secretion process takes place in waves, or portions.

The results of special investigations using meat broth or milk in various quantities as food stimuli for gastric secretion have shown that the duration of the phases of the gastric cycle depend on the quantity and type of food stimuli, evidently because of differences in the speed of their evacuation from the stomach.

On the basis of the results of this and previous investigations [2, 4], during investigation of the secretory function of a stomach with intermittent type of HCl secretion, if food stimuli are used as stimulators of secretion it is possible to introduce the concept of a "gastric cycle" (Fig. 3), made up of the following phases: 1) the phase of rest, 2) the phase of active HCl secretion (after administration of a food stimulus to the animal and before the shift of pH toward the acid side has ended), 3) the phase of pH stabilization (after complete acidification of the gastric contents and before the shift of pH toward the alkaline side begins), and 4) the phase of restoration of the background pH level (from the beginning of the pH shift toward the alkaline side until restoration of the pH to its basal or near-basal level).

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# REGULATION OF THE CORONARY CIRCULATION DURING ACUTE EXPERIMENTAL STIMULATION OF HYPOTHALAMIC EMOTIOGENIC ZONES


V. L. Golubykh



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KEY WORDS: emotional stress; hypothalamus.


The predominant feature of responses associated with emotional stress, and to some extent in those simulated by stimulation of the hypothalamic emotiogenic zones, is elevation of the blood pressure (BP), which is due both to an increase in cardiac output and to systemic vasoconstriction [1-5]. How the coronary vessels react under these conditions is not quite clear. In experiments on anesthetized animals, a response of coronary vasoconstriction has been demonstrated during adrenergic $\beta$-receptor block [6, 8, 9] or in experiments under special conditions [7].

The reaction of the coronary vessels is largely dependent on the state of the organism as a whole and, in particular, it is determined by general anesthesia [10, 11, 14].

In experiments on unanesthetized cats, Nogina [3, 4] found an increased response of vasoconstriction accompanied by a rise of BP, depending on the severity of the emotional response to stimulation of the lateral hypothalamic nuclei. By contrast, vasodilatation was observed in dogs in the initial period of the response to excitation, evoked both by natural stimuli and by stimulation of the posterior hypothalamus [12, 13, 15].

Even a cursory glance at the data on centrogenic responses of the coronary vessels reveals their contradictoriness. Regulation of the coronary blood flow is known to be aimed mainly at satisfaction of the metabolic demands of the myocardium.

The object of this investigation was to study the neurogenic component of this response to stimulation of hypothalamic emotiogenic nuclei.

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Laboratory of Regulation of the Heart and Coronary Circulation, All-Union Cardiologic Scientific Center, Academy of Medical Sciences of the USSR, Moscow.


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