

SECRETORY FUNCTION OF THE STOMACH IN HYPERTHERMIA*

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(Received February 21, 1957. Submitted by Active Member of the AMN SSSR V. N. Chernigovskii)

In the clinical and experimental literature at the present time there are many reports on the secretory and motor function of the stomach under physiological conditions.

In medical practice diseases may often be met which are accompanied by a febrile reaction and in which disorders of the function of the digestive apparatus are observed. This has been described by many writers: S. P. Borkin [1] and others [2, 4, 7, 10, 11]. However, the problem of disturbance of the secretory function of the gastrointestinal tract in febrile conditions has not yet been adequately investigated. The secretory function of the stomach in hyperthermia is the subject of contradictory reports in the literature [3, 5, 9, 12, 13].

We therefore decided to study the secretory function of the stomach in various stages of experimental fever.

In this article we give our findings on the changes in the secretory function of the stomach and in the properties of the gastric juice during hyperthermia.

EXPERIMENTAL METHOD

Experiments were carried out on five dogs: on four with isolation of the stomach, the operation being performed by I. P. Pavlov's method (Turkoz, Chernysh, Dzhul'bars and Tsygan), and in three of these a gastric fistula of the Basov type was added, while in one dog (Kutsyi) esophagostomy was performed and a gastric fistula made.

We studied: 1) the secretion of gastric juice to various stimulants of gastric secretion (milk, meat, bread, sham feeding and subcutaneous injection of histamine); 2) the acidity of the juice (free, total and combined) by the Michaelis method; 3) the digestive power of the juice by Mett's method; 4) its content of water and solids by Bang's method and 5) the content of organic and inorganic substances in the juice.

After establishment of a basis for comparison at 38-39° C, for 4 hours we studied the secretory function of the stomach of the same animals in a state of hyperthermia in a specially constructed dry-air chamber, heated by electric lamps.

In some experiments we applied the digestive stimulus at the moment the dog was put in the chamber, and in others at the time of maximum rise of body temperature, i.e. at the end of the 2nd and 3rd hour of the observation.

The rectal temperature of the animals was recorded every 15 minutes by means of a thermocouple. During hyperthermia we carried out pneumography by the usual method.

EXPERIMENTAL RESULTS

During overheating the temperature of the animals rose on the average by 1° C (mean variation of the nor-

* Delivered at the VIth scientific conference of senior students and interns of the 1st Leningrad Academician I. P. Pavlov Medical Institute on February 12, 1955 and to the Leningrad Society of Pathophysiologists on December 26, 1956.

mal body temperature of the animals was 38.3-38.8° C). To illustrate the changes in the body temperature during overheating we give the temperature curve of the dog Turkoz (Fig. 1): the temperature begins to rise in the second half of the first hour and reaches its maximum in the 2nd-3rd hour of overheating.

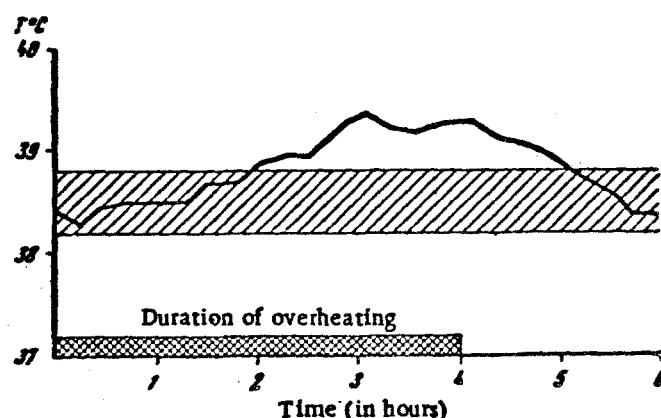


Fig. 1. Temperature curve during overheating. Dog Turkoz (experiment dated October 5, 1954).

The kymographic tracing of respiration during this experiment showed a marked increase in the rate of breathing, to 300 per minute.

During the process of overheating, in addition to a rise of temperature the animals showed great restlessness. The experimental animals lost from 250 to 600 g in weight.

The secretory function of the stomach was measured during overheating in the following manner. The latent period of secretion, if the digestive stimulus was applied at the time of the rise of temperature, was prolonged to 12-19 minutes, in place of the normal 6-9 minutes, but was unchanged in the experiments in which the digestive stimulus was applied when the dog was placed in the chamber. The gastric secretion was depressed during hypothermia, as shown by reduction in the volume of juice secreted, a lowering of its acidity and of its digestive power.

As an illustration we give the results of the experiment on the dog Turkoz.

It will be seen from Fig. 2 that during the period of hyperthermia (experiment dated October 5, 1954) the secretion of juice to meat was greatly reduced: in the 1st hour to 2.1 ml in place of the mean normal value of 5.6 ml, i.e. by 62%; in the second hour by 70 % and in the 3rd hour by 56 %, while in the 4th hour mucus was secreted in place of juice. During the whole period of hyperthermia, 6 ml of juice was obtained in place of the normal 14 ml, i.e. the secretion was reduced by 57 %.

Besides the quantitative changes in the gastric juice during hyperthermia, changes of a qualitative character were found too. Free hydrochloric acid was absent from the gastric juice, the total acidity fell to 20 units in the first hour in place of the average normal value of 88, and the content of combined hydrochloric acid rose, possibly due to the increased secretion of mucus. The digestive power of the juice was weakened. The percentage content of solids in the juice was increased, in respect to both organic and inorganic substances, and the water content was correspondingly reduced. Similar results were obtained with the dog Chernysh.

Similar changes in the secretion of gastric juice were observed in experiments with milk as a digestive stimulus, the only difference being that the volume of gastric juice secreted was not reduced so sharply as in response to meat, possibly because with milk, a large volume of fluid is introduced into the gastro-intestinal tract.

The same results were obtained from a study of secretion in response to bread in the dogs Chernysh and Tsygan. However, changes in the amount and quality of the juice in response to bread were less pronounced than those to meat and milk.

On repeating the hyperthermia, the results obtained were similar but expressed to a lesser degree.

After hyperthermia the altered gastric secretion was restored to normal during the first week. It can be seen from Fig. 3 that even on the day after the hyperthermia the volume of juice secreted had risen and its acidity and digestive power were increased.

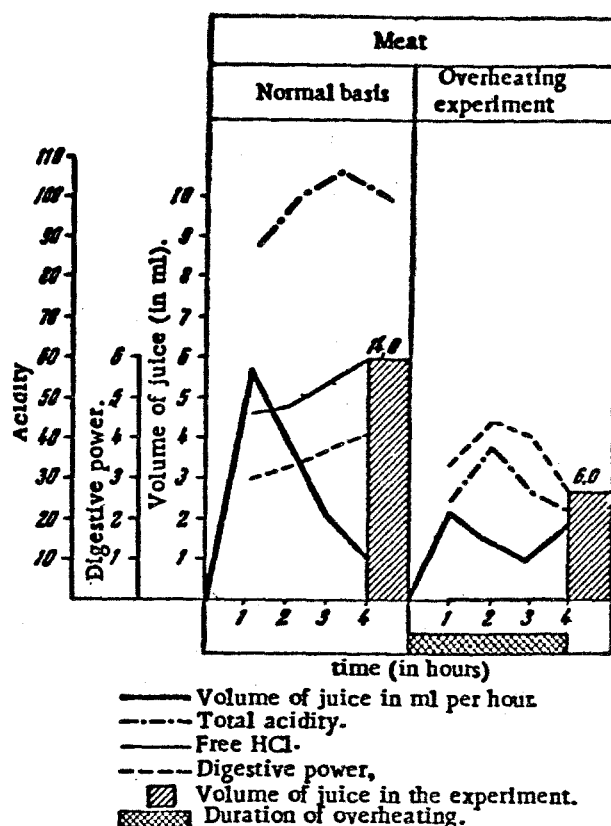


Fig. 2. Gastric secretion to meat during hyperthermia (experiment dated October 5, 1954).

From their experimental and clinical observations on the action of a high air temperature on the body, certain workers have drawn attention to the presence of a so-called period of after-effect, lasting for 10-14 days. However the conditions of their experiments were somewhat different, for in some investigations the animals were given a digestive stimulus after hyperthermia only, while in our experiments we made observations throughout the hyperthermia and on the following days.

M. L. Eidinova [7] pointed out that exposure of animals to a temperature of 40° C for 45 minutes was accompanied by very slight changes in the secretory activity of the stomach and in the properties of the gastric juice, while exposure to overheating at 50° C for 45 minutes resulted in lasting changes in the secretion, continuing for 3 weeks. In all this author's experiments the digestive stimulus was applied to the animals after hyperthermia.

It has been shown [5] that exposure to the sun or a temperature of 40°C in a chamber for 4 hours causes prolonged changes in the gastric function of dogs: during the 3 days following such overheating there is observed at first an increase in the secretion, later a reduction and finally another increase; similar findings are reported by other writers [6].

Investigation of the secretory function of the stomach of the dog Kutsyi in which gastrotomy and esophagostomy had been performed, in sham feeding experiments with meat and by subcutaneous injection of histamine during hyperthermia showed that just as in the experiments on animals with isolation of the stomach there is a qualitative and quantitative change in the gastric secretion. This change takes the form of lengthening of the latent period of secretion to 16-21 minutes instead of the normal 6-8 minutes, if the digestive stimulus is applied during the maximum rise of body temperature of the animal. The volume of gastric juice secreted is reduced by 2-5 times, the total acidity falls as a result of a diminution of free hydrochloric acid, the amount of combined hydrochloric acid rises, the digestive power of the juice is reduced, the residual solid content is increased in respect to organic substances but the absolute excretion of solids is reduced to 800 mg in place of the normal 2500 mg.

In experiments in which the digestive stimulus was applied during maximum rise of body temperature, hyposecretion was observed. The total volume of gastric juice secreted during the usual period of investigation was slightly reduced. In these experiments the dog Kutsyl lost 500 g in weight, possibly the result of loss of a large quantity of water through polypnoea and salivation.

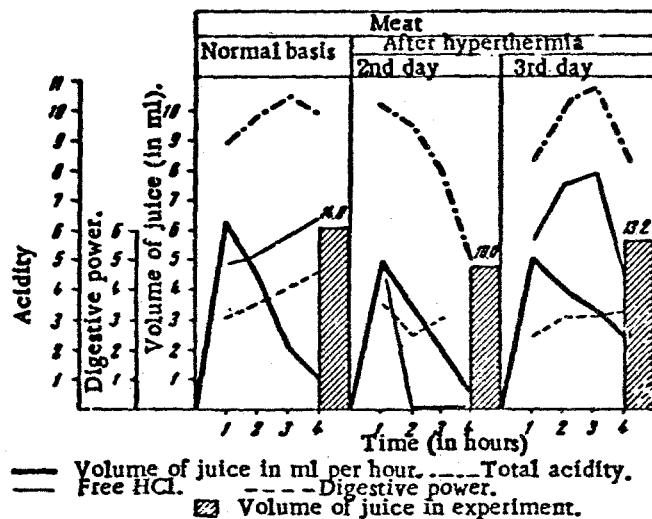


Fig. 3. Gastric secretion in response to meat after hyperthermia (experiment dated October 7-8, 1954).

Thus our experimental results show that during hyperthermia of an animal the secretory function of the stomach is modified both quantitatively and qualitatively. The changes observed following a single period of hyperthermia are restored to normal within the first week.

SUMMARY

The author presents results of his study of secretory function of the stomach during overheating of dogs to 38-39° C for 4 hours.

It was established that the amount of gastric juice secreted during hyperthermia is decreased to all types of food stimulants. Its digestive power is also decreased. The acidity of the gastric juice is diminished down to complete absence of the free hydrochloric acid. The percentage of the hard substances is increased, while their absolute value is decreased.

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