PANCREATIC SECRETION IN RESPONSE TO DIFFERENT AMOUNTS AND CONCENTRATIONS OF HYDROCHLORIC ACID SOLUTIONS*

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The study of the use of hydrochloric acid for stimulating the external secretion of the pancreas is of considerable theoretical and practical importance.

It has been shown by the work of I. P. Pavlov and his school that one of the most powerful stimuli of pancreatic secretion is the action of acids, in particular hydrochloric acid, on the duodenal wall [1, 2, 3, 4].

Although these workers established the important fact of the specific stimulatory action of hydrochloric acid, they did not undertake a study of the quantitative aspects of this action. They did not investigate the effect on pancreatic secretion of introducing into the duodenum hydrochloric acid solutions of concentrations higher than the physiological ones.

I. L. Dolinsky expressed the view, in 1894, that introduction of more concentrated solutions of hydrochloric acid into the duodenum should cause a greater secretory response than if 0.5% hydrochloric acid is used [2].

Apart from this, we could find no references in the literature to the effect of varying the amount of hydrochloric acid introduced on pancreatic secretion.

Nor has the secretory response of the pancreas to introduction into the duodenum of acid together with pancreatic secretion been studied, although this procedure more closely approaches the conditions applying during natural digestion.

EXPERIMENTAL METHODS

The experiments were performed on two dogs (Palma and Tarzan), provided with a pancreatic fistula, by our modified method [5]. In addition, the dogs had a gastric fistula, which remained open during the whole time of the experiment.

Hydrochloric acid of different concentrations was introduced from a buret during 1 minute, at 15 minute intervals.

The amount of pancreatic secretion was measured at 15 minute intervals, and from these values we derived the values per hour, and for the whole experiment, lasting two hours.

In some experiments, the pancreatic secretion was reintroduced into the duodenum.

In all, we performed 106 experiments on both dogs.

EXPERIMENTAL RESULTS

We first determined the background values, for periodic secretion and for secretion following introduction of water. We found that periodic secretion took place in both dogs.

Introduction of water into the duodenum caused a certain rise in pancreatic secretion, as compared with spontaneous periodic secretion.

We then examined the effect on pancreatic secretion of varying the concentration and the amount of acid introduced into the duodenum.

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The results are presented in Figure 1, from which it appears that introduction of 25 ml of 0.05% hydrochloric acid caused a stimulation of pancreatic secretion, as compared with the background values.

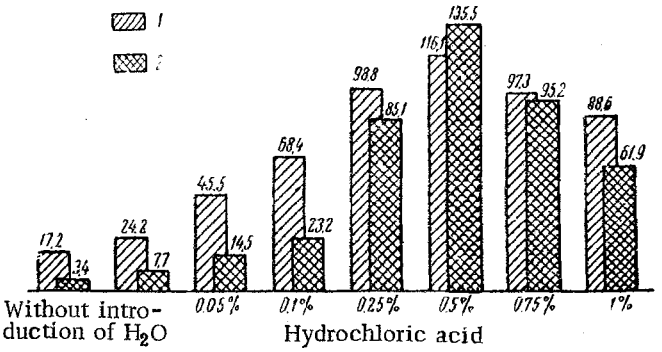

Fig. 1. Amount of pancreatic secretion produced in response to introduction into the duodenum of 25 ml of hydrochloric acid of various concentrations. 1) The dog Palma; 2) the dog Tarzan.

Introduction of 25 ml of 0.05 to 0.5% hydrochloric acid caused a rise in pancreatic secretion in both dogs, which, however, showed individual variations: the increase in secretion varied parallel with the concentration of acid for Palma, whereas Tarzan showed only a weak response to low concentrations, with a sudden rise when the hydrochloric acid concentration reached 0.25%.

The secretory response to one and the same concentration of hydrochloric acid varied from day to day, for both dogs, which is doubtless evidence of the profound influence of the state of the higher nervous system of the animals on pancreatic secretion.

Raising the acid concentration to 0.75% caused a marked fall in pancreatic secretion, in both dogs, and the effect of 1% acid was still more pronounced. For Palma it amounted to 70% of the amount secreted in response to 0.5% acid. The fall in secretion in response to 1% acid was particularly evident in the experiments with Tarzan, only 45% of the amount given by 0.5% acid being produced.

Thus, our experiments do not confirm Dolinsky's supposition that still further increase in pancreatic secretion can be achieved using relatively large volumes (25 ml) of hydrochloric acid solutions of concentrations exceeding the "physiological" range.

The results of the experiments on the effect of varying the amounts of acid introduced on pancreatic secretion are presented in Figure 2.

Only a very slight rise in the amount of pancreatic secretion results from introduction into the duodenum of 5 ml of 0.05% hydrochloric acid; the effect is about the same, or even in some cases smaller, than when the same amount of water is given.

Increasing the amount of 0.05% acid to 15 ml had a slightly greater effect, but even this barely exceeded that given by water alone.

The response to introduction of 25 ml of 0.05% acid was twice as great as that to an equal volume of water.

Increasing the amounts of 0.25% and 0.5% hydrochloric acid caused a corresponding increase in the amount of pancreatic secretion produced.

Introduction of 5 and 15 ml of 1% acid produced a greater amount of secretion than did the same volumes of any other concentration of acid. Raising the volume of 1% acid to 25 ml caused a marked fall in pancreatic secretion.

It thus appears that only large amounts (25 ml) of the more concentrated acid exert a pronounced inhibitory effect on pancreatic secretion.

The effects of introducing different solutions of hydrochloric acid directly into the duodenum or via the stomach are presented in Fig. 3.

Introduction through the stomach of 25 ml of 0.05 and 0.25% hydrochloric acid gave a slightly smaller effect than when the acid solutions were introduced directly into the duodenum. Practically the same secretory response was found when 25 ml of 0.5% acid was introduced via the stomach or directly into the duodenum.

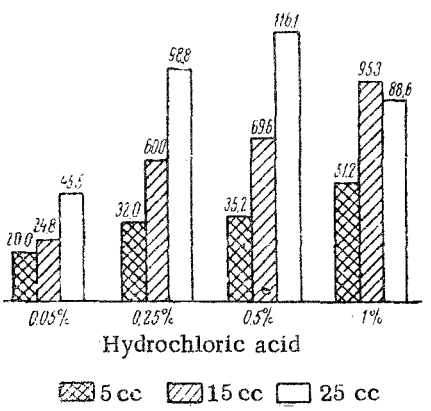

Fig. 2. Production of pancreatic secretion in response to introduction into the duodenum of various amounts of hydrochloric acid of different concentrations.

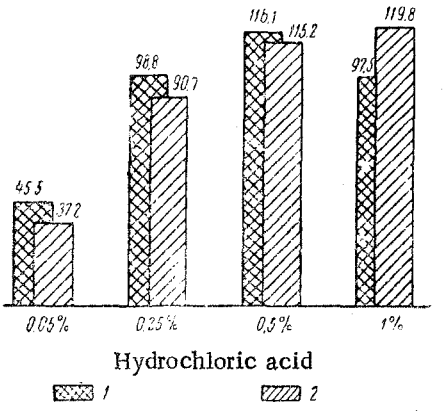

Fig. 3. Production of pancreatic secretion in response to introduction of different solutions of hydrochloric acid (1) into the duodenum, and (2) into the stomach.

The production of pancreatic secretion after introduction of 25 ml of 1% hydrochloric acid via the stomach was greater than when it was placed directly into the duodenum.

An explanation of this finding is that 1% hydrochloric acid, being a powerful irritant, evokes a defense reaction of the gastric wall, involving copious secretion of mucus. As as result, some of the acid is neutralized by the alkaline gastric mucus secretion. The concentration of the acid then approaches more closely the optimum values, as a result of which pancreatic secretion exceeds that found when the acid is placed directly into the duodenum.

We also studied the effect on pancreatic secretion of introducing 25 ml of 0.5 and 0.75% hydrochloric acid into the duodenum, simultaneously with pancreatic juice. Under these conditions, and using 0.5% hydrochloric acid, the amount of pancreatic secretion fell by 20% below that found when pancreatic juice was not reintroduced into the duodenum.

This effect may be explained as being due to partial neutralization of the 0.5% acid by alkalis present in the pancreatic juice, thus lowering the stimulatory power of the acid solution. For the same reason, the amount of pancreatic secretion produced in response to introduction of 0.75% acid together with pancreatic juice was 12% greater than with acid alone. In this case, neutralization of part of the acid raised the stimulatory power of the solution.

LITERATURE CITED

[1] A. A. Valter, Secretory Function of the Pancreas.* Thesis, St. Petersurg, 1897.

[2] I. L. Dolinsky, Effect of Acids on Pancreatic Secretion*, Thesis, St. Petersburg, 1894.

[3] A. R. Krever, Analysis of the Secretory Function of the Pancreas,*Thesis, St. Petersburg, 1899.

[4] L. P. Popelsky , Russk. Vrach, 1902, No. 49, 1797-1799.

[5] O. B. Sobieva and V. E. Robinson, Fiziol. Zhur. SSSR, 39, 629-631 (1953).

* In Russian.