

FUNCTIONAL AND MORPHOLOGICAL ADAPTATION
OF THE GASTRIC GLANDS TO DISTURBANCES OF
EXTERNAL PANCREATIC SECRETION AND
EXPERIMENTAL REFLUX PANCREATITIS

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The mucous membrane of the gastric fundus was investigated in dogs after interruption of the external pancreatic secretion and the formation of experimental reflux pancreatitis. A marked increase in the number of chief cells and a decrease in the number of parietal cells were found in the gastric fundal glands between 6 and 15-17 months after the operation. Meanwhile the RNA concentration in the chief cells was increased. These changes were constant throughout the period of investigation (until 20 months). The results are in full agreement with changes in the secretory function of the stomach described previously under the same conditions and they can therefore be regarded as being compensatory or adaptive in character.

KEY WORDS: reflux pancreatitis; ligation of the pancreatic ducts; oxido-reductases; chief and parietal cells.

Changes in the secretory function of the stomach and in the digestion of protein by the gastric juice of dogs at various times after ligation of the pancreatic ducts and the formation of experimental reflux pancreatitis were described previously [1, 2]. In particular, the secretion of gastric juice and its digestive power were increased considerably, its acidity (both free and total) was reduced, and the dogs began to produce a gastric juice capable of digesting protein with the formation of large quantities of single amino acids 4-7 months after these operations. The changes discovered were stable in character throughout the whole of the subsequent period of investigation (until 20 months).

The problem of possible structural changes in the gastric glands corresponding to this functional adaptation of the stomach accordingly arose.

This paper describes a histological and histochemical investigation carried out on the same animals as those in which the changes in gastric secretion described above have been found after ligation of the pancreatic ducts and the formation of reflux pancreatitis.

EXPERIMENTAL METHOD

The external secretion of the pancreas was blocked by ligation of its ducts. The pancreas was carefully separated from the surrounding abdominal organs. To separate the head of the gland more completely from the wall of the duodenum, it was infiltrated with procaine by A. V. Vishnevskii's method. The gland was wrapped in omentum and buried in the abdominal cavity. Experimental reflux pancreatitis was induced by the method suggested by Tuzhilin et al. [3].

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TABLE 1. Changes in Number of Chief and Parietal Cells in the Gastric Mucosa of Dogs at Various Times after Ligation of the Pancreatic Ducts (1) and the Operation to Produce Experimental Reflux Pancreatitis (2)

Parameter studied	Control	After operation				
			6-7 months	10-12 months	15-17 months	19-20 months
No. of chief cells	357±73,7	1	403,5	584,2	572,3	577,3
		2	360,3	431,3	565,25	599,3
No. of parietal cells	65,4±14,2	1	44,5	28,4	29,3	28,3
		2	59,6	55,4	27,5	30,8
Parietal cells/chief cells (in %)	23,7±30,5	1	11,04	4,9	5,1	4,9
		2	16,4	10,5	4,86	5,33

The dogs were sacrificed 6-7 months (five animals), 10-12 months (eight), 15-17 months (seven) and, finally, 19-20 months (six animals) after the operation.

The mucous membrane of the gastric fundus was taken for histochemical investigation. The activity of several oxido-reductases was determined (lactate, glucose-6-phosphate, succinate, glutamate, alcohol, and glycerophosphate dehydrogenases, NAD-diaphroases). Paraffin sections were stained with hematoxylin-eosin, with bromphenol blue for protein, with alcian blue for acid mucopolysaccharides by Steedman's method, and with Sudan black for lipids; SH groups were detected by the method of Barrnett and Seligman, RNA by Brachet's method, and the PAS reaction was carried out.

EXPERIMENTAL RESULTS

After ligation of the pancreatic ducts the following changes were observed: a sharp decrease in size of most of the lobes of the gland, the development of marked sclerosis at the periphery, cystic dilatation of the terminal segments of the glands, and infiltration of the interstitial connective tissue with lymphocytes and plasma cells. Similar changes also were found in experimental reflux pancreatitis, the only difference being that the picture of the morphological changes in the pancreas as described above appeared in the later stages after the operation (10-12 months compared with 6-7 months).

Highest activity of the oxido-reductases was found in the parietal cells of the gastric mucosa. No difference in the activity of these enzymes could be found between the experimental and control animals. A stronger PAS reaction was found in the epithelium of the neck of the glands in the gastric mucosa and the content of acid mucopolysaccharides was increased in the epithelium of the neck and pits of the glands in the gastric mucosa of the experimental dogs. All these changes were discovered 6-7 months after ligation of the pancreatic ducts and 10-12 months after the operation to form reflux pancreatitis. Subsequently these changes completely disappeared.

Starting with the 6th-7th month after the operation of ligation of the pancreatic ducts and the 10th-12th month after the operation to form experimental reflux pancreatitis an increase was observed in the

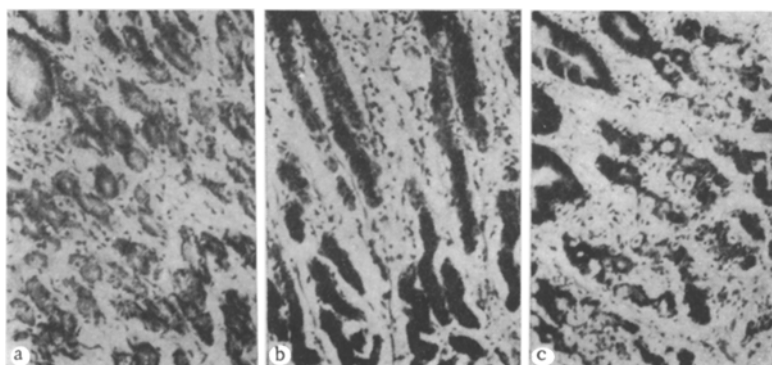


Fig. 1. Gastric fundal mucosa of dogs: a) control; b) 10 months after ligation of pancreatic ducts; c) 13 months after operation to form experimental reflux pancreatitis. Brachet's stain for RNA, 250×.

number of chief cells in the gastric fundal glands. Meanwhile the number of parietal cells decreased. These changes continued progressively with an increase in the period elapsing after the operation (Table 1). The greatest increase in the number of chief cells in the glands of the gastric fundus was observed 10-12 months after the operation of ligation of the pancreatic ducts. The greatest decrease in the number of parietal cells was observed at the same time. Similar data were obtained when the fundal mucosa was investigated in dogs with experimental reflux pancreatitis, the only difference being that the changes observed reached their maximum in the later stages after the operation (15-17 months). These changes, it will be noted, later became stable in character.

Finally, starting from the 6th-7th month after both types of operation on the pancreas a gradual increase was observed in the RNA concentration in the chief cells of the gastric fundal glands (Fig. 1). This increase reached a maximum at approximately the same time as the number of chief and parietal cells in the gastric fundal mucosa of the experimental dogs became stabilized.

The morphological changes in the gastric glands after ligation of the pancreatic ducts and in reflux pancreatitis as described above correspond completely to the functional changes in gastric activity observed by the writers previously during a disturbance of external pancreatic secretion. The increase in the digestive power of the gastric juice observed in the present experiments was evidently connected with the increase in the number of chief cells in the fundal glands of the gastric mucosa, while the decrease in acidity of the gastric juice corresponded to a decrease in the number of parietal cells in the mucosa. It is an undoubted fact that the changes in the secretory activity of the stomach and the morphological changes in its mucosa in experimental reflux pancreatitis were connected with the disturbance of the external secretory activity of the pancreas, for similar changes also occurred after ligation of the pancreatic ducts; the absence of changes in the insular system of the pancreas likewise will be noted.

The changes in the external pancreatic secretion in experimental reflux pancreatitis evidently developed more gradually than those following ligation of the pancreatic duct. This, in particular, could be the cause both of the morphological changes in the gastric mucosa and of the later appearance of functional adaptation of the gastric glands.

The functional and morphological changes in the gastric glands in experimental reflux pancreatitis and after ligation of the pancreatic ducts can be regarded as an integral reaction of adaptation to the disturbances of the external secretory (digestive) function of the pancreas.

LITERATURE CITED

1. D. F. Blagovidov, A. N. Pomel'tsov, and V. N. Shatalov, *Byull. Éksperim. Biol. i Med.*, No. 11, 19 (1972).
2. D. F. Blagovidov, A. N. Pomel'tsov, and V. N. Shatalov, *Zh. Éksperim. i Klin. Med.*, 13, No. 1, 35 (1973).
3. S. A. Tuzhilin et al., *Éksper. Khir.*, No. 6, 22 (1968).