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MORPHOLOGICAL CHANGES IN THE PANCREAS AFTER TOTAL OCCLUSION OF ITS DUCT SYSTEM BY SYNTHETIC POLYMER MATERIAL

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Surgical treatment of chronic pancreatitis is an urgent and difficult problem. The main aim of treatment is to relieve pain and prevent recurrence of the disease. These aims are achieved at present by extensive resection of the organ and by total pancreatectomy. However, endocrine disturbances arising after total pancreatectomy are difficult to control and there is thus a need for development of a safer and less traumatic method of treatment of chronic pancreatitis.

Observations on patients with advanced forms of chronic pancreatitis show that progression of atrophy of the exocrine parenchyma of the pancreas can lead to weakening and disappearance of the distressing pain so characteristic of this disease [3]. At the same time the results of experimental investigations have shown that in some cases atrophy of the exocrine parenchyma of the pancreas can be produced by ligation of its efferent ducts [2, 4].

However, even a little experience of the use of this method under both experimental and clinical conditions has shown that complete occlusion of the pancreatic ducts is extremely difficult to achieve by ligation because of technical difficulties in the performance of the operation and the risk of development of postoperative complications (aggravation of intraductal hypertension, failure of the ligature with the formation of pancreatic fistulas, and so on).

Accordingly attempts are currently being made to improve the method of occlusion of the pancreatic ducts by their total plugging with synthetic polymers [5, 6]. An extremely im-

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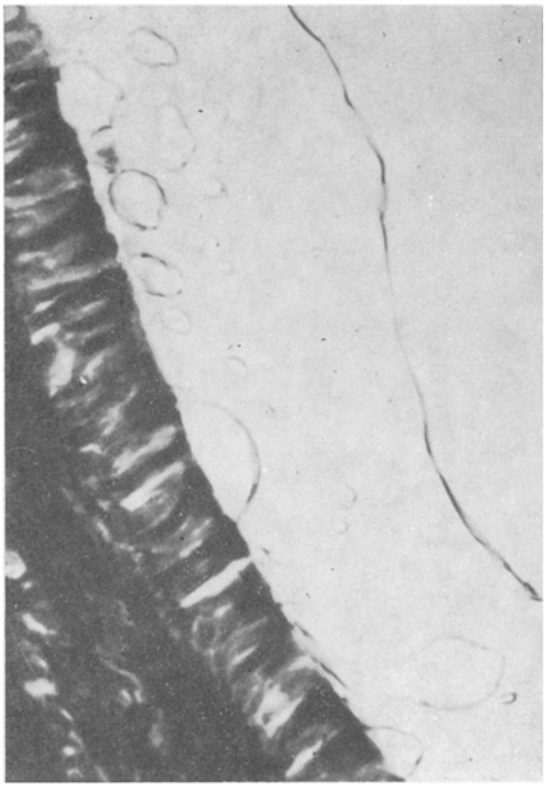

Fig. 1

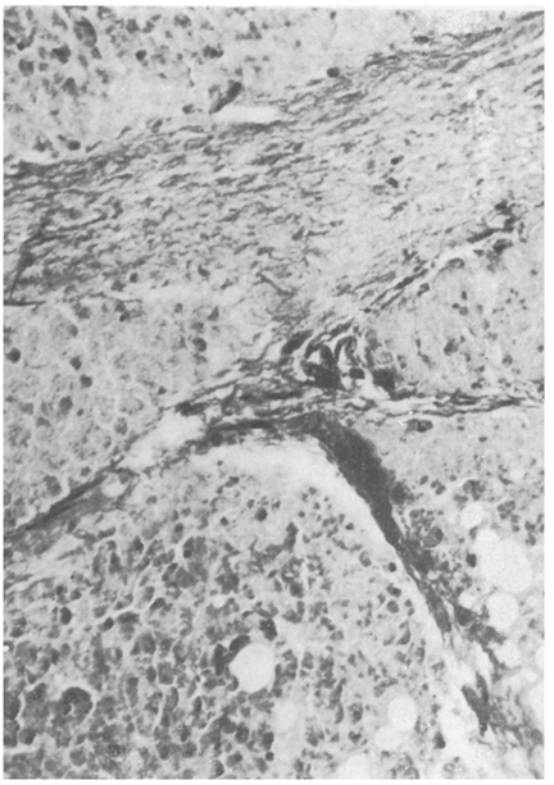

Fig. 2

Fig. 1. Wall of principal pancreatic duct with polymer material in contact with its endothelium 10 days after occlusion: absence of inflammatory reaction. Lillie's stain, 650 ×.

Fig. 2. Pancreas of dog 10 days after total occlusion of its ducts: increase in interlobular connective tissue and atrophy of acini at periphery of lobules. Lillie's stain, 90 ×.

portant aspect of this problem is the correct choice of plugging material. No Soviet-produced materials have yet been specially developed for these purposes.

The requirements for materials for use in occlusion of the pancreatic ducts have been formulated in the laboratory for application of polymers in medicine, A. F. Vishnevskii Institute of Surgery, Academy of Medical Sciences of the USSR, under the direction of Professor T. T. Daurova, and compounds based on oligosiloxanediols have been developed to meet these requirements [1].

The aim of the present investigation was to study the time course of morphological changes in the pancreas after total occlusion of its duct system by means of these compounds.

EXPERIMENTAL METHOD

Under hexobarbital anesthesia (20 mg/kg body weight) experiments were performed on 33 adult mongrel dogs of both sexes weighing 12-25 kg. The pancreatic duct system was occluded by trans- or extraduodenal injection of the silicone compound (0.8-2.0 ml) through a cannula from a Record syringe, followed by ligation and division of the ducts in order to ensure the airtightness of the total occlusion.

Morphological changes in the pancreas after total occlusion of its duct system were studied after an interval of between 3 days and 2 years. Histological sections were stained with hematoxylin and eosin and by Van Gieson's and Lillie's methods.

Pancreatic islet-cell function was evaluated by periodic determination of the blood sugar level up to 2 years after the operation (by Hatelson's method, modified by Boehringer, West Germany).

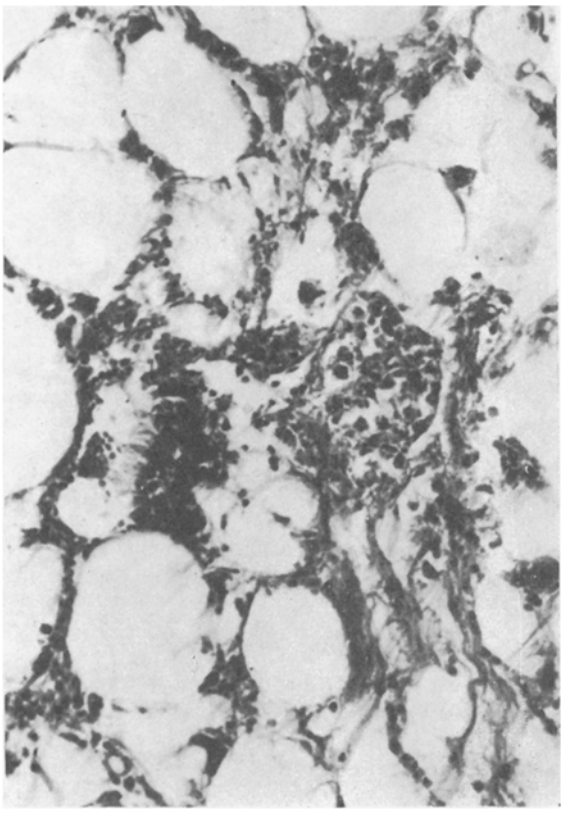

Fig. 3. Pancreas of dog 2 years after total occlusion of its ducts: exocrine parenchyma replaced by adipose and connective tissue; preserved islet of Langerhans in the center. Lillie's stain, 260 ×.

EXPERIMENTAL RESULTS

The injected polymer fills the duct system of the pancreas, penetrates into the tiny side branches, and solidifies in it, in firm contact against the walls of the ducts but without inducing an inflammatory reaction in them (Fig. 1).

After 3 days the lumen of some intercalary ducts was dilated and there was some increase in thickness of the interlobular connective-tissue septa, with a low degree of small-cell infiltration.

After 10 days appreciable thickening of the interlobular connective-tissue septa was observed. The quantity of connective tissue around many of the interlobular ducts was increased. The lobules were a little reduced in volume. The process of atrophy began from the periphery of the lobules, where the acinar cells lost their granular appearance; their cytoplasm and nuclei began to stain poorly. Droplets of fat appeared in some cells. In most cases the intercalary ducts were compressed, and their lumen reduced or closed. No significant changes were found in the cells of the islets of Langerhans (Fig. 2).

After 20-30 days, besides completely atrophied lobules replaced by adipose and connective tissue there were other lobules whose exocrine parenchyma was still intact. In these preserved areas of acinar tissue the cells in most cases were haphazardly arranged and their cytoplasm was homogeneous, filled with fine granules, or undergoing fatty degeneration. The nuclei of many cells were either palely stained or pycnotic. Islets of Langerhans of different shapes and sizes could be clearly seen among the atrophic acinar tissue. In some places they were hypertrophied. Some vessels were sclerosed. Cells of the ganglia showed no significant changes.

Atrophy of the exocrine parenchyma was virtually complete after 2-3 months. By that time a marked decrease in the size and weight of the pancreas could be noted. The pancreatic

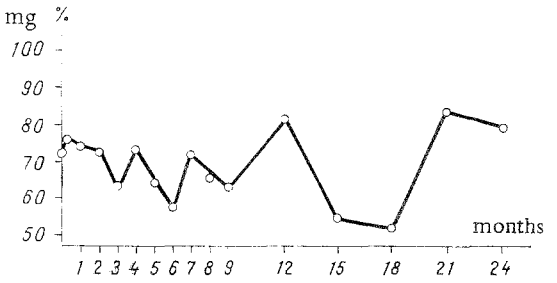

Fig. 4. Dynamics of blood sugar level (in mg %) of dog after total occlusion of pancreatic duct.

tissue consisted of a combination of adipose tissue and fibrous connective tissue, with endocrine cells scattered among them forming islets or separate groups of cells.

After 6 months no significant changes were observed compared with the previous time.

After 1, 1.5, and 2 years intensive proliferation of connective and adipose tissue was observed, replacing the exocrine parenchyma of the pancreas. The duct system of the gland was completely sclerosed. The islets of Langerhans were preserved, sometimes clustered in groups, and some of them were distinctly hypertrophied, evidently on account both of hyperplasia of the cells and of fusion of several small islets. Some blood vessels and ganglia remained intact (Fig. 3).

At all times of observation there were no visible changes in the polymer material itself. No signs of pathological changes could be detected in connective-tissue cells surrounding the polymer.

A study of the dynamics of the blood sugar level showed no sign of diabetes mellitus (Fig. 4).

The results thus demonstrate that total occlusion of the duct system of the pancreas by plugging it with polymer material of a type which does not undergo *in vivo* degradation for a long time, combined with additional ligation of the ducts, leads to gradual atrophy of the exocrine parenchyma of the gland while the morphology and functions of its endocrine apparatus are preserved.

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