COMPARATIVE EXPERIMENTAL MORPHOLOGICAL EVALUATION OF THE COMPLICATIONS OF CHOLEDOCHODUODENOSTOMY

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KEY WORDS: anastomosis; bile duct; liver.

The formation of an anastomosis between the bile duct and duodenum is widely used as a method of treating obstructive jaundice. Depending on the situation at the operation, either a side-to-side or an end-to-side anastomosis can be used. The latter type of anastomosis has been limited in its application because of frequent postoperative complications [1, 2, 7, 9].

To establish a functionally improved version of end-to-side choledochoduodenostomy, two series of experiments were undertaken in the investigation described below.

EXPERIMENTAL METHOD

In 42 dogs of series I (control) the common bile duct was sutured into the duodenal wall and a serous tube was formed around the anastomosis and adjacent part of the bile duct [4]. In series II (38 animals) an original method was used to form the anastomosis (Author's Certificate No. 762865). The bile duct was divided from before backward, creating an ellipsoid for 1 cm of its length. The end of the duct was sutured into the opened duodenum in the oblique-transverse direction. During burial of the anastomosis and the adjacent part of the bile duct a fold was made in the lumen of the duodenum from its wall. The mouth of the anastomosis was located on the efferent side of this fold.

For the morphological investigation pieces of liver, bile duct, and anastomosis were fixed in 10% neutral formalin solution, buffered by Lillie's method and in Carnoy's fluid. Sections were stained with hematoxylin and eosin and by Van Gieson's method. Histochemical reactions were carried out for lipids with Sudan red, for glycogen by Shabadash's method, and for neutral glycosaminoglycans by the PAS reaction. Activity of acid and alkaline phosphatases was determined by Gomori's method and of nonspecific esterases by the method of simultaneous azo-coupling described by Nachlas and Seligman [8].

The width of the choledochoduodenostomy was measured before the operation and at various times after it. The long and short diameters of the ellipse were determined in the animals of series II. The width of the bile duct was measured at the point where it entered the duodenal wall. The numerical results were subjected to statistical analysis by Student's method.

EXPERIMENTAL RESULTS

Depending on the times of observation the animals were divided as indicated in Table 1.

Microscopically, in the control series of experiments up to 30 days after the operation the diameter of the anastomosis decreased from 3.1 ± 0.6 to 2.4 ± 0.05 mm ($P > 0.05$). Later the constriction of the anastomosis continued, so that 1 year after the operation it was only half as wide as originally ($P < 0.001$).

In the experimental series the anastomosis contracted along its entire perimeter at all times of observation. However, the reduction in the long diameter was greater than that

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TABLE 1. Distribution of Animals by Times of Observation

Series of experiments	Time of observation, days							Total
	3	7	15	30	90	180	360	
	число животных							
I (control)	4	5	6	6	5	6	10	42
II (experiment)	4	6	4	5	6	7	6	38
Total	8	11	10	11	11	13	16	80

TABLE 2. Mean Data for Area of Choledochoduodenostomy (in mm^2)

Series of experiments	Time of observation, days						
	3	7	15	30	90	180	360
I (control)	2,32	3,74	1,63	4,0	0,75	1,14	1,91
II (experiment)	9,8	11,58	12,84	10,86	8,59	6,78	10,36

of the short. For instance, 1 month after the operation the former was reduced to 10.0 ± 0.01 to 5.0 ± 0.7 mm ($P < 0.01$). A significant decrease in the short diameter was not observed until the 180th day of observation.

The evacuating power of the anastomosis depended directly on its area. Table 2 gives mean data for the area of the different versions of choledochoduodenostomy. It shows that this parameter was superior at all times of observation to the control.

In the postoperative period an increase in width of the bile duct was observed. In the control animals significant dilation took place 15 days after the operation and continued to progress with an increasing degree of significance ($P < 0.001$ 1 year later). Dilatation of the duct in the experiments of series II was less marked at all times of observation.

In the animals of the experimental group a fold was found in the lumen of the duodenum, and its size and location depended on the character of insertion of the buried sutures.

Histological investigation of the choledochoduodenostomy showed that in both series of experiments in the early period (under 7 days) after the operation granulation tissue rich in blood vessels, young fibroblasts, and lymphoid and epitheliod cells, containing high alkaline phosphatase and nonspecific esterase activity, was present at the site of anastomosis between the bile duct and duodenum. The morphological structure of the walls of the duct and duodenum immediately adjacent to the anastomosis was preserved, although their mucous membranes were edematous and congested. Adhesions were formed between them by young scar tissue.

Young scar tissue consisting of collagen fibers with fibrocytes and empty blood vessels was found in the region of the anastomosis 30 days after the operation. Collections of lymphoid cells and fibroblasts with moderate phosphatase activity were rarely found. Later, mature scar tissue was found at the junction between the walls of the duodenum and bile duct.

On the days immediately after the operation marked edema was present in the wall of the bile duct. The epithelium of the duct was often in a state of increased secretion, exhibiting high esterase activity. In some animals of series I infiltration of an inflammatory nature was found in the submucosa at late stages also. In some cases areas denuded of epithelial cover could be seen in the region of the duct adjacent to the anastomosis.

Changes in the liver were demonstrated in the early period after the operation in the form of congestion of the central veins and lymphatics in the portal tracts, moderate basophilia of the cytoplasm of the liver cells, and an increase in their phosphatase activity. Later these changes underwent regression.

The course of the postoperative period was complicated in 11 animals in the control series and six in the experimental series. In most cases the complications were the result of obliteration of the anastomosis. In some experiments, mainly in control animals, inflammatory changes were observed in the bile duct even when the anastomosis remained sufficiently

patent. This situation confirms suggestions in the literature [3, 5, 6, 10] that narrowing of the anastomosis is not the only cause of the onset of structural and functional changes in the organs adjacent to the anastomosis.

This investigation thus showed that choledochoduodenostomy by the present writers' method can preserve an anastomosis of statistically satisfactory size in the postoperative period; the creation of the valve and the location of the anastomosis on its efferent side prevents regurgitation of the intestinal contents into the biliary tract. This may explain the fewer number of complications and the less severe pathomorphological changes in the bile duct and liver of the animals of this group.

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ULTRASTRUCTURE OF THE MUCOUS MEMBRANE OF THE SMALL INTESTINE IN GERMFREE RATS BECOMING CARRIERS OF *Vibrio cholerae*

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Despite the great importance of the cholera carrier state its pathogenesis has been very inadequately investigated [3, 5, 8, 10]. One promising trend in this situation is the formation of a model of a chronic *Vibrio cholerae* carrier state in germfree rats [2].

In this paper we examine the ultrastructure of the mucous membrane of the small intestine of germfree rats in which a carrier state is produced with respect to *Vibrio el-tor* and *V. cholaerae*.

EXPERIMENTAL METHOD

Germfree rats of the OFA breed and the Fisher F-344 strain, aged 2-12 months, were infected either with *V. el-tor* (Ogawa serotype, not secreting an exotoxin) in a dose of 2×10^9

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