MORPHO-FUNCTIONAL CHANGES IN THE PANCREAS AFTER RESECTION OF THE JEJUNUM IN CATS

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The jejunum was resected in male cats. Changes in the structure of the exocrine and endocrine parts of the organ were studied in histological preparations. Amylase and lipase activity and the sugar concentration were determined in the animals' blood. Hypertrophy and hyperplasia were found in the acrinar part of the gland during 1-14 days of the experiment and in the endocrine part during 7-30 days. On the 21st and 30th days of the experiment some decrease was observed in the dimensions of the acinar cells and nuclei, and on the 180th day the endocrine cells were reduced in size. The function of the exocrine part of the pancreas was disturbed for 2-21 days of the experiment, but that of the endocrine part was disturbed only on the 7th day, after which it returned to normal.

KEY WORDS: pancreas; resection of small intestine.

Interest in the compensatory and adaptive reactions of certain organs in response to the removal of others has recently increased [2, 5-7]. Yet despite its importance, the problem of changes in the pancreas following resection of the intestine has been inadequately studied [1, 3, 4, 8-10]. This was the motivation of the present investigation.

EXPERIMENTAL METHOD

Male cats weighing 1700-2300 g were used. The jejunum was resected. The experimental and control animals were killed at different times after the operation (from 12 h to 6 months, five animals at each time). Pieces from the middle part of the pancreas were fixed in Carnoy's fluid, and paraffin sections were stained with hematoxylin–eosin and by Feulgen's method. The areas of the structural components of the gland were measured, and, by a method of drawing and weighing, the mitotic index (MI) and the coefficient of death of the nuclei (CDN) also were determined. The DNA content in the nuclei was determined by cytophotometry.

The blood vessels were injected with ink–gelatin mass by Komakhidze's method. Sections 60-120 μ in thickness, cut on a freezing microtome, were cleared in xylol and mounted in Canada balsam. The diameter of the blood vessels was measured with a screw ocular micrometer.

The blood amylase activity was determined by the method of Éngel'gardt and Gerchug, the serum lipase activity by Comfort's method, and the blood sugar by the method of Haggedorn and Jensen.

The numerical data were analyzed by the Fischer–Student method. Differences were regarded as significant when $P < 0.01$.

EXPERIMENTAL RESULTS

Resection of the jejunum caused definite changes in both exocrine and endocrine parts of the pancreas. As Table 1 shows, on the 7th-14th day after the operation the area of cross-section of the acini was increased by 14-16%. Later it decreased, and 6 months after the operation it was smaller than in the control,

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TABLE 1. Changes in Structure of Exocrine Part of Pancreas after Resection of Jejunum in Cats

Time after sacrifice of animals (in days)	Group of animals	Area (in μ)				of nucleus	of nucleolus	MI (in ‰)	CDN (in ‰)	DNA (in conventional units)
		of cross section of acinus	of lumen	of acinar cell	of cytoplasm					
1/2	Experimental	420	3,0	70	52	18	1,7	0,1	0,1	0,12
	Control	420	3,0	70	53	17	1,7	0,1	0,1	0,13
1	Experimental	422	3,1	71	53	18	1,8	0,1	0,2	0,11
	Control	420	3,0	68*	51	17	1,7	0,1	0,1	0,12
2	Experimental	430	3,2	79	58	21	1,9	0,8	0,7	0,16
	Control	428	3,1	78	60	18*	1,9	0,1*	0,1*	0,12*
7	Experimental	485	3,8	95	72	23	2,9	1,6	1,0	0,15
	Control	420*	3,2*	80*	60*	20*	1,9*	0,0*	0,0*	0,11*
14	Experimental	480	3,5	90	68	22	2,8	0,4	0,8	0,15
	Control	420*	3,0*	79*	60*	19*	1,9*	0,1*	0,1*	0,12*
21	Experimental	402	2,5	64	48	16	1,8	1,1	1,1	0,11
	Control	427*	3,2*	76*	56*	20*	2,4*	0,1*	0,6*	0,12
30	Experimental	400	2,8	70	53	17	1,7	0,9	0,6	0,11
	Control	430*	3,4*	78*	57*	21*	2,2*	0,1*	0,1*	0,12
90	Experimental	420	3,1	71	53	18	1,8	0,2	0,1	0,12
	Control	426	3,2	72	53	19	1,9	0,1	0,1	0,11
180	Experimental	412	3,3	69	54	15	1,9	0,3	1,3	0,12
	Control	434*	3,2	77*	61*	16*	2,1*	0,1*	0,8*	0,12

*Differences between experiment and control statistically significant.

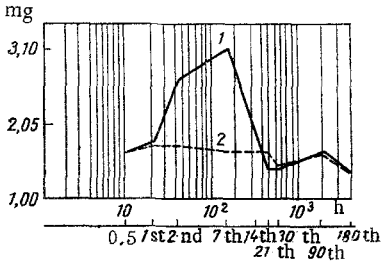

Fig. 1

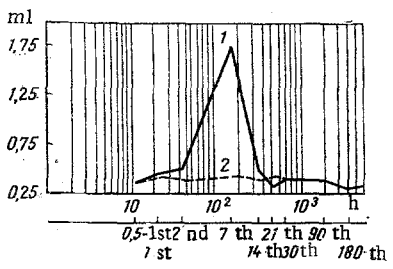

Fig. 2

Fig. 1. Change in amylase activity. Abscissa, time of operation; ordinate, amylase activity (in mg); 1) in cats undergoing operation; 2) in control cats.

Fig. 2. Changes in lipase activity. Ordinate, lipase activity (in ml of of 20 N NaOH). Remainder of legend as in Fig. 1.

but the difference was not significant. The lumen of the acini showed corresponding changes. These changes were associated chiefly with an initial increase and subsequent decrease in size of the acinar cells. The mitotic activity of the acinar cells and the DNA content in the nuclei also increased over a period of 2-30 days. However, increased death of the acinar cells (reflected in CDN) was observed at the same time, and cell division could be regarded as being predominantly to compensate for the dead cells. This is shown by the fact that the number of cells in the acinus remained constant (average five), rising to seven only 6 months months after the operation. The increase and corresponding decrease in size of the acinar cells were due to changes in the area both of the cytoplasm and of the nucleus. The nucleolus of the acinar cells was increased on the 7th and 14th days and reduced later.

Amylase and lipase activity increased on the 2nd-14th days after the operation. It fell after 21 days, but returned to normal on the 30th day (Figs. 1 and 2).

The changes were more marked in the endocrine part of the gland (Table 2). The area of the islet cells was increased from the 7th to the 90th day, but later was smaller than in the control. Just as in the acinar cells, this increase was on account of both cytoplasm and nucleus. The decrease in the area of the cell took place entirely on account of the cytoplasm. Mitotic activity, like the DNA content in the nucleus, increased for a period of 7-30 days, but there was a corresponding increase in the value of CDN. Meanwhile, the number of nuclei per unit area of the islets decreased in the course of 7-30 days, so that the number of cells did not increase.

TABLE 2. Changes in Structure of Endocrine Part of Pancreas after Resection of Jejunum in Cats

Time after sacrifice of animals (in days)	Group of animals	Area (in μ^2) of islet cell	of cytoplasm	of nucleus	of nucleolus	Number of nuclei per unit area of islet tissue	MI (in ‰)	CDN (in ‰)	DNA (in conventional units)
1/2	Experimental	91	72	19	3,0	33	0,10	0,10	0,08
	Control	91	72	19	3,1	33	0,10	0,10	0,09
1	Experimental	92	72	20	3,1	33	0,10	0,10	0,07
	Control	91	72	19	3,0	34	0,10	0,10	0,08
2	Experimental	102	80	22	3,1	33	0,10	0,10	0,08
	Control	100	79	21	3,0	33	0,10	0,10	0,07
7	Experimental	124	151	34	4,6	31	1,00	0,80	0,11
	Control	105*	83*	22*	3,1*	34*	0,10*	0,10*	0,07*
14	Experimental	115	133	32	4,4	30	1,20	1,00	0,13
	Control	100*	78*	22*	3,1*	33*	0,10*	0,10*	0,08*
21	Experimental	115	83	32	2,3	31	1,40	0,90	0,10
	Control	98*	72*	26*	1,7*	34*	0,10*	0,10*	0,07*
30	Experimental	116	87	29	4,2	31	0,30	0,20	0,10
	Control	100*	76*	24*	3,1*	33*	0,10*	0,10*	0,08*
90	Experimental	102	81	21	3,2	33	0,10	0,10	0,09
	Control	101	81	20	3,1	34	0,10	0,10	0,10
180	Experimental	76	54	22	1,8	34	0,15	0,40	0,07
	Control	108*	84*	24	2,1*	34	0,10*	0,10*	0,07

* Number of nuclei per unit area of islet tissue.

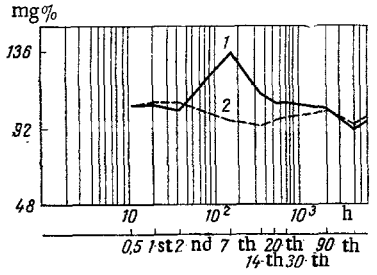

Fig. 3. Changes in blood sugar of cats. Ordinate, blood sugar concentration (in mg%). Remainder of legend as in Fig. 1.

During the period of hypertrophy and hyperplasia of the islet cells the blood sugar concentration rose. It reached a maximum on the 7th day when it was 13.6 mg% compared with 96 mg% in the control (Fig. 3).

The diameter of the vessels showed no significant change throughout the experiment.

Thus, in response to resection of the jejunum, changes are found in the pancreas. These changes are progressive in character and are expressed chiefly as hypertrophy of the cells. In the later stages, however, evidence of atrophy appears in the gland. The problem of whether the normal structure of the gland is subsequently restored, as is the case with its function, requires further investigation.

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