Histologic Findings and Amylase Contents of the Pancreas and Parotid Gland of Rats with Experimental Peritonitis or Ileus*

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KAKIZAKI, G., NOTO, N., FUJIWARA, Y., OIZUMI, T., SOENO, T. and SAITO, T. *Histologic Findings and Amylase Content of the Pancreas and Parotid Gland of Rats with Experimental Peritonitis or Ileus*. Tohoku J. exp. Med., 1972, 108 (2), 155-164 ——. Histologic examination and measurement of amylase content of the pancreas and parotid gland were done on rats with peritonitis or ileus. Histologic findings and amylase content of the parotid gland were normal when the pancreas remained histologically normal in these conditions; while pathologic changes and low amylase content of the parotid gland were brought about when histopathologic findings of the pancreas was induced by peritonitis or ileus experimentally produced. There was no significant relation between serum amylase levels and the grade of histopathologic changes of the pancreas in rats with peritonitis or ileus. ——— amylase; pancreatitis; ileus; peritonitis

The authors (Kakizaki *et al.* 1971, 1972) demonstrated that experimentally produced acute pancreatitis caused atrophic changes and hypofunction of the parotid gland, and that histologic findings and amylase content of the parotid gland changed parallel to the severity of pancreatic lesions in the repairing period of acute pancreatitis.

In the present study of ours, experimental production of perforative peritonitis and intestinal obstruction were made in rats, and histologic examination and measurement of amylase content of the pancreas and parotid gland and measurement of serum amylase values were done.

MATERIALS AND METHODS

Twenty-two male rats of the Wistar-strain weighing between 220 g and 480 g were used throughout the experiment and divided into the following two groups.

Peritonitis group: For producing perforative peritonitis, eleven rats were used. Seven rats were laparotomized under ether anesthesia, the duodenum was transected completely at

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the site about 1 cm apart from the pylorus, and then the abdomen was closed. Twenty-four hours after the procedure, blood specimens from the abdominal vein were examined for amylase content, and the pancreas and parotid gland were excised for histologic examination and estimation of amylase content (chronic type).

In the remaining four rats, the abdomen was opened under ether anesthesia, the duodenum transected completely at the site about 1 cm apart from the pylorus, then intestinal contents were led into the abdominal cavity as much as possible and the abdomen was closed. Seven hours after the procedures, amylase content was estimated on serum, pancreatic and parotid tissues and histologic examination of the pancreas and parotid gland was done (acute type).

Ileus group: For producing intestinal obstruction, eleven rats were used. Six rats were laparotomized under ether anesthesia, the intestine was ligated with a silk at the site about 7.5 cm apart from the pylorus, then the abdomen was closed. Twenty-four hours after the procedures, histologic examination of the pancreas and parotid gland and amylase estimation of the serum, pancreas and parotid gland were done (upper-ligation type).

In the remaining five rats, the abdomen was opened under ether anesthesia, the end of ileum ligated by a silk and the abdomen was closed. Forty-eight hours after the procedures, examination was done on the items mentioned above (lower-ligation type).

Serum amylase was estimated according to Somogyi's method (Somogyi 1938), and estimation of amylase in the pancreas and parotid gland was done in the same ways as described in a previous paper of ours (Kakizaki *et al.* 1971).

RESULTS

Peritonitis group

1. Chronic type

Histologic findings

Pancreas: Exudation and cell infiltration in peripancreatic fatty tissue were moderately noticed and there were no other special findings in all.

Parotid gland: There were no pathologic changes.

Organ amylase value (Table 1)

Pancreas: Amylase values of the pancreas showed normal values ranging from 364×10^2 mg/100 ml to 524×10^2 mg/100 ml with a mean of 408×10^2 mg/100 ml.

TABLE 1. *Organ amylase and serum amylase from rats with peritonitis of chronic type*

No. of rats	Body weight (g)	Organ amylase (mg/100 ml)		Serum amylase (mg/100 ml)
		Pancreas	Parotid gland	
1	360	372×10^2	624×10^2	950
2	370	418×10^2	632×10^2	810
3	370	524×10^2	$1,036 \times 10^2$	800
4	350	392×10^2	848×10^2	838
5	350	417×10^2	820×10^2	1,048
6	370	364×10^2	828×10^2	996
7	330	366×10^2	734×10^2	770
Mean		408×10^2	789×10^2	887

Parotid gland: Amylase values of the parotid gland showed normal values ranging from 624×10^2 mg/100 ml to 1036×10^2 mg/100 ml with a mean of 789×10^2 mg/100 ml.

Serum amylase value

As shown in Table 1, serum amylase values showed subnormal values ranging from 770 mg/100 ml to 1,048 mg/100 ml with a mean of 887 mg/100 ml.

Acute type

Histologic findings

Pancreas: Exudation and cell infiltration in the peripancreatic fatty tissue were moderately or markedly noticed, but no special pathologic changes were found in the pancreas itself.

Parotid gland: Exudation and cell infiltration in the periglandular fatty tissue were moderately noticed, but no special pathologic changes were observed in the parotid gland itself.

Organ amylase value (Table 2)

Pancreas: Amylase values of the pancreas ranged from 332×10^2 mg/100 ml to 437×10^2 mg/100 ml with a mean of 387×10^2 mg/100 ml. All were within the normal limits except for No. 11 rat with a little lower values.

TABLE 2. *Organ amylase and serum amylase from rats with peritonitis of acute type*

No. of rats	Body weight (g)	Organ amylase (mg/100 ml)		Serum amylase (mg/100 ml)
		Pancreas	Parotid gland	
8	380	354×10^2	644×10^2	2,300
9	390	437×10^2	664×10^2	1,988
10	380	426×10^2	706×10^2	2,134
11	400	332×10^2	688×10^2	2,341
Mean		387×10^2	676×10^2	2,191

Parotid gland: Amylase values of the parotid gland showed normal values ranging from 644×10^2 mg/100 ml to 706×10^2 mg/100 ml with a mean of 676×10^2 mg/100 ml.

Serum amylase value

As shown in Table 2, serum amylase values showed higher values ranging from 1,988 mg/100 ml to 2,341 mg/100 ml with a mean of 2,191 mg/100 ml.

TABLE 3. *Histologic findings of the pancreas and parotid gland from rats with ileus of upper-ligation type*

Organ	No. of rats Histologic findings	12	13	14	15	16	17
Pancreas	Atypical arrangement of glandular cells	(-)	(-)	(-)	(-)	(-)	(-)
	Desquamation	(-)	(-)	(-)	(-)	(-)	(-)
	Vacuolation of glandular cells	(-)	(-)	(-)	(-)	(-)	(+)
	Disappearance of zymogen granules	(-)	(-)	(-)	(-)	(-)	(+)
	Acinar ectasis and ductal dilatation	(-)	(-)	(-)	(-)	(-)	(+)
	Exudation and cell infiltration in interstitial tissue	(-)	(-)	(-)	(-)	(-)	(+)
	Exudation and cell infiltration in peripancreatic fatty tissue	(-)	(-)	(-)	(-)	(-)	(+)
	Hydropic changes of islet cells	(-)	(-)	(-)	(-)	(-)	(-)
Parotid gland	Atypical arrangement of glandular cells	(-)	(-)	(-)	(-)	(-)	(+)
	Desquamation	(-)	(-)	(-)	(-)	(-)	(-)
	Vacuolation of glandular cells	(-)	(-)	(-)	(-)	(-)	(±)
	Disappearance of zymogen granules	(-)	(-)	(-)	(-)	(-)	(±)
	Ductal dilatation	(-)	(-)	(-)	(-)	(-)	(-)
	Acinar atrophy	(-)	(-)	(-)	(-)	(-)	(+)
	Exudation and cell infiltration in interstitial tissue	(-)	(-)	(-)	(-)	(-)	(-)
	Exudation and cell infiltration in periglandular fatty tissue	(-)	(-)	(-)	(-)	(-)	(-)

*Ileus group*2. *Upper-ligation type**Histologic findings* (Table 3)

Pancreas: Histologic findings of the pancreas were normal in all except for No. 17 rat (Fig. 1).

Parotid gland: Histologic findings of the parotid gland were normal in all except for No. 17 rat (Fig. 2).

Organ amylase value (Table 4).

Pancreas: Amylase values of the pancreas ranged from 277×10^2 mg/100 ml to 788×10^2 mg/100 ml with a mean of 551×10^2 mg/100 ml. Normal values were noticed in all except for No. 17 rat with a low value of 277×10^2 mg/100 ml.

Parotid gland: Amylase values of the parotid gland ranged from 504×10^2 mg/100 ml to 1068×10^2 mg/100 ml with a mean of 831×10^2 mg/100 ml. Normal values were noticed in all except for No. 17 rat with a slightly low value of 504×10^2 mg/100 ml.

Fig. 1. Photomicrograph of pancreas of No. 17 rat in ileus group. Ductal dilatation, vacuolation of glandular cells and disappearance of zymogen granules with exudation and cell infiltration in interstitial tissue and peripancreatic fatty tissue are noticed. H.E. stain.

Fig. 2. Photomicrograph of parotid gland of No. 17 rat in ileus group. Atypical arrangement of glandular cells and acinar atrophy are moderately noticed, vacuolized glandular cells being also present. H.E. stain.

Serum amylase value

As shown in Table 4, serum amylase values showed normal or lower values. In 3 cases (Nos. 12, 15 and 16) the values ranged from 802 mg/100 ml to 904 mg/100 ml, and the other three (Nos. 13, 14 and 17) showed the values ranging from

TABLE 4. *Organ amylase and serum amylase from rats with ileus of upper-ligation type*

No. of rats	Body-weight (g)	Organ amylase (mg/100 ml)		Serum amylase (mg/100 ml)
		Pancreas	Parotid gland	
12	430	508×10^2	846×10^2	857
13	330	666×10^2	836×10^2	1,435
14	420	788×10^2	864×10^2	1,219
15	350	672×10^2	866×10^2	802
16	360	394×10^2	$1,068 \times 10^2$	904
17	340	277×10^2	504×10^2	1,186
Mean		551×10^2	831×10^2	1,067

1186 mg/100 ml to 1435 mg/100 ml. A mean of 1067 mg/100 ml was obtained in this group.

3. Lower-ligation type

Histologic findings

Pancreas: As shown in Table 5, pathologic histologic findings of the pancreas were noticed in No. 18 and No. 19 rats (Figs. 3 and 4), but no special changes in other three rats.

Parotid gland: As shown in Table 5, pathologic histologic findings of the parotid gland were noticed in No. 19 rat (Fig. 5), but no special changes in others.

Organ amylase value: (Table 6)

Pancreas: Amylase values of the pancreas ranged from 226×10^2 mg/100 ml

TABLE 5. *Histologic findings of the pancreas and parotid gland from rats with ileus of lower-ligation type*

Organ	Histologic findings	No. of rats	18	19	20	21	22
Pancreas	Atypical arrangement of glandular cells		(±)	(+)	(-)	(-)	(-)
	Desquamation		(-)	(-)	(-)	(-)	(-)
	Vacuolation of glandular cells		(+)	(+)	(-)	(-)	(-)
	Disappearance of zymogen granules		(+)	(+)	(-)	(-)	(-)
	Acinar ectasis and ductal dilatation		(+)	(+)	(-)	(-)	(-)
	Exudation and cell infiltration in interstitial tissue		(+)	(+)	(-)	(-)	(-)
	Exudation and cell infiltration in peripancreatic fatty tissue		(-)	(+)	(-)	(-)	(-)
	Hydropic changes of islet cells		(-)	(-)	(-)	(-)	(-)
Parotid gland	Atypical arrangement of glandular cells		(-)	(+)	(-)	(-)	(-)
	Desquamation		(-)	(-)	(-)	(-)	(-)
	Vacuolation of glandular cells		(-)	(+)	(-)	(-)	(-)
	Disappearance of zymogen granules		(-)	(+)	(-)	(-)	(-)
	Ductal dilatation		(-)	(-)	(-)	(-)	(-)
	Acinar atrophy		(-)	(+)	(-)	(-)	(-)
	Exudation and cell infiltration in interstitial tissue		(-)	(+)	(-)	(-)	(-)
	Exudation and cell infiltration in periglandular fatty tissue		(-)	(+)	(-)	(-)	(-)

Fig. 3. Photomicrograph of pancreas of No. 18 rat in ileus group. Ductal dilatation and acinar ectasis are markedly noticed, and vacuolation of glandular cells and disappearance of zymogen granules are also present. H.E. stain.

Fig. 4. Photomicrograph of pancreas of No. 19 rat in ileus group. Ductal dilatation, vacuolation of glandular cells, disappearance of zymogen granules, and exudation and cell infiltration in interstitial tissue are markedly noticed. H.E. stain.

to $654 \text{ mg}/100 \text{ ml}$ with a mean of $487 \times 10^2 \text{ mg}/100 \text{ ml}$. No. 19 rat showed markedly lower values of $226 \times 10^2 \text{ mg}/100 \text{ ml}$. No. 18 rat had a little lower values of $330 \times 10^2 \text{ mg}/100 \text{ ml}$ and the others were of normal values.

Parotid gland: Amylase values of parotid gland ranged from $436 \times 10^2 \text{ mg}/100$

Fig. 5. Photomicrograph of parotid gland of No. 19 rat in ileus group. Atypical arrangement of glandular cells, acinar atrophy and disappearance of zymogen granules are markedly noticed and vacuolation of glandular cells are also present. H.E. stain.

TABLE 6. *Organ amylase and serum amylase from rats with ileus of lower-ligation type*

No. of rats	Body- weight (g)	Organ amylase (mg/100 ml)		Serum amylase (mg/100 ml)
		Pancreas	Parotid gland	
18	320	330×10^2	$1,088 \times 10^2$	1,333
19	480	226×10^2	436×10^2	1,340
20	440	584×10^2	$1,086 \times 10^2$	1,692
21	480	654×10^2	$1,210 \times 10^2$	1,644
22	320	642×10^2	670×10^2	1,407
Mean		487×10^2	898×10^2	1,487

ml to $1,088 \times 10^2$ mg/100 ml with a mean of 898×10^2 mg/100 ml. Normal values were noticed in all except for No. 19 rat with a low value.

Serum amylase value

As shown in Table 6, serum amylase values ranged from 1333 mg/100 ml to 1692 mg/100 ml with a mean of 1487 mg/100 ml. Normal values were noticed in all except for No. 20 and No. 21 rats with higher values.

DISCUSSION

Results of our present investigation using rats revealed that, 1) in the case of experimentally produced peritonitis, histologic findings and amylase content of the pancreas and parotid gland were found normal, and serum amylase levels showed no significant relation to pathologic changes of the pancreas; 2) in the case of experimentally produced ileus, histologic findings and amylase content of the

parotid gland were normal when the pancreas was normal in histologic findings, while pathologic changes and low amylase content of the parotid gland were observed when histologic findings of the pancreas were abnormal; and there was no significant relation between histologic findings of the pancreas and serum amylase levels.

Decrease in serum amylase has been observed in adreno-cortical stress (Howard *et al.* 1955), hepatocellular disease (Cummins and Bockus 1951), and following the administration of propylthiouracil (Challis *et al.* 1957), in addition to advanced pancreatic parenchymal destruction (Popper and Plotke 1941, Howard *et al.* 1955). On the other hand, serum amylase elevations have been reported in a number of situations in which there is no pancreatic affection. They include diseases of biliary tract (Lewison 1941, Smith *et al.* 1952, Pfeffer *et al.* 1953), penetrating and perforated peptic ulcer (Hinton 1934, Probst *et al.* 1939, Pemberton *et al.* 1950, Malinowski 1952, Mahaffey *et al.* 1955), intestinal obstruction (Polowe 1943, Raffensperger 1951, Byrne and Boyd 1957), bowel transection (Schneewind 1956), renal insufficiency (Sachar 1952), mumps (Dunlop 1933, Zelman 1944, Candel and Wheelock 1946), and others. Our experimental results concerning serum amylase showed the followings. In experimentally produced perforative peritonitis, the chronic type showed lower values and the acute type higher values of serum amylase associated with normal histologic findings of the pancreas. In experimentally produced intestinal obstruction, upper-ligation type showed normal or lower values and lower-ligation type normal or higher values independent of pancreatic changes. Namely, serum amylase values were not significantly related to the pancreatic changes.

Thus it might be assumed that perforative peritonitis or intestinal obstruction, experimentally produced in rats, did not exert a direct effect upon histologic changes of the parotid gland and that, only when pathologic changes of the pancreas were induced in these conditions, pathologic changes and low amylase content of the parotid gland were brought about. Furthermore, it was observed that there was no significant relation between serum amylase levels and histologic changes of the pancreas of rats with peritonitis or ileus, both of which were experimentally produced.

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