
The Role of Surgical Treatment for Chronic Pancreatitis

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During the last 25 years, 134 patients with chronic pancreatitis were treated surgically in our clinic. According to intraoperative measurement of the pancreatic intraductal pressure, both perfusion pressure and residual pressure in the patients with dilated pancreatic duct were significantly higher than those in control patients. Operative procedures included side-to-side pancreaticojejunostomy in 47 patients, 40%–80% caudal pancreatectomy in 28, pancreaticoduodenectomy in 16, pancreatic sphincteroplasty in 10, and others. The effect of operation on abdominal pain was noted in 97% of the patients. The study of operative effect on abdominal pain and follow-up results showed the excellent maintenance of operative benefit. Surgical treatment, however, could not help improve impaired function of the pancreas. Ten of 34 late deaths were related to the failure of controlling diabetes. Therefore, long-term follow-up care to the pancreatic dysfunction is considered to be necessary even after complete relief of abdominal pain.

A FEW DECADES ago chronic pancreatitis was considered a relatively rare disease in Japan. Recently, however, the number of patients with chronic pancreatitis is increasing with the advent of diagnostic modalities such as endoscopic retrograde cholangiopancreatography, ultrasonography, computed tomography, and so forth. The senior author (TS) commenced surgical treatment for the patients with chronic pancreatitis in 1960. The surgical treatment for chronic pancreatitis, based on the 25 years' experience, is evaluated in the present study.

Patients and Methods

From January 1960 to March 1985, a total of 145 patients with chronic pancreatitis were admitted to our clinic. Of these 145 patients, 114 patients were males and 31 were females. Their ages ranged from 11 to 72 years, with a mean age of 45 years. The etiologies of the disease

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were alcohol abuse, *i.e.*, taking more than 90 grams of ethanol daily, in 78 patients, gallstone in 14 patients, pancreatic injury in seven patients, and acute pancreatitis in six patients. The etiology was unknown in 40 patients. Pancreatic calculi were found in 58% of the patients and diabetes mellitus in 47%.

Indications for surgical treatment of chronic pancreatitis in our institution are as follows: (1) intractable pain uncontrolled by medical treatment; (2) complications such as pancreatic cyst, abscess, or fistula; (3) biliary tract disease; and (4) suspected carcinoma of the pancreas. One hundred forty-two operations were performed in 134 patients. Operative procedures included side-to-side pancreaticojejunostomy in 47 patients, 40%–80% caudal pancreatectomy in 28 patients, pancreaticoduodenectomy in 16 patients, total pancreatectomy in one patient, biliary tract operation in 13 patients, sphincteroplasty of the main pancreatic duct in 10 patients, pancreatic cystodigestive anastomosis in eight patients, and others.

Choice of the operative procedure was made by the status of the main pancreatic duct and the location of the lesion. Pancreatic duct drainage operations were performed in patients with dilated duct of more than 8 mm in diameter, while in patients without ductal dilatation ablative procedures were chosen (Table 1). An operative mortality was judged to be any death occurring within 30 days after operation.

Intraoperative measurement of the pancreatic intraductal pressure was carried out in five patients of chronic pancreatitis with ductal dilatation of more than 8 mm in diameter and in 10 patients of gastric cancer with normal pancreas as control. Introduction of a No. 23 gauge needle into the main pancreatic duct was carried out by direct

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puncture through the surface of the pancreas in the patients with chronic pancreatitis. In the patients of gastric cancer, a tube was inserted into the main pancreatic duct at the stump of the pancreas after caudal pancreatectomy for the purpose of lymphnode dissection at the time of total gastrectomy. The needle or the tube inserted into the main pancreatic duct was attached to a connecting tube, a three-way stopcock, a pressure transducer, and a 20-ml syringe, all filled with saline solution. The zero level of the pressure transducer was adjusted at the level of the ampulla of Vater. Pancreatic intraductal pressure was obtained by the irrigation of the main pancreatic duct with normal saline at a rate of 1.5 ml per minute. Data were analyzed using Student's t-test.

The effect of operation was assessed in patients who survived for longer than 6 months after operation. Follow-up information was obtained by clinic visit, phone call, or questionnaire. The mean follow-up durations after various operative procedures were 9.1 years for side-to-side pancreaticojejunostomy, 8.5 years for caudal pancreatectomy, 7.6 years for pancreaticoduodenectomy, 8.4 years for pancreatic sphincteroplasty, and 10.0 years for other operative procedures.

Results

Operative death was encountered in five patients (3.7%). Three patients died after ablative procedures. One patient died after pancreaticolithotomy and one after biliary tract operation. No operative deaths occurred after pancreatic duct drainage operations.

Reoperations

Nine patients required reoperation. The first operative procedures and the reoperative procedures are shown in Table 2. Recurrence of the abdominal pain was the main indication for reoperation. The interval between the first operation and the reoperation ranged from 7 months to 12 years. In six out of the nine patients, the first operation was performed only for the correction of complications such as pancreatic pseudocyst and pancreatic abscess. One

TABLE 1. *Surgical Procedures for Chronic Pancreatitis*

Patients with dilated duct	66
Side-to-side pancreaticojejunostomy	47
Pancreatic sphincteroplasty	10
Caudal pancreaticojejunostomy	2
Pancreaticoduodenectomy	5
Others	2
Patients without dilated duct	76
Caudal pancreatectomy	27
Pancreaticoduodenectomy	11
Total pancreatectomy	1
Biliary tract operation	12
Cystodigestive anastomosis	8
Others	17

of the two patients who had undergone side-to-side pancreaticojejunostomy as the first operative procedure developed severe jaundice 5.8 years after the first operation and underwent pancreaticoduodenectomy because of the suspicion of pancreatic cancer. In the other patient, since incarcerated pancreatic calculi near the orifice of the main pancreatic duct had not been removed by the first operation of side-to-side pancreaticojejunostomy, these were removed by pancreatic sphincteroplasty 12 years after the first operation, owing to recurrence of severe abdominal pain. Favorable results were obtained by the reoperations, except for one patient who died of intra-abdominal bleeding after caudal pancreatectomy.

Late Deaths

There were 34 late deaths during the follow-up period. Ten of them died of diabetes mellitus, seven of malignant tumor, five of heart disease, three of cerebral disease, three of liver disease, and six of other diseases.

Pancreatic Intraductal Pressure Study

Typical curves of pancreatic intraductal pressure are shown in Figures 1 and 2. Immediately after irrigation of the main pancreatic duct with normal saline, pancreatic intraductal pressure rose to the plateau level, which means perfusion pressure. Residual pressure was gained after

TABLE 2. *Operative Procedures for the First Operations and Reoperations*

Patient	Procedures for the First Operation	Procedures for the Reoperation
1	Pancreatic cystojejunostomy	Left splanchnicectomy
2	Pancreatic cystogastrostomy	Side-to-side pancreaticojejunostomy
3	External drainage of the pancreatic cyst	Caudal pancreatectomy
4	External drainage of the pancreatic cyst	Distal pancreatectomy
5	Drainage of the pancreatic abscess	Side-to-side pancreaticojejunostomy
6	Side-to-side pancreaticojejunostomy	Pancreatic sphincteroplasty
7	Side-to-side pancreaticojejunostomy	Pancreaticoduodenectomy*
8	Pancreatic sphincteroplasty	Distal pancreatectomy
9	Pancreaticolithotomy	Vagotomy, distal gastrectomy (Billroth II)

* Reoperation was performed in other hospital.

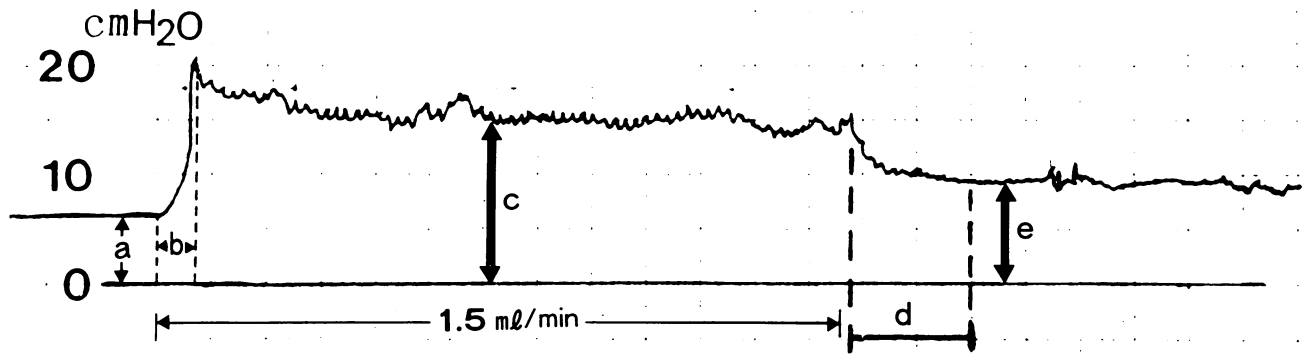


FIG. 1. Pancreatic intraductal pressure of the patient of gastric cancer with normal pancreas. a = basal pressure, b = rising time, c = perfusion pressure, d = decay time, e = residual pressure.

ceasing irrigation. Both perfusion pressure and residual pressure in the patients with chronic pancreatitis were significantly higher than those in the control (Table 3).

Effect on Abdominal Pain

The effect of operation on abdominal pain was surveyed in 104 patients. Disappearance of pain at the time of follow-up was noted in 90.7% of the patients undergoing

side-to-side pancreaticojejunostomy and in 90.5% of the patients undergoing caudal pancreatectomy. Overall, disappearance and alleviation of pain were noted in 80.8% and 16.3% of the patients, respectively, which shows a favorable effect of operation in 97.1% of the patients (Table 4). Alleviation or disappearance of pain occurred immediately after operation. Etiological factors of the disease or the length of follow-up duration did not influence the operative effect on abdominal pain.

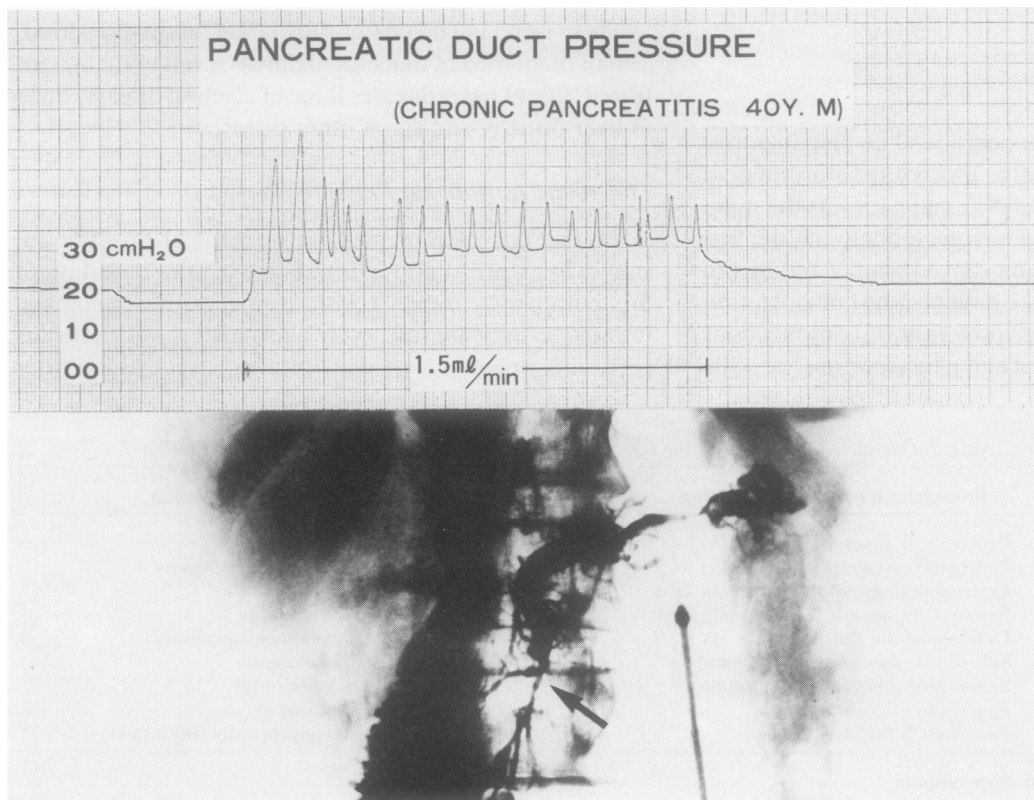


FIG. 2. Pancreatic intraductal pressure of the patient of chronic pancreatitis with dilated pancreatic duct. Perfusion pressure rises to 30 cm H₂O. Residual pressure is 20 cm H₂O. Intraoperative pancreatogram shows the stenosis of the main pancreatic duct (arrow) with distal dilatation.

TABLE 3. Pancreatic Intraductal Pressure

Patients	Perfusion Pressure	Residual Pressure
Control (N = 10)	15.2 ± 4.6 cm H ₂ O*	8.0 ± 2.8 cm H ₂ O
Chronic pancreatitis (N = 5)	38.0 ± 12.5 cm H ₂ O†	22.2 ± 3.7 cm H ₂ O†

* All results represent mean ± standard deviation.

† p < 0.005 vs. control.

Exocrine Function of the Pancreas

Comparison between the results of pre- and postoperative pancreozymin-secretin test was made in 17 patients, revealing postoperative improvement in five patients, no change in six patients, and aggravation in six patients. BT-PABA test was performed both before operation and at the time of follow-up in 13 patients. Postoperative improvement was obtained in five patients and aggravation in eight patients. Daily excretion of fecal fat was measured before and after operation in 19 patients. Fecal fat excretion decreased in six patients, remained unchanged in two patients, and increased in 11 patients at the time of follow-up.

Endocrine Function of the Pancreas

Oral glucose tolerance test, which was performed before and after operation in 42 patients, showed unchanged result in six patients and worse result in 36 patients at the time of follow-up. In all of the patients undergoing pancreatic resection, glucose tolerance was aggravated at the time of follow-up (Table 5).

Postoperative Changes in Body Weight

Comparison of body weights between the period immediately prior to the operation and the last follow-up was made in 76 survivors. Gain of more than 5% to the preoperative body weight at the time of follow-up was obtained in 27% of the patients undergoing side-to-side pancreaticojejunostomy, 41% of the patients undergoing caudal pancreatectomy, and 18% of the patients undergoing pancreaticoduodenectomy. Loss of more than 5% to preoperative body weight was noted in 55% of the patients undergoing pancreaticoduodenectomy. Overall,

TABLE 4. Effect of Operation on Abdominal Pain

Type of Operation	Number of Patients	Pain		
		Disappeared	Alleviated	Persisted
Caudal pancreatectomy	21	19 (90.5)*	2 (9.5)	
Pancreaticoduodenectomy	11	6 (54.5)	4 (36.4)	1
Side-to-side pancreaticojejunostomy	43	39 (90.7)	4 (9.3)	
Pancreatic sphincteroplasty	9	3	5	1
Caudal pancreaticojejunostomy	2	2		
Pancreatic cystodigestive anastomosis	5	2	3	
Biliary operation	9	8	1	
Others	4	3		1
Total	104	84 (80.8)	17 (16.3)	3 (2.9)

* Numbers in parentheses indicate percentage.

gain of body weight was confirmed in 36% of the patients, loss in 28%, and no change in 37% (Table 6).

Follow-up Results

Follow-up results were classified into three groups such as good, fair, and poor. The criteria for this classification were described previously.¹ One hundred fifteen patients were followed up for longer than 6 months after operation. Of these 115 patients, 81 are still alive and 34 died of various diseases. In 24 out of 34 late deaths, cause of death did not have direct relation to chronic pancreatitis, and they are excluded from the follow-up study. The remaining 10 patients who died of diabetes mellitus are included in the follow-up study as the poor group.

Good result was obtained in 74.4% of the patients undergoing side-to-side pancreaticojejunostomy, 82.4% of those undergoing caudal pancreatectomy, and 50% of those undergoing pancreaticoduodenectomy. All of the seven patients whose follow-up result was poor after side-to-side pancreaticojejunostomy died of diabetes mellitus. Overall, good result was confirmed in 70.3% of the patients, fair in 16.5%, and poor in 13.2% (Table 7). Analysis of follow-up results according to the length of postoperative duration revealed the excellent maintenance of operative benefit (Table 8). Comparison of the follow-up

TABLE 5. Postoperative Change of Glucose Tolerance

Type of Operation	Number of Patients	Glucose Tolerance at Follow-up		
		Improved	Unchanged	Aggravated
Side-to-side pancreaticojejunostomy	26	0	3 (12)*	23 (88)
Distal pancreatectomy	5	0	0	5
Pancreaticoduodenectomy	5	0	0	5
Others	6	0	3	3
Total	42	0	6 (14)	36 (86)

* Numbers in parentheses indicate percentage.

TABLE 6. Postoperative Change in Body Weight

Type of Operations	Number of Patients	Body Weight at Follow-up		
		Gained	Unchanged	Lost
Caudal pancreatectomy	17	7 (41)*	6 (35)	4 (24)
Pancreaticoduodenectomy	11	2 (18)	3 (27)	6 (55)
Side-to-side pancreatico-jejunostomy	30	8 (27)	13 (43)	9 (30)
Others	18	10 (56)	6 (33)	2 (11)
Total	76	27 (36)	28 (37)	21 (28)

* Numbers in parentheses indicate percentage.

results between alcoholic and idiopathic chronic pancreatitis showed the superiority of the latter (Table 9).

Discussion

The number of patients who die of chronic pancreatitis is gradually increasing,² though the annual incidence of chronic pancreatitis in this country has not been revealed clearly.

It has been recognized that most of the symptoms of chronic pancreatitis, including abdominal pain and pancreatic insufficiency such as steatorrhea and diabetes, can be controlled by medical treatment. Ammann et al.³ pointed out that spontaneous relief of abdominal pain in uncomplicated chronic pancreatitis was accompanied by a marked increase of pancreatic dysfunction and calcification. There is no assurance, however, that the clinical course of all patients with chronic pancreatitis follows that of Ammann's patients. It seems intolerable for the patient to wait for an indeterminate time in the hope of spontaneous relief of pain. According to the survey about the clinical course by the study group on chronic pancreatitis of the Japanese Welfare and Health Ministry,⁴ abdominal pain remained unchanged or deteriorated in 24.4% of 131 patients who were followed up for longer than 3 years under medical treatment. The authors con-

TABLE 7. Follow-up Results after Operation for Chronic Pancreatitis

Type of Operation	Number of Patients	Results		
		Good	Fair	Poor
Caudal pancreatectomy	17	14 (82.4)*	3 (17.6)	
Pancreaticoduodenectomy	10	5 (50.0)	2 (20.0)	3 (30.0)
Side-to-side pancreatico-jejunostomy	39	29 (74.4)	3 (7.7)	7 (17.9)
Pancreatic sphincteroplasty	7	3	3	1
Caudal pancreatico-jejunostomy	2	1	1	
Pancreatic cystodigestive anastomosis	7	5	1	1
Biliary operation	6	5	1	
Others	3	2	1	
Total	91	64 (70.3)	15 (16.5)	12 (13.2)

* Numbers in parentheses indicate percentage.

TABLE 8. Follow-up Results According to the Length of Postoperative Duration

Length of Postoperative Duration	Number of Patients	Follow-up Results		
		Good	Fair	Poor
Shorter than 5 years	27	16 (59.3)*	4 (14.8)	7 (25.9)
Longer than 5 years	64	48 (75.0)	11 (17.2)	5 (7.8)

* Numbers in parentheses indicate percentage.

sider that the candidates for surgical treatment are not only those who have complications requiring surgical correction but also those who have medically uncontrollable pain. Since the effect of operation on abdominal pain appears immediately after operation, this effect cannot be attributed to the increase of pancreatic dysfunction. Accordingly, surgical treatment should be done without waiting for the spontaneous pain relief by the progress of pancreatic dysfunction in the patients with intractable pain, if the lesion of the pancreas is surgically approachable.

Though the exact mechanism producing pain in chronic pancreatitis has not been well established yet, elevated pancreatic intraductal pressure and involvement of sensory nerves in scar were supposed to be the possible causes. According to the study of intraoperative measurement of pancreatic intraductal pressure by Bradley,⁵ mean pancreatic intraductal pressure in the patients of chronic pancreatitis with dilated duct was significantly higher than that of control patients. White et al.⁶ observed that elevation of pancreatic intraductal pressure above 25 cm of water produced abdominal pain in a patient with chronic pancreatitis. The authors measured pancreatic intraductal pressure by a method different from that of White et al. We observed, however, that perfusion pressure in the patients of chronic pancreatitis with dilated pancreatic duct exceeded 25 cm of water under the condition of constant perfusion of normal saline at a rate of 1.5 ml per minute. Therefore, it seems reasonable that elevated pancreatic intraductal pressure is one of the causes producing abdominal pain.

Surgical treatment for chronic pancreatitis consists mainly of pancreatic duct drainage procedures and ablative procedures of the pancreas. The rationale of pancreatic duct drainage procedures is the reduction of increased intraductal pressure. Among three pancreatic duct drainage procedures such as pancreatic sphincteroplasty,

TABLE 9. Follow-up Results According to the Etiologies

Etiology	Number of Patients	Follow-up Results		
		Good	Fair	Poor
Alcoholic pancreatitis	50	28 (56)*	10 (20)	12 (24)
Idiopathic pancreatitis	23	19 (82.6)	4 (17.4)	0

* Numbers in parentheses indicate percentage.

caudal pancreaticojejunostomy, and side-to-side pancreaticojejunostomy, side-to-side pancreaticojejunostomy is generally considered to bring about the most favorable results.^{7,8} We also prefer side-to-side pancreaticojejunostomy to other duct drainage procedures. Seventy-one per cent of our patients with dilated duct of more than 8 mm in diameter underwent side-to-side pancreaticojejunostomy without operative mortality. Since about 80% of them were proved to benefit from the operation by the present study, side-to-side pancreaticojejunostomy should be chosen first for the patients with dilated duct. It is important to make a wide anastomosis on the occasion of performing side-to-side pancreaticojejunostomy to obtain a better result.⁹ From our experience of one patient requiring reoperation after side-to-side pancreaticojejunostomy, removal of the incarcerated pancreatic calculi in the main duct of the head of the pancreas is also important to prevent recurrence of abdominal pain.

All patients with chronic pancreatitis do not have a dilated pancreatic duct. Grodzinsky et al.¹⁰ reported the absence of pancreatic duct dilatation in eight of 22 patients with advanced chronic pancreatitis. More than 50% of our patients undergoing operation possessed no marked dilatation of the main pancreatic duct. Since Way et al.¹¹ showed that side-to-side pancreaticojejunostomy failed to provide satisfactory pain relief in patients without dilated pancreatic duct, other procedures should be considered for them.

Theoretically, interruption of the sensory nerves from the pancreas is an adequate procedure for pain relief, regardless of the status of the main pancreatic duct. In practice, however, expected results cannot be achieved by this procedure.¹² Therefore, ablative procedures are chosen for the patients without dilated pancreatic duct. Ablative procedures include pancreaticoduodenectomy, 40 to 80% caudal pancreatectomy, 80 to 95% caudal pancreatectomy, and total pancreatectomy. An adequate procedure can be selected according to the location and extent of the lesion. Eighty to 95% caudal pancreatectomy and total pancreatectomy should be performed only when the duct drainage procedures or ablative procedures such as pancreaticoduodenectomy and 40 to 80% caudal pancreatectomy failed to relieve abdominal pain, because the inevitable diabetes after near-total or total pancreatectomy proved to be controlled with great difficulty.¹³⁻¹⁵ Forty to 80% caudal pancreatectomy offers the best results if the lesion can be encompassed by this procedure. Though the candidates for 40 to 80% caudal pancreatectomy are generally thought to be very rare, about 20% of our patients underwent this procedure with extremely excellent follow-up results.

As for pancreaticoduodenectomy, Taylor et al.¹⁶ and Gall et al.¹⁷ recommended this procedure for chronic pancreatitis based on their excellent results. On the other hand, follow-up results of our patients undergoing pancreaticoduodenectomy were not very satisfactory, due mainly to poor nutritional state and diabetes. Strict selection of the patients for this procedure seems to be necessary.

This study shows that surgical treatment for chronic pancreatitis can bring relief of abdominal pain in most of the patients, but it cannot help improve impaired function of the pancreas. Considering that 30% of late deaths were related to the failure to control diabetes, long-term follow-up care for pancreatic dysfunction is indispensable, even after complete relief of abdominal pain.

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