Shimane J. Med Sci.,Vol.12, pp.39-60, 1989/90

SEGMENTAL PANCREATIC AUTOTRANSPLANTATION WITH ENTERIC DRAINAGE AFTER TOTAL OR SUBTOTAL PANCREATECTOMY FOR PANCREATIC CANCER OR CHRONIC PANCREATITIS

(pancreatic autotransplantation/pancreatic cancer/ chronic pancreatitis)

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(Received October 1, 1990/Accepted November 26, 1990)

Heterotopic autotransplantation of the distal pancreas with enteric drainage was performed to preserve the pancreatic function after total or subtotal pancreatectomy in 4 cases of cancer of the pancreas and 3 cases of chronic pancreatitis. In cases of cancer of the pancreatic head who necessitated regional total pancreatectomy for large vascular involvements by the cancer, only the distal pancreas segment which was revealed to be free of cancer invasion by intraoperative pathologic examination was autotransplanted to the iliac vessels. Their pancreas grafts have been functioning and normoglycemia could be maintained without exogenous insulin administration. The present cases of the pancreatic cancer are alive and free from recurrence at present (the longest follow-up duration is 25 months). In cases of chronic pancreatitis with diffuse calcification or no dilatation of the pancreatic duct, distal subtotal pancreatectomy was done and the removed pancreas segment was autotransplanted to the iliac vessels with enteric drainage. Their grafts have survived, and normoglycemia without insulin administration could be maintained in all cases but one who had required insulin administration preoperatively. Painless effect was satisfactory (the longest follow-up duration is 56 months). In conclusion, segmental autotransplantation of the distal pancreas is effective to improve the quality of life after total or subtotal pancreatectomy.

Cancer of the pancreas with large vasular involvements of portal vein, celiac axis and its limbs and/or superior mesenteric artery necessitates regional total pancreatectomy for curative resection [1]. For chronic pancreatitis with diffuse calcification or without dilatation of main pancreatic duct, extensive focus resection such as total or subtotal pancreatectomy is the surest way to relieve the distress [2]. However, total or subtotal pancreatectomy has severe metabolic consequences.

We have attempted to preserve the pancreatic function after total or subtotal pancreatectomy by means of performing heterotopic autotransplantation of the distal pancreas segment with enteric drainage for four cases of cancer of the pancreas and three cases of chronic pancreatitis. The present study is follow-up evaluation of the endocrine and exocrine pancreatic functions at 4 months to 56 months after segmental autotransplantation of the distal pancreas in seven cases.

METHODS

Regional pancreatectomy in our series was performed for cancer of the head of the pancreas with large vascular involvement by the cancer without hepatic, peritoneal and other distant metastases. Extended total pancreatectomy was done with en bloc removal of regional lymph nodes and other soft tissues, including the large vascular involvement(s) by the cancer such as portal vein, celiac axis, hepatic artery and/or superior mesenteric artery was removed with vascular reconstruction by end-to-end anastomosis without vascular graft. In some cases, whole stomach or a part of bowel was removed owing to loss of its blood supply.

In these cases, distal pancreas was cut on at least 3 cm ditant line from the edge of the cancer, and only the distal segment was prepared for autotransplantation, which was demonstrated "no cancer cell in the stump, in the adjacent lymph node and in the pancreatic juice of the segment" by intraoperative pathologic examination. The remainder of the excised pancreas with en bloc removed tissue was submitted for light microscopic pathologic studies.

For chronic pancreatitis with diffuse calcification or without dilatation of the main pancreatic duct, we have done

focal resection. For distal subtotal pancreatectomized cases, almost all the removed pancreas segment (i.e., 70-80 % of the whole pancreas) was prepared for autotransplantation. A small rim of the stump of the segment was submitted for light microscopic pathologic studies.

The spleen was removed, and the pancreas segment was trimmed and measured its weight, preparing for transplantation. An arteriovenous fistula to prevent thrombosis [3] of the graft was constructed by end-to-end anastomosis between the splenic artery and vein at the distal pancreas. Then, it was transplanted to the right lateral iliac fossa, principally by end-to-side anastomosis of the splenic vessels to the iliac vessels. As a general rule, the pancreatic juice was drained to the jejunum by end-to-end pancreaticojejunostomy [4]. The graft was placed in an extraperitoneal pocket at right lateral iliac area.

Patency of the graft vessels was assessed by common iliac arteriography or digital subtraction angiography (DSA).

Preoperative and postoperative endocrine pancreatic function was assessed by oral glucose tolerance test (OGTT) with determination of plasma glucose and immunoreactive insulin levels, and C-peptide immunoreactivity (CPR) was measured in common iliac vein on the transplanted side, simultaneously in another peripheral vein in a selected case. The dose of glucose for OGTT was 75g, samples were drawn at 0, 30, 60, 90, 120, 180 minutes after oral glucose administration. The insulinogenic index for initial response was calculated by dividing the increment of plasma insulin by the increment of plasma glucose above fasting level at 30 minutes after glucose administration [5]. Daily change of plasma glucose levels after the operation was observed by its frequent measurements.

Preoperative and postoperative exocrine pancreatic function was assessed by Pancreatic Function Diagnostant Test (PFD test), using synthetic peptide of n-benzoyl-l-tyrosyl-p-aminobenzoic acid [6]. Normal range of PFD test in our Institute is over 73 %. In a case who had permanent external pancreatic fistula of the graft, daily volume of the pancreatic juice was observed.

Postoperative pancreatic function in totally pancreatectomized cases with the autograft represents the graft function itself, and the one in subtotally pancreatectomized cases with

the autograft does the functions of the graft and adding the small cephalic remainder of the pancreas.

CASE REPORT

The list of the objective cases of this study is shown in Table 1.

Case 1 :

A 51-year-old, alcoholic man with a 15-year history of severe abdominal and back pain had required frequent hospitalization under a diagnosis of chronic pancreatitis being complicated diabetes, since then he had required insulin injection (20 U/day) and narcotics. Preoperative and operative examinations revealed chronic pancreatitis with diffuse calcification except small cephalic portion of the pancreas around the duodenum, and with irregular dilatation of the pancreatic duct (Fig. 1). In December 1984, distal subtotal pancreatectomy, dissected the pancreas on the right side of the portal vein, was performed as whole focal resection. Almost all the removed pancreas segment was transplanted to the right iliac vessels with end-to-end pancreaticoileostomy (in this case, jejunal mesentery was shortened and pancreaticojejunostomy was impossible). The graft size was about 80 % of whole pancreas (only in this case, the weight of the graft was not measured). Pathologic findings of the specimen showed severe chronic pancreatitis with decayed acinar tissue and fibrosis, and with thinly scattered islets. Postoperatively, patency of the graft vessels was demonstrated by angiography till 4 years after operation, but only the distal splenic arteriovenous fistula did not patent by 4 years after operation (Fig. 2). Diabetic glucose tolerance and low CPR response on OGTT were gradually aggravated, but CPR release in common iliac vein on the transplanted side was higher than in another peripheral vein, meaning slight functioning of the graft (Fig. 3). At present, the same dose of insulin administration as the preoperative is required. The value of PFD test was 63 % preoperatively, and 79 % at 1 month after operation, maintaining 73-75 % till 4 years after operation (Fig. 15). Abdominal and back pain has completely resolved and he has come back to his previous job.

Case 2 :

A 65-year-old woman was diagnosed as cancer of the head of the pancreas with localized large vascular involvements of superior mesenteric artery and portal vein (Fig. 4), and celiac axis and common hepatic artery (Fig. 5) by the cancer. In July 1987, curative extended total pancreatectomy associated with segmental resection of all the involved large vessels. Whole stomach and upper half of the jejunum (ca. 200 cm) were removed on account of loss of blood supply. Distal pancreas segment weighing 30 g, which was shown to be free from cancer by intraoperative pathologic studies, was transplanted to her right lateral iliac fossa. External pancreatic drainage without pancreaticoenterostomy was constructed using a silicon tube to prevent pancreatic leakage into peritoneal space. Postoperative pathologic studies showed well differentiated tubular adenocarcinoma (duct cell carcinoma), and slight edema in acini and intact islets. Postoperatively, patency of the graft vessels has been recognized by angiography till now, but distal splenic arteriovenous fistula showed obstruction by 18 months after operation similarly to case 1. Glucose tolerance and insulin response on OGTT after operation showed the same as before operation(Fig. 6), and she has not necessitated insulin administration till now. Ca. 50 ml of pancreatic juice drained from the graft has been observed every day (Fig.15). She has been free from recurrence of the cancer, and enjoying her home life.

Case 3 :

A 63-year-old man was diagnosed as cancer of the head of the pancreas with localized vascular involvements of portal vein, celiac axis and common hepatic artery by the cancer. In March 1988, curative extended total pancreatectomy associated with segmental resection of the involved large vessels. Whole stomach and a part of upper jejunum (ca. 50 cm) were removed. Distal pancreas segment weighing 40 g, being free from cancer was transplanted to the right iliac vessels with pancreaticojejunostomy. Postoperative pathologic studies showed moderately differentiated tubular adenocarcinoma (duct cell carcinoma), and normal acinar tissue and intact islets. Postoperatively, patency of the graft vessels has been demonstrated by angiography till now. Glucose tolerance and insulin response on OGTT after operation showed almost the same as before

operation (Fig. 7), and no insulin administration has been requested till now. Preoperative value of PFD test was unknown, and the one showed 58 % at 1 month after operation and decreased to 30 % at 8 months after operation (Fig. 15). He has been free from recurrence of the cancer, and enjoying his taste for driving a car.

Case 4 :

A 58-year-old man was diagnosed as pancreatic ascites because of massive fluid in peritoneal space (Fig. 8) and high levels of amylase (34360 IU/L) and protein (3.8 g/dL) in ascites. Endoscopic retrogradepancreatography (ERP) revealed an irregularly formed cyst of the body of the pancreas communicating with the main pancreatic duct (Fig. 9). We considered that the source of pancreatic ascites should be disruption of the cyst caused by alcoholic chronic pancreatitis. In addition, he had undergone partial gastrectomy (Billroth-I typed reconstruction) on account of perforative duodenal ulcer 17 years ago. In August 1988, he underwent surgical treatment. The cyst, of which wall was very thin and fragile, tightly adhered to the pancreas itself, the remnant stomach and the omentum. Hence, en bloc resection of ca. 70 % distal portion of the pancreas including the cyst (i.e, pancreas dissection on the middle line of the portal vein), spleen, distal stomach and greater omentum was performed. The distal pancreas segment weighing 43 g, was prepared under ex vivo trimming. It was transplanted to the right iliac vessels with pancreaticojejunostomy. Pathologic studies of the specimen showed mild chronic pancreatitis with interlobular fibrosis and almost normal islets, and pseudocyst constituted by hyalinized collagenous tissue without lining epithel. Postoperatively, patency of the graft vessels has been shown by angiography. Preoperatively, oxyhyperglycemia with hyperresponse of insulin on OGTT, probably derived from postgastorectomy [7], was observed. The same response on OGTT, including the same grade of insulin release was recognized postoperatively, (Fig. 10), and insulin administration has not been requested. The value of PFD test was 84 % preoperatively, and has maintained 79-83 % (Fig. 15). He has made a complete recovery from the distress and come back to his job.

Case 5 :

A 70-year-old alcoholic woman had suffered from severe

abdominal pain, and was diagnosed as chronic pancreatitis. ERP revealed a small calculus in cephalic portion of the main pancreatic duct without dilatation of the distal duct. In September 1988, she underwent operation. The pancreas was hard and atrophic except small portion of the head around the duodenum. Distal subtotal pancreatectomy, cutting on the right side of the portal vein, was performed as whole focal resection including pancreatic calculus. Distal 80 % of the resected pancreas weighing 40 g, was transplanted to the right iliac vessels with pancreaticojejunostomy. Pathologic studies of the specimen showed moderate chronic pancreatitis with acinar atrophy and periductal fibrosis, and almost normal islets. Postoperatively, patency of the graft vessels has been shown by angiography till now. Postoperative glucose tolerance on OGTT was almost the same as the preoperative, and its insulin release was rather hyperresponse than the preoperative (Fig. 11). Insulin administration has not been requested. The value of PFD test was 74 % preoperatively, 58 % at 1 month and 64 % at6 months after operation. She has been completely recovered from abdominal pain, and enjoying home life.

Case 6 :

A 63-year-old woman was diagnosed as cancer of the head of the pancreas with localized vascular involvements of portal vein and dorsal pancreatic artery closely to splenic artery by the cancer. In March 1989, curative extended total pancreatectomy associated with segmental resection of the portal vein and distal subtotal gastrectomy were done. The distal pancreas segment weighing 25 g, being confirmed to be free of cancer by intraoperative pathologic studies, was transplanted to the right iliac fossa with pancreaticojejunostomy. Postoperative pathologic studies of the specimen showed moderately differentiated tubular adenocarcinoma (duct cell carcinoma), and thin islets in atrophic and fibrotic acini of the pancreas. Patency of the graft vessels has been recognized by angiography. Postoperative glucose tolerance on OGTT was almost the same as the preoperative, and its insulin response slightly decreased in comparison to the preoperative (Fig. 12). No insulin administration has been requested at present. The value of PFD test was 81 % preoperatively, 54 % at 1 month and 50 % at 3 months after operation (Fig. 15). She has been free of recurrence of the cancer, and enjoying her home life.

Case 7 :

A 62-year-old man was diagnosed as a cyst of the head and body of the pancreas. In April 1989, distal subtotal pancreatectomy including the cyst was carried out, dissecting the pancreas on the right side of the portal vein. After ex vivo trimming with cutting off the cyst, a pancreas segment weighing 75 g, was transplanted to the iliac vessels with pancreaticojejunostomy. Postoperative pathologic studies of the specimen demonstrated almost normal structure of the pancreas with cystoadenocarcinoma which was sharply localized in intracapsularly. The stump of the segment was completely free from the carcinoma. Patency of the graft vessels has been recognized by angiography. Postoperative glucose tolerance on OGTT was rather better than the preoperative, and sufficient insulin response to glucose was obtained (Fig. 13). Normoglycemia without insulin administration has remained. The value of PFD test was 85 % preoperatively, and 78 % at 1 month after operation (Fig. 15). He has been free from reccurrence of the cancer, and come back to his job.

RESULTS

The results of each case are descrived in above-mentioned Case Reports, respectively. They are summarized in Table 1.

Postoperatively, patency of the pancreatic graft vessels has been confirmed by angiography till now in all seven cases.

However, splenic venogram in DSA (arteriography) was not detected, which means no patency of the distal splenic arteriovenous fistula, by 48 months after operation in case 1 (Fig. 2) and by 18 months after operation in case 2. Thrombosis did not occur in all cases, and other complications in the graft such as bleeding, infection, pancreatic leakage or pancreatitis did not occur in all cases. All of the pancreatic grafts have survived. The mean weight of pancreatic graft except case 1 was 42.2 $\pm$ 7.1 g (mean $\pm$ SE), in which the maximum was 75 g in case 7 and the minimum was 25 g in case 6 (Table 1).

Postoperatively, all of the patients but case 1 have been able to remain normoglycemia without insulin administration. Glucose tolerance and insulin response on OGTT in each case is demonstrated in Case Reports, respectively. Individual postoperative values of the initial insulinogenic index on OGTT

are summarized in Fig. 14. Those in cases 2, 5 and 7 showed satisfactory levels (the latest values : 0.34, 0.35 and 0.54, respectively), which were rather higher than individual preoperative levels. Those in cases 3 and 6 showed very low levels (the latest values : 0.15 and 0.04, respectively), and they have had a narrow escape from insulin administration. The one in case 4 was 0.74 preoperatively, increased to 1.18 at one month after operation, and decreased to 0.36 at 6 months after operation, but the absolute value of insulin release on OGTT at 6 months after operation was sufficient (Fig. 10). The CPR response on OGTT in case 1 was gradually aggravated postoperatively, and he requests the same dose of insulin administration as the preoperative (Fig. 3). Postoperative daily change of plasma glucose levels without insulin administration, especially in totally pancreatectomized cases (cases 2, 3 and 6), was satisfactorily stable (Fig. 16).

Postoperative change of exocrine pancreatic function of the graft is summarized in Fig. 15. Postoperative values of PFD tests in cases 1, 4, 5 and 7 showed sufficient and almost similar to the preoperative. Those in cases 3 and 6 showed gradual down grade. Daily volume of pan-creatic juice from external drainage of the graft in case 2 has shown constantly about 50 ml. All patients have been generally administered digestives such as pancreatin 3-9 g, and adding antidiarrhoeica in cases 2, 3 and 6, hence all patients can be controlled diarrhea.

It was easy to observe the pancreatic graft by means of ultrasonography and palpation, because the graft was placed in extraperitoneal space of the lateral iliac area. All patients with this procedure for pancreatic cancer (cases 2, 3, 6 and 7) are free from recurrence of the cancer at present. Their pancreatic grafts are functioning, and they have not required insulin injection. They have obtained satisfactory quality of life after operation.

Disabling pain of chronic pancreatitis has completely resolved in all patients with this procedure (cases 1, 4 and 5). Their pancreatic grafts have survived and well functioned without need of insulin injection in cases 4 and 5, and with need of the same dose of insulin administration as the preoperative in case 1. They have obtained satisfactory quality of life after this operation.

DISCUSSION

We have performed heterotopic autotransplantation of the distal pancreas segment for four patients with cancer of the pancreas (three of regional total pancreatectomy for cancer of the head of the pancreas and one of distal subtotal pancreatectomy for cystadenocarcinoma of the head and body of the pancreas) and for three patients with chronic pancreatitis.

The indication of total pancreatectomy for cancer of the head of the pancreas is controversial [1, 8-12]. In the present three patients with cancer of the head of the pancreas, cancerous involvement of celiac axis including splenic artery (cases 2 and 3) or the involvement of dorsal pancreatic artery closely to splenic artery (case 6), additionally to the involvement of portal vein, was observed. In such cases, there was no choice but to do extended total pancreatectomy with en bloc removal of the vascular involvements with the view of the curative resection. However, total pancreatectomy has severe metabolic consequences such as brittle diabetics, fatty liver or malnutrition. We have attempted to preserve the pancreatic function after total pancreatectomy by means of autotransplantation of the distal pancreas, which was demonstrated to be free of cancer invasion by histological examination.

In totally pancreatectomized cases in our series, only the distal pancreas segments in the present three cases 2, 3 and 6 could be used for autotransplantation. This procedure contains the same problems as pancreaticoduodenectomy (Whipple procedure) against total pancreatectomy. The main reason for performing total pancreatectomy in preference to pancreaticoduodenectomy is multicentricity of the tumor [8-12]. Cubilla and Fitzgerald represented that 19 % of the cases showed duct epithelium changes (carcinoma in situ) associated with pancreas cancer, but most of them were adjacent to the primary cancer, and they were observed distantly in the body and the tail of the pancreas only in 1 % of the cases with cancer of the head of the pancreas (2/195), [11]. In the present cases, transplanted pancreas segments were cut on at least 3 cm distal line from the edge of the cancer, and no cancer cell in the stump of them was demonstrated by intraoperative pathologic studies. Intraductal dissemination to the distal pancreas

is also one of the patterns of development of cancer of the head of the pancreas [10, 12], and intraluminal floating cells may be there in this pattern [10]. In the present cases, no cancer cell was observed in the pancreatic juice of the segment by intraoperative pathologic examination. Additionally, no metastatic finding of the lymph node around the segment in the present cases was shown by the intraoperative studies.

We consider that our above-mentioned criteria (i.e., cutting line of the segment is at least 3 cm distal from the edge of the cancer and intraoperative pathologic studies show no cancer cell in the stump, in the pancreatic juice and in the adjacent lymph node of the segment), is sufficient to avoid the risk of the remnant cancer cell in the autotransplanted pancreas segment. In fact, no recurrence of the cancer is found in the transplanted pancreas segments of the present three cases.

The reason why we did not choose the site of autotransplantation orthotopically (i.e., by means of in situ vascular reconstruction) but heterotopically to the lateral iliac fossa (extraperitoneally), is as follows. The pancreatic graft can be independent of the risk of the retroperitoneal local recurrence of the pancreatic cancer. It is easy to follow and observe the pancreatic graft by means of palpation, ultrasonography and other diagnostic means, which is placed in the lateral iliac fossa just closely to the abdominal wall. Then, surgical treatment can be undergone easily and as soon as possible, even if recurrence of the cancer might be occurred in the pancreatic graft (fortunately, we have not experienced such a case). Lastly, pancreatic juice of the graft was principally drained to the jejunum, and it is safe to place the pancreaticojejunostomy in the extraperitoneal pocket.

We have done distal subtotal pancreatectomy as whole focal resection in the present cases of chronic pancreatitis with diffuse calcification (case 1), without dilatation of the pancreatic duct (case 5), with pancreatic ascites (case 4) and with non-invasive cystadenocarcinoma (case 7). In such cases, it should be unsuitable to make anastomosis between the pancreatic duct or cyst and gastrointestine, and pancreatectomy should be the surest way to relieve the pain of chronic pancreatitis [2]. However, extensive pancreatectomy such as subtotal pancreatectomy has metabolic consequences similarly to

total pancreatectomy, and some surgical procedures are available to preserve the pancreatic function [13, 14]. We have applied heterotopic autotransplantation of the resected distal pancreas segment with pancreaticojejunostomy. Therefore, not only endocrine but also exocrine functions could be preserved, and painless effect derived from resection (absolute denervation) could remain permanently because of heterotopic placing. In this procedure, it is easy to perform secondary cephalopancreaticoduodenectomy for completion pancreatectomy after the autotransplantation of the distal pancreas, even if pain derived from the residual head of the pancreas will be persistent [13]. Fortunately, we have not experienced such a case.

Technically, our procedure of the transplantation is the same one as allotransplantation of the pancreas for type-I diabetes [15]. We made splenic arteriovenous fistula at the tail of the pancreas segment to prevent thrombosis [3]. We demonstrated that the splenic artriovenous fistula of the pancreas segment did not influence to the function from a view point of the tissue blood flow of the pancreas in another experimental studies [16]. In the present study, the artriovenous fistula had not been patent late after operation(18-48 months), but thrombosis of the transplanted pancreas segment did not occur in any cases. We consider that the artriovenous fistula plays an important role of preventing thrombosis early after operation, and it is sufficient and necessary to be patent only for early phase after operation.

All of the present pancreatic grafts have survived. But, in case 1 with follow-up duration of 56 months, endocrine function of the graft (glucose tolerance and plasma CPR response on OGTT in the iliac vein on the transplanted side) had been gradually aggravated after operation, and the same dose of insulin administration as the preoperative was required. In this case, pathologic findings of the pancreas showed severe chronic pancreatitis with scattered islets, and then total number of islets of the graft may be very small. For the progressive deterioration of glucose tolerance and endogenous insulin release in case 1, so-called Sandmeyer's diabetes [17] or progressive aggravation of chronic pancreatitis itself in the graft may be partially responsible. On the other hand, exocrine pancreatic function (PFD value) had not become worse in progress after operation. Precise meaning of the discre-

pancy between endocrine and exocrine functions in this case is unknown.

The other six patients can maintain normoglycemia without exogenous insulin (follow-up duration of 4-25 months). Although the mean weight of pancreatic graft was 42.2 ± 7.1 g (the minimum 25 g, the maximum 75g), glucose tolerance and insulin release on OGTT showed almost the same as the preoperative in respective cases. In subtotally pancreatectomized cases, almost all the pancreatic tissue (transplanted pancreas plus small remainder of the pancreas head) was preserved. In totally pancreatectomized cases, only the pancreatic tissue of the transplanted segment was preserved. However, the initial insulinogenic indices are very low levels, especially in totally pancreatectomized cases, which is owed partially to the post-gastorectomic oxyhyperglycemia [7] and mainly to small volume of the pancreatic tissue. In the present follow-up duration, these patients can remain normoglycemia and stable levels of plasma glucose in daily change, but careful observation for delayed onset diabetes (Sandmeyer's diabetes [17]) must be required.

Various ways for management of the pancreatic juice in pancreas graft have been studied [4, 13, 15, 18, 19]. We have applied enteric drainage, principally to the jejunum, because digestive function of the pancreatic juice can be preserved, and the method such as ductal occlusion may cause fibrosis of the pancreas [19] resulting in endocrine dysfunction. In case of autotransplantation, there is no problem of rejection and it is safer for the anastomosis between pancreas and intestine to be placed extraperitoneally, even if leakage from the pancreaticoenterostomy might be occurred. In the present cases, exocrine function was obtained in proportion to the volume of the pancreas, and some digestive ability could functioned but a case (case 2) with permanent external pancreatic drainage. In cases with pancreatic cancer with rapid decrease of PFD value, we are looking for its cause (for example, duct obstruction owing to recurrent cancer, or no patency of the pancreatic orifice at the pancreaticojejunostomy) but unknown at present.

Postoperatively, patients with painful chronic pancreatitis can be completely relieved from the pain, and patients with pancreatic cancer can be free from recurrence till now.

They can be enjoying common social life.

We conclude that segmental pancreatic autotransplantation with enteric drainage can preserve both endocrine and exocrine functions in selected patients with total or subtotal pancreatectomy for pancreatic cancer or chronic pancreatitis, and the postoperative quality of life is extremely satisfactory.

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Table 1. Results of heterotopic autotransplantation of the distal pancreas.

case no.	age, sex	primary disease	operation for primary disease	size or weight of the graft	follow-up duration	technical success	insulin administration
1	51, m.	chronic pancreatitis	distal subtotal pancreatectomy	ca. 80% of the pancreas	56 mo.	yes	yes ÷
2	65, f.	cancer of the head of the pancreas	extended total pancreatectomy	30 g	25 mo.	yes	no
3	63, m.	cancer of the head of the pancreas	extended total pancreatectomy	40 g	17 mo.	yes	no
4	58, m.	chronic pancreatitis	distal subtotal pancreatectomy	43 g	12 mo.	yes	no
5	70, f.	chronic pancreatitis	distal subtotal pancreatectomy	40 g	12 mo.	yes	no
6	63, f.	cancer of the head of the pancreas	extended total pancreatectomy	25 g	5 mo.	yes	no
7	62, m.	cystoadenocarcinoma of the pancreas	distal subtotal pancreatectomy	75 g	4 mo.	yes	no

(÷ The same dose of insulin administration as preoperatives is required at present.)

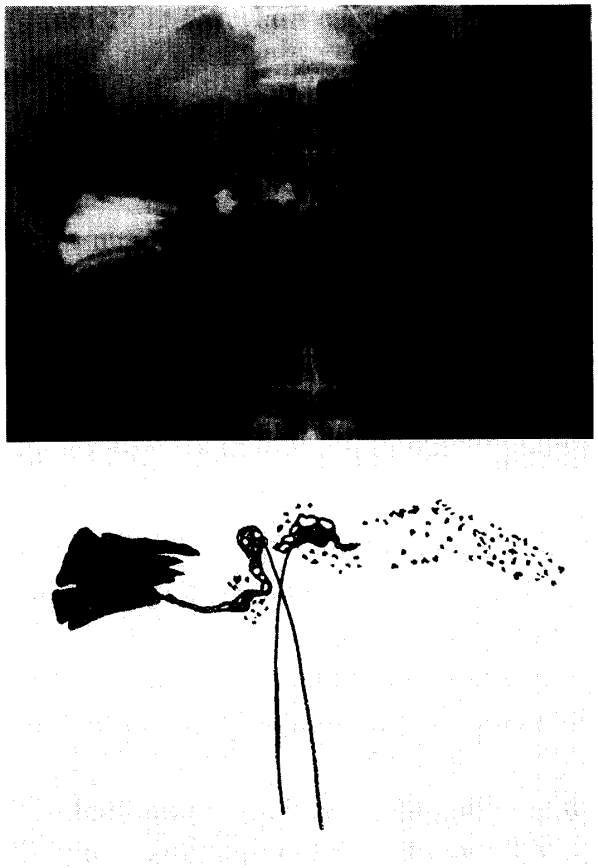

Fig. 1. Intraoperative pancreatography and its schema in case 1. Diffuse calcification except small portion of the head of the pancreas and irregular dilatation of the main pancreatic duct are shown.

Fig. 2. Postoperative angiography of the pancreatic graft in case 1. Left. (postop. 1mo.) ; Transplanted splenic artery and vein are well detected. The vein is arterialized and dilated by distal splenic arterio-venous fistula. Middle. (postop. 2yr.) ; Splenic artery and vein are well detected. The vein is still dilated. Right. (postop. 4yr.) ; Only splenic artery is detected but the vein is not detectable. The splenic arteriovenous fistula may not patent. (Small arrows indicate transplanted splenic artery, and wide arrows indicate the splenic vein.)

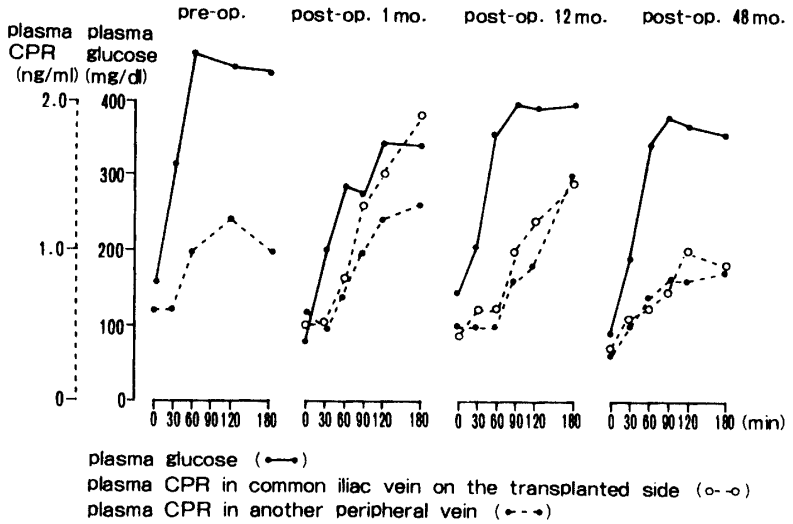

Fig. 3. Results of oral glucose tolerance tests in case 1.

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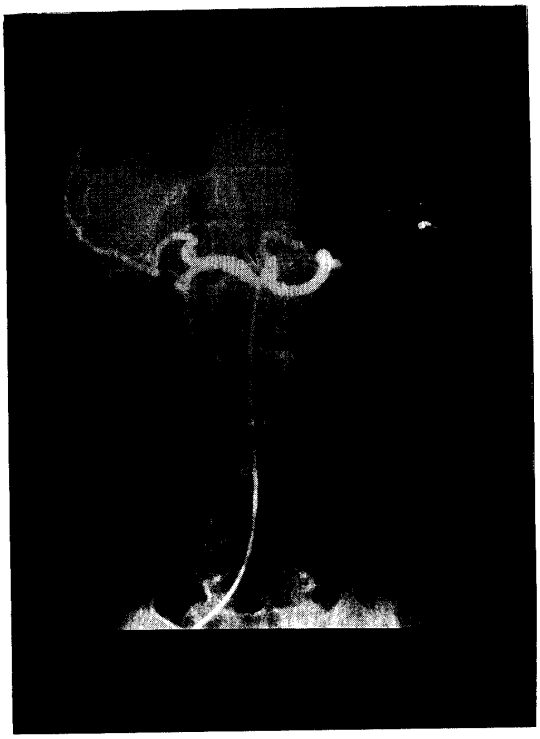

5

Fig. 4. Preoperative portography (trans-superior mesenteric artery) in case 2. Remarkable stenosis of intrapancreatic portal vein and superior mesenteric vein is demonstrated (arrows).

Fig. 5. Preoperative celiac arteriography in case 2. Tumor encasement of celiac axis and its branches is shown (arrows).

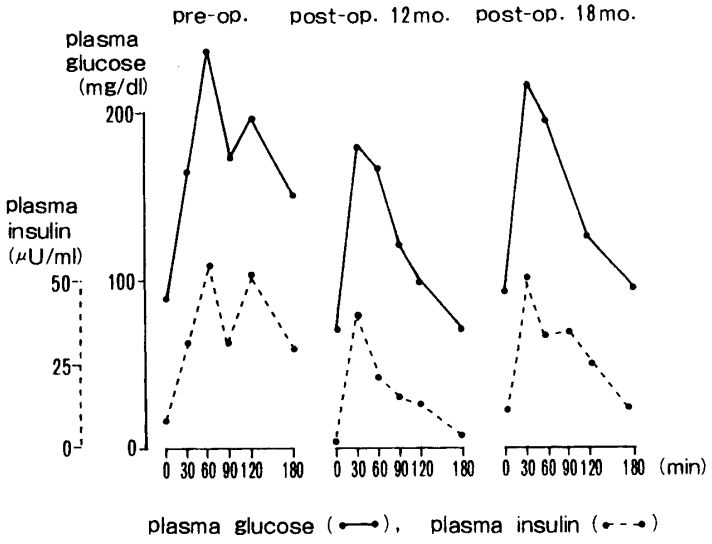

Fig. 6. Results of oral glucose tolerance tests in case 2.

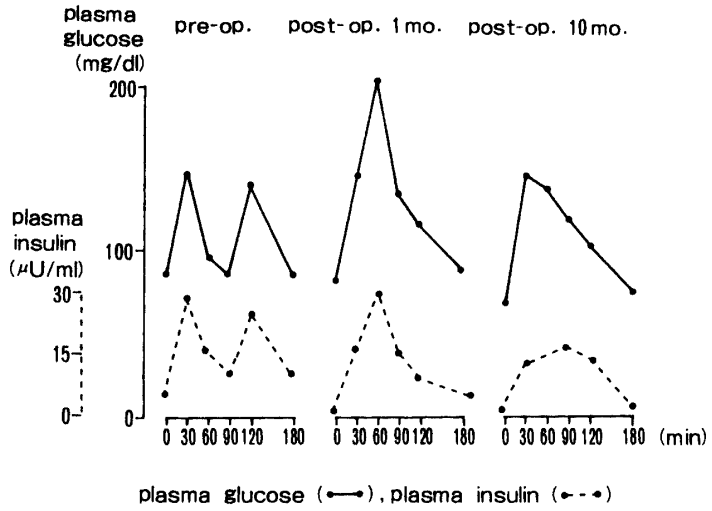

Fig. 7. Results of oral glucose tolerance tests in case 3.

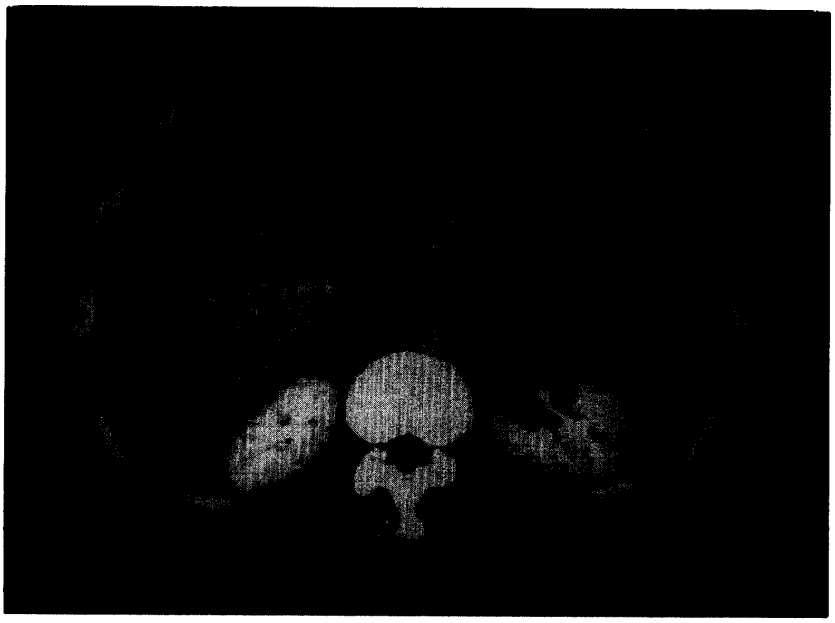

Fig. 8. Computed tomography in case 4. Massive ascites is detectable, in which amylase level was 34360 IU/L and protein level was 3.8 g/dL.

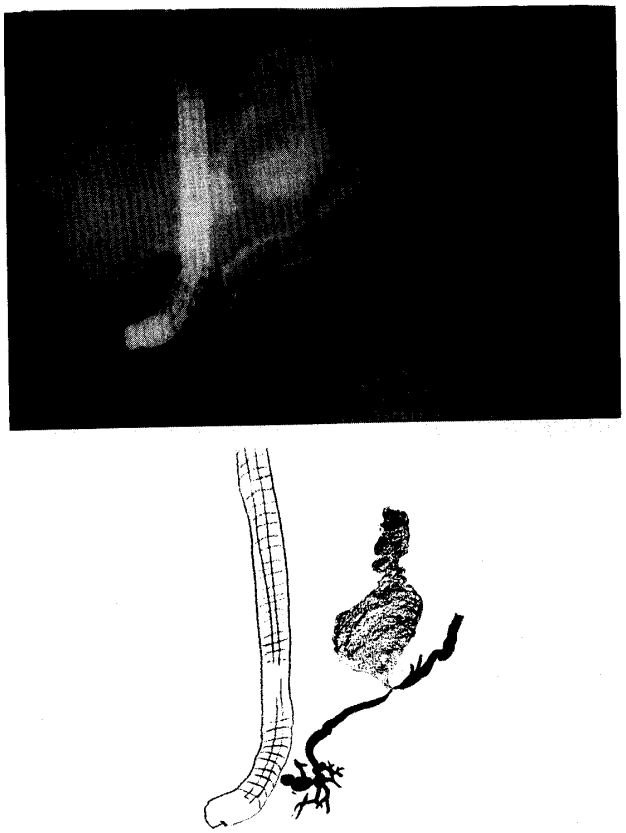

Fig. 9. Endoscopic retrograde pancreatography and its schema in case 4. An irregularly formed cyst communicating with the pancreatic duct is demonstrated.

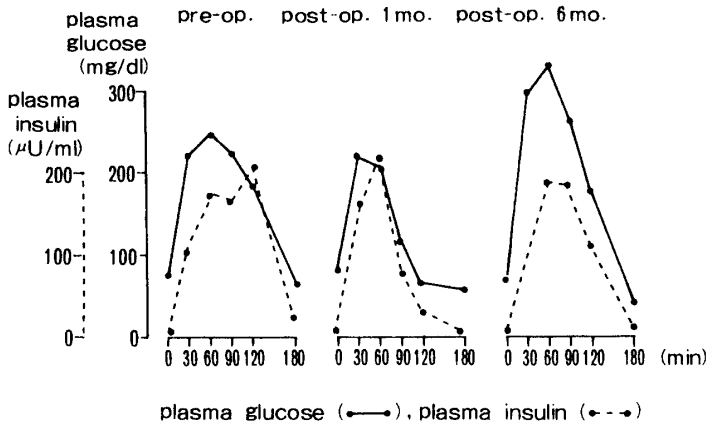

Fig. 10. Results of oral glucose tolerance tests in case 4.

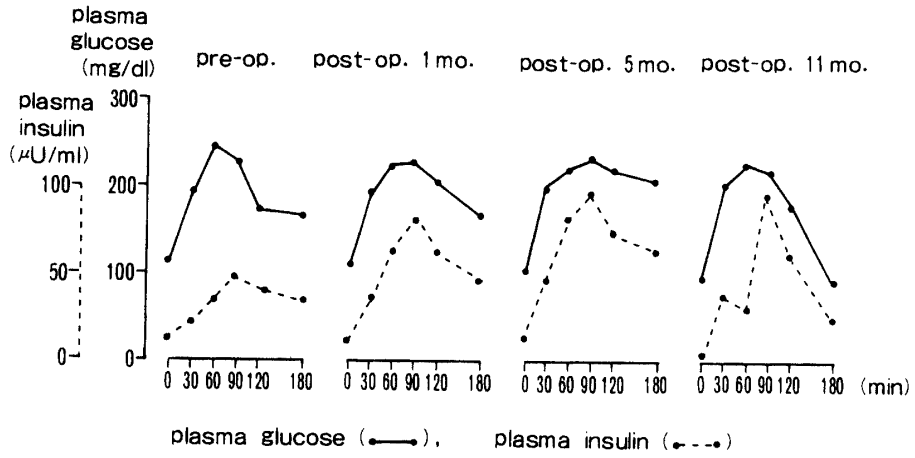

Fig. 11. Results of oral glucose tolerance tests in case 5.

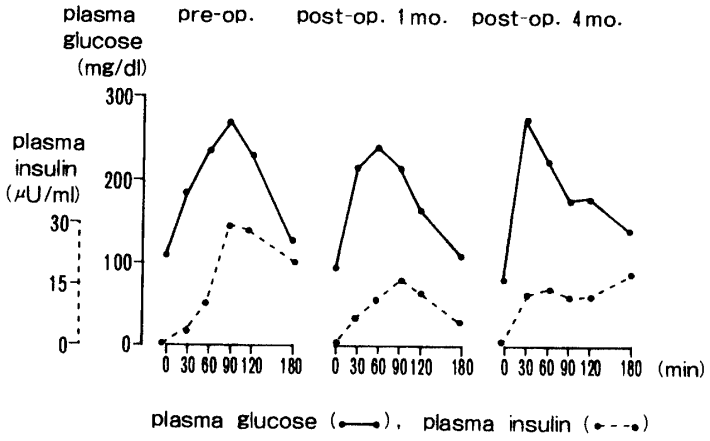

Fig. 12. Results of oral glucose tolerance tests in case 6.

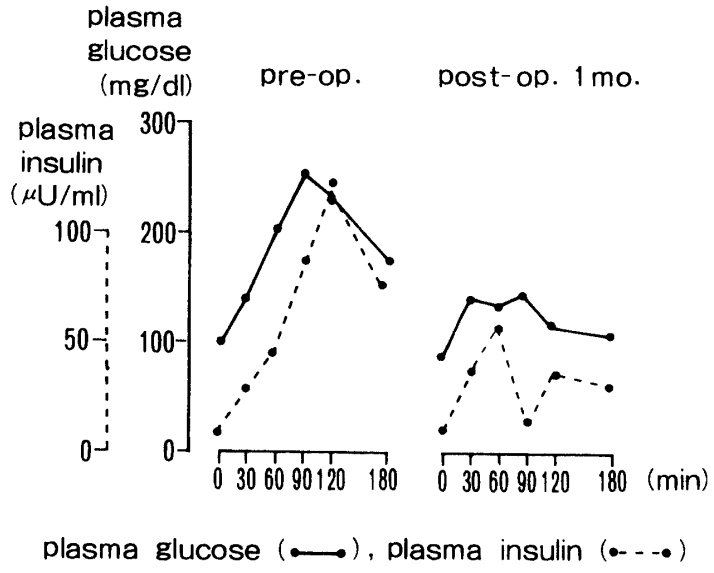

Fig. 13. Results of oral glucose tolerance tests in case 7.

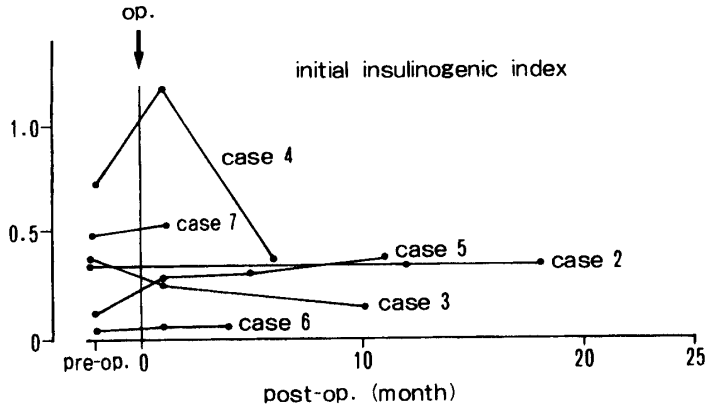

Fig. 14. Postoperative changes of initial insulinogenic index on oral glucose tolerance tests.

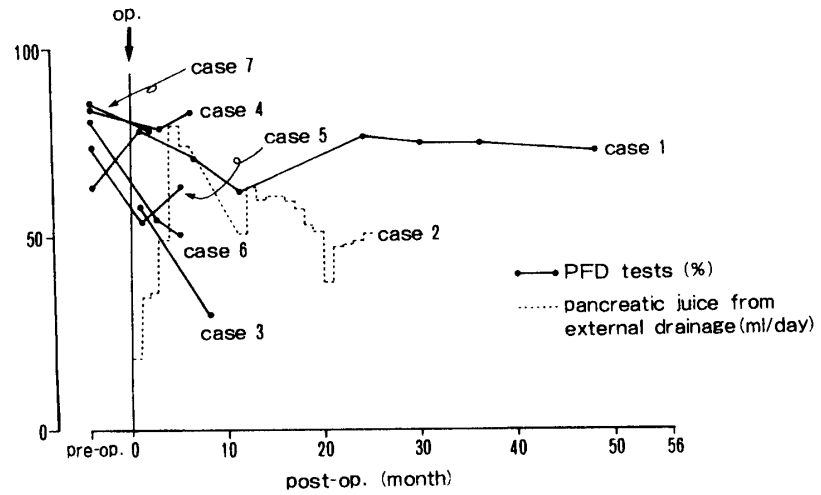

Fig. 15. Postoperative change in exocrine pancreatic function.

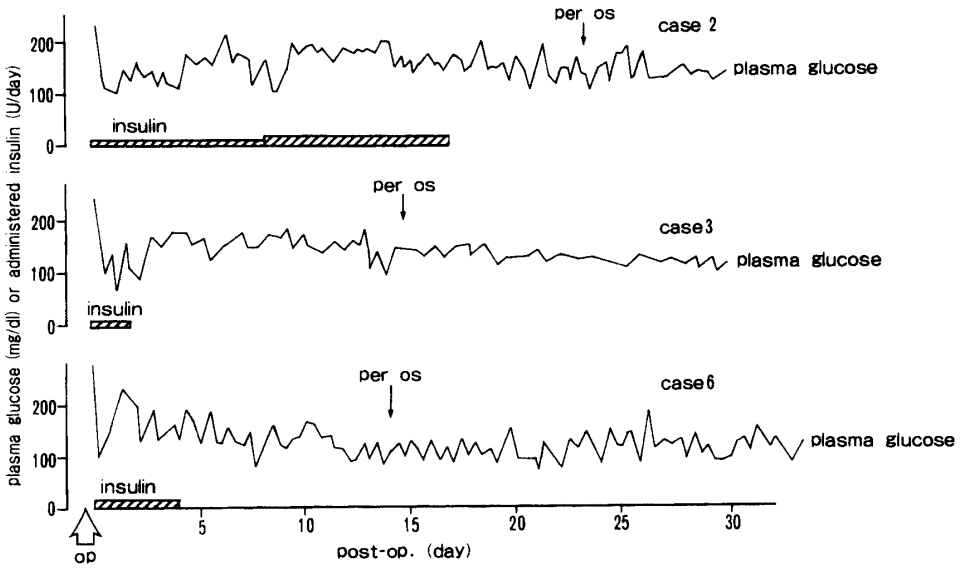

Fig. 16. Daily changes of plasma glucose level after total pancreatectomy with segmental pancreatic autotransplantation.