

## Pancreatectomies for Benign or Borderline Malignant Cystic Tumors of the Pancreas

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### ABSTRACT

At present, benign or borderline malignant cystic tumors located in the head, uncus, body or tail of the pancreas that are not small and superficial enough to be enucleated are usually resected with a pancreatoduodenectomy (PD) or distal pancreatectomy (DP). Such operations may cause digestive disorders, glucose intolerance. Duodenum-preserving pancreatoduodenectomy (DpPHR), uncinata resection (UR), segmental pancreatectomy (SR) and spleen-preserving distal pancreatectomy (SpDP) are function-preserving procedures. The purpose of this study was to evaluate whether DpPHR, SR and SpDP were valuable procedures in pancreatic surgery. Patients were treated by DpPHR (n=7; 1 serous cystadenoma, 1 mucinous cystadenoma, 5 intraductal papillary mucinous tumors), UR

(n=1; 1 intraductal papillary mucinous tumor), SR (n=4; 1 solid and cystic tumor, 1 serous cystadenoma, 2 mucinous cystadenomas) and SpDP (n=7; 5 mucinous cystadenomas, 2 intraductal papillary mucinous tumors). There were no fatalities during or immediately following surgery. All patients but one were not glucose intolerance and digestive disorders. We believe that DpPHR, UR, SR and SpDP were minimally invasive procedures in pancreatic surgery; it is a reliable technique for benign or borderline malignant cystic tumors and has a surgical risk similar to that of standard operations. Its principal advantage is that it preserves pancreatic parenchyma, biliary tract and the spleen better than PD or DP.

**Key words:** Pancreas, Cystic tumor, Surgical procedures, Minimally invasive

### INTRODUCTION

There are various benign and borderline malignant cystic tumors, including serous cystadenoma, mucinous cystadenoma, solid and cystic tumor, intraductal papillary adenoma/carcinoma and invasive papillary carcinoma. At present, benign or borderline malignant cystic tumors located in the head, uncus, body or

tail of the pancreas that are not small and superficial enough to be enucleated are usually resected with a pancreatoduodenectomy (PD) or distal pancreatectomy with splenectomy (DP). These operations may cause digestive disorders and glucose intolerance<sup>1)</sup>. Less extensive resection of the duodenum, pancreas and/or spleen has been the procedure of choice

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recently for borderline tumors<sup>2)</sup>. Duodenum preserving pancreatoduodenectomy (DpPHR), uncinete pancreatectomy (UR), segmental pancreatectomy (SR) and spleen-preserving distal pancreatectomy (SpDP) are function-preserving procedures.

The purpose of this study was to evaluate whether DpPHR, UR, SR and SpDP were valuable procedures in pancreatic surgery for benign or borderline malignant tumors of the pancreas.

### PATIENTS AND METHODS

Nineteen patients with benign or borderline malignant cystic tumors of the pancreas receiving surgical treatment at Sapporo Medical University Hospital between April 1993 and August 2000 were reviewed retrospectively with regard to the pathological diagnosis, digestive function and clinical follow-up after operation.

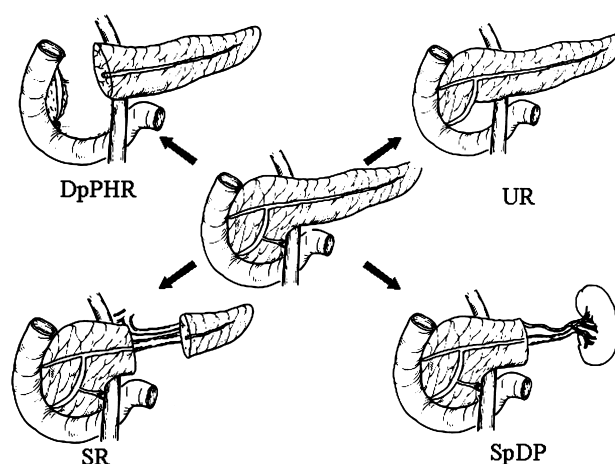
Patients were treated by DpPHR (n=7; 1 serous cystadenoma, 1 mucinous cystadenoma, 5 intraductal papillary mucinous tumors), UR (n=1; 1 intraductal papillary mucinous tumor), SR (n=4; 1 solid and cystic tumor, 1 serous cystadenoma, 2 mucinous cystadenomas) and SpDP (n=7; 5 mucinous cystadenomas, 2 intraductal papillary mucinous tumors) (Fig. 1).

Before and at 5 postprandial time points (30, 60, 90 and 120 minutes), blood samples were taken for the measurement of C-peptide (CP) and glucagon (GLU).

We compared these procedures with regard to (1) postoperative complications (2) responses of CP and GLU to a test meal (600Kcal) and (3) postoperative weight changes comparing before and after operation.

### RESULTS

The characteristics of the patients who underwent these pancreatectomies are shown in Table 1. Histopathological examination revealed that 8 patients had intraductal papillary mucinous tumors, 8 patients had mucinous cystadenomas, one patient had serous cystadenoma and one patient had a solid and cys-



**Fig. 1** Function-preserving procedures for benign or low grade malignant cystic tumors of the pancreas.

Operative procedures were adopted as follows, Duodenum-preserving pancreatoduodenectomy (DpPHR) for tumors located in the head, uncinete pancreatectomy (UR) for tumors located in the uncinete process, segmental pancreatectomy (SR) for tumors located in the body and spleen-preserving distal pancreatectomy (SpDP) for tumors located in the tail of the pancreas.

tic tumor. One intraductal papillary mucinous tumor was minimally invasive carcinoma. There were no significant differences between gender or age and tumor location. There was a significant difference in tumor location between mucinous cystadenomas and intraductal mucinous tumors. Mucinous cystadenoma commonly occurred in the body or tail of the pancreas and intraductal papillary mucinous tumors commonly occurred in the head of the pancreas.

Postoperative complications occurred in 4 (21%) of the 19 patients (two biliary stenoses, one duodenal stenosis, one pancreatic leakage). Biliary or duodenal stenosis occurred in 3 (43%) of the 7 patients who underwent DpPHR. However, no patient underwent reoperation for a postoperative complication. There were no fatalities during or immediately following surgery and all patients could be discharged after it.

After discharge from the hospital, all patients were alive without recurrent disease after a median follow-up of 3 years. The patient with minimally invasive papillary adenocarcinoma is presently alive and well without any

**Table 1** Patients' characteristics

	Tumor Location			P value
	Head	Body	Tail	
Gender				
Male	5	1	2	
Female	3	3	5	n.s.
Age, yrs (mean±SD)	56.8±16.2	58.2±16.1	52.4±16.8	n.s.
Histopathological diagnosis				
Solid and cystic tumor		1		
Serous cystadenoma	1	1		
Mucinous cystadenoma	1	2	5	
Intraductal papillary mucinous tumor	6*		2	P<0.05**
Operation procedures				
DpPHR	7			
UR	1			
SR		4		
SpDP			7***	

\*; Minimally invasive carcinoma in one case

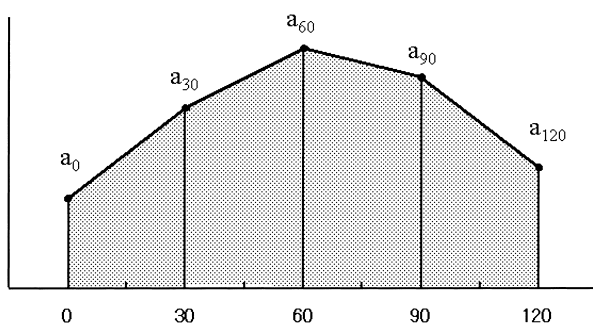
\*\*; There was a significant difference in tumor location between mucinous cystadenomas and intraductal mucinous tumors (head vs. tail).

\*\*\*; Laparoscopically operation in one case

DpPHR; Duodenum-preserving pancreas head resection, UR; Uncinate process resection, SR; Segmental resection, SpDP; Spleen-preserving distal pancreatectomy.

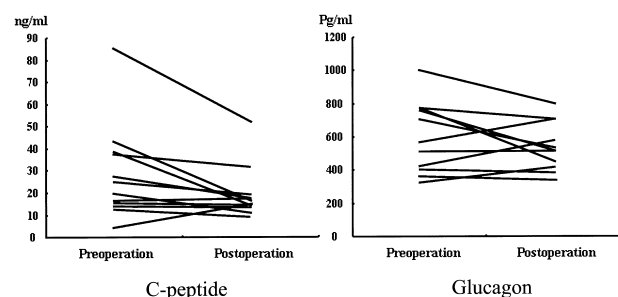
evidence of recurrent disease more than 4 years after the operation.

Total secretion levels of CP and GLU were calculated with a numerical formula of total secretion= $1/2(a_0+a_{120})+a_{30}+a_{60}+a_{90}$ . (a=serum levels at postprandial time points). Fig. 2. Total secretion of CP and GLU is shown in Fig. 3. A

**Fig. 2** Total secretion of C-peptide and glucagon

Total secretions of C-peptide (CP) and glucagon (GLU) were calculated with a numerical formula of total secretion= $1/2(a_0+a_{120})+a_{30}+a_{60}+a_{90}$  (a=serum levels at postprandial time points).

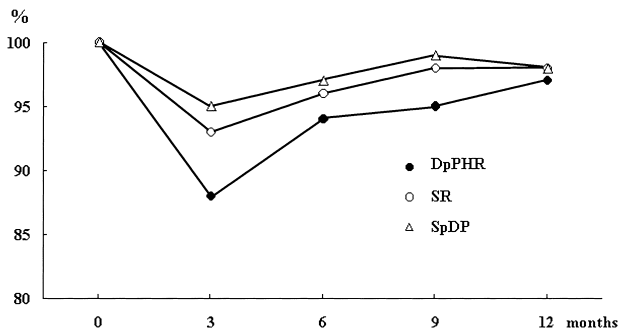
significant difference was found in the change of CP. There was no difference in change of GLU. After the follow-up period, all patients but one who developed diabetes after SpDP had neither glucose intolerance nor digestive disorders. Glucose tolerance was amelioration remarkably, in a case of SpDP, accordingly

**Fig. 3** Changes in Total Secretion of C-peptide and Glucagon

All patients but one who developed diabetes after SpDP were not glucose intolerance and digestive disorders. Glucose tolerance was amelioration remarkably, in a case of SpDP, accordingly postoperative CP level decline to a normal range.

postoperative CP level decline to a normal range.

Although the recovery of body weight in patients who underwent DpPHR was delayed more than in other patients, it recovered within 1 year in almost all patients (Fig. 4).



**Fig. 4** Postoperative time course of the body weight recovery

Although recovery of body weight in patients who underwent DpPHR was delayed more than in other patients, however it recovered within 1 year in almost all patients.

## DISCUSSION

DpPHR is a type of partial head resection. An important step in this operative procedure is preservation of the blood supply to the duodenum and bile duct. To preserve blood flow, the mesoduodenum was preserved and the Kocher maneuver was not performed. Beger<sup>3)</sup> emphasized that protection of all vessels of the mesoduodenum along the ascending duodenum is important in duodenum-preserving pancreatic head resection, because he experienced one instance of postoperative duodenal fistula caused by complete dissection of the mesoduodenum. Another important step is identification of the intrapancreatic bile duct. Dissection of the bile duct should not exceed half the circumference in order to preserve the blood flow to the duct.

UR<sup>4)</sup> is a type of DpPHR. Removal of the uncinate process of the pancreas with the preservation of Wirsung's duct allows resection of a localized tumor within the uncinate process of the pancreas, maintains the flow of pancreatic juice into the duodenum, and preserves the

dorsal part of the head of the gland. The cut end of the head of the pancreas is closed by interrupted sutures.

Tumors located in the body of the pancreas that are not small and superficial enough to be enucleated are usually resected with distal pancreatectomy with splenectomy. These operations may cause digestive disorders, glucose intolerance, and late postsplenectomy infection. Segmental resection (SR)<sup>5)</sup> is a procedure whereby the cephalic stump is sutured and the distal stump anastomosed with a Roux-en-Y jejunal loop.

In spleen-preserving distal pancreatectomy (SpDP)<sup>6)</sup>, the operative technique emphasizes division of the splenic artery and vein beyond the tip of the distal pancreas without mobilization of the spleen.

We consider that these partial resections of the pancreas should be performed for treating benign or borderline malignant cystic tumors. The favorable prognosis suggests that complete extirpation with a free margin is essential for treating these neoplasms, and thus their limited involvement enables surgeons to perform partial resection of the pancreas. Care must be taken to ensure complete extirpation of this tumor. However, histological examination of the resected specimens revealed that one patient had minimally invasive intraductal papillary adenocarcinoma after DpPHR. He has survived 4 years and is doing well now. In intraductal papillary mucinous tumors, preoperative differentiation between adenoma and adenocarcinoma is often difficult. Koito<sup>7)</sup> suggested that MRCP appears to be more effective and less invasive than ERCP to evaluate changes in the size and extent of tumors and to determine if new lesions appear, as well as to follow up mucin-producing pancreatic tumors. Sugiyama<sup>8)</sup> proposed that intraductal papillary mucinous tumors with a main pancreatic duct diameter greater than or equal to 15 mm, or tumor diameter greater than or equal to 30 mm (branch duct type) showed a high prevalence of adenocarcinoma.

There were no severe early postoperative complications after these partial resections of the pancreas. However, postoperative complications occurred in 4 (21%) of the 19 patients (two biliary stenoses, one duodenal stenosis, one pancreatic leakage). Biliary or duodenal stenosis after DpPHR is a quite possible complication when the intrapancreatic biliary duct or duodenum became ischemic. No patient underwent reoperation for a postoperative complication. There were no fatalities during or immediately following surgery and all patients could be discharged thereafter. Great care must be taken when performing pancreaticojejunostomy, because blood flow to the pancreas and duodenum may be impaired by the operative procedures.

As for CP, postoperative decline was statistically significant, but this was not the case for GLU. Total secretion of GLU was maintained in most cases. Glucose tolerance was amelioration remarkably, in a case of SpDP, accordingly postoperative CP level decline to a normal range. Govil et al.<sup>9)</sup> reported that twelve patients became diabetic after surgery: three of 20 in whom the spleen was preserved and nine of 16 who underwent splenectomy and suggested that splenic preservation, apart from preventing postsplenectomy sepsis, might also delay the onset of diabetes. In present series, amelioration of Glucose tolerance was recognized in a case of SpDP, instead of deterioration in a case of SpDP. The endocrine changes and the resection area are undoubtedly closely correlated. However, the details concerning this correlation are a subject for future study of these limited pancreatectomies.

The body weight was lowest 3 months after operation and recovered smoothly within 1 year. Due to the high morbidity rate of DpPHR, recovery was slower after operation. The recovery will become faster in the future if postoperative complications decrease.

## CONCLUSION

The prognosis for surgically resectable borderline malignant tumors is better than that for invasive pancreatic duct carcinoma. When treating benign or borderline malignant cystic tumors of the pancreas, techniques that allow preservation of pancreatic and gastroenteric functions should be selected when possible. We believe that DpPHR, UR, SR and SpDP are minimally invasive procedures in pancreatic surgery; they are reliable techniques for benign or borderline malignant cystic tumors and have surgical risks similar to those of standard operations. Their principal advantage is that they preserve the pancreatic parenchyma, biliary tract and the spleen better than PD or DP.

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