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Pancreaticoduodenectomy with External Drainage of the Pancreatic Remnant

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OBJECTIVE: Leakage of the pancreaticojejunal anastomosis is a serious complication after pancreaticoduodenectomy. External drainage of the pancreatic remnant is one of several methods for reducing pancreaticojejunal anastomotic leakage or fistula. We investigated complications after pancreaticoduodenectomy with and without external drainage of the pancreatic remnant.

METHODS: Patients who underwent pancreaticoduodenectomy at King Chulalongkorn Memorial Hospital, Bangkok, Thailand from November 1991 to October 2007 were enrolled. Before 2001, no external pancreatic drainage was employed during pancreaticojejunal anastomosis (non-stented group). Since 2001, external drainage of the pancreatic remnant has been routinely performed with a paediatric feeding tube (stented group).

RESULTS: There were 28 patients in the non-stented group and 45 in the stented group. Stented patients had undergone significantly more previous abdominal operations, pylorus preserving pancreaticoduodenectomy, and end to end anastomosis of the pancreatic remnant and jejunal limb. Leakage of the pancreaticojejunal anastomosis or pancreatic fistula, overall complications, and re-laparotomy rate were significantly higher in the non-stented group (leakage or fistula 21.4% *vs.* 6.7%, overall complications 50% *vs.* 33.3%, and re-laparotomy 18% *vs.* 2.2%). The only death was in the non-stented group.

CONCLUSION: External drainage of the pancreatic remnant after pancreaticoduodenectomy is an effective method for prevention of pancreaticojejunal anastomosis leakage and other related complications. [*Asian J Surg* 2008;31(4):167–73]

Key Words: external pancreatic drainage, pancreatic fistula, pancreaticoduodenectomy, pancreaticojejunal anastomotic leakage

Introduction

Pancreaticoduodenectomy (PD) was first successfully performed and reported by Kausch in Berlin in 1912.[1] In 1935, Whipple et al popularized this complex procedure and reported three patients with carcinoma of the ampulla of Vater who had undergone PD.[2] Until 1980, the operative mortality was relatively high, ranging from 17% to 23% in some large series.[3–5] With increasing experience and advances in medical and surgical technology, the mortality rate has dramatically decreased to less than 5%, but the overall morbidity is still high at 25–50%.[6–11]

Amongst a long list of complications currently recognized after PD, leakage of the pancreaticojejunal anastomosis and pancreatic fistula are the most dangerous. The incidence has been 8–20% in recent studies.[6–11] Although the majority of patients with pancreatic fistulae can be successfully treated by conservative means, serious consequences such as bleeding and severe intra-abdominal infection may occur.[6–8,12–14] Furthermore, delayed gastric

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emptying, re-laparotomy, prolonged hospital stay, and increasing hospital costs are also unwanted related sequelae.

One of the major aims of PD is to establish proper management of the pancreatic remnant. Prevention of pancreaticojejunal anastomotic failure following PD has been attempted with several modifications of the surgical techniques. Amongst them, external drainage of the pancreatic remnant has been practiced and reported with satisfactory outcomes.[15–18] The basic concept of draining the pancreatic enzymes away from the jejunal limb to promote healing of the anastomosis is attractive, especially in centres with low or medium surgical capacity for these complex operative procedures. We have added external drainage of the pancreatic remnant in patients who underwent PD since 2001. This change began after we encountered a patient with fatal haemorrhage from leakage of the pancreaticojejunal anastomosis in what should have been an uneventful PD in late 2000. The idea that draining the pancreatic enzymes out of the body would minimize the risk of pancreaticojejunal anastomotic leakage and subsequent complications inspired us to undertake the present study.

The purpose of the present study was to examine the occurrence of complications in patients who underwent PD before and after external pancreatic drainage.

Patients and methods

Patients who had undergone pancreaticoduodenectomy with external drainage of the pancreatic remnant from January 2001 to October 2007 were compared prospectively with those who had undergone the same operation without external drainage from November 1991 to December 2000. All operations were performed by Suvit Sriussadaporn at King Chulalongkorn Memorial Hospital, Bangkok, Thailand.

Surgery was performed in almost exactly the same way in all patients. In brief, after the surgical specimen was removed, the jejunum was brought through the retromesenteric route to form an anastomosis with the pancreatic remnant and bile duct. Then, the gastric remnant (in classical PD) or first part of the duodenum (in pylorus-preserving PD) was anastomosed to the jejunum in an antecolic, end-to-side fashion.[19] Before 2001, reconstruction of the pancreaticojejunal anastomosis was performed without using an external pancreatic drainage (non-stented group). Since 2001, external pancreatic drainage has been added during reconstruction of the pancreaticojejunal anastomosis (stented group). Most of the anastomoses were performed using the end-to-end method (21 of 28 non-stented and all stented patients). The end-to-end pancreaticojejunal anastomosis was performed by invaginating the cut end of the pancreatic remnant, approximately 2 cm in length, into the end of the jejunal limb. The end of the jejunal limb was fixed to the pancreatic parenchyma with an interrupted 3-0 polypropylene suture. External pancreatic drainage was created by using a paediatric polyvinyl chloride feeding tube. This was inserted into the pancreatic duct as a stent, and brought out through the jejunal and abdominal wall, and connecting to a reservoir (urine bag) (Figure). The stent was secured

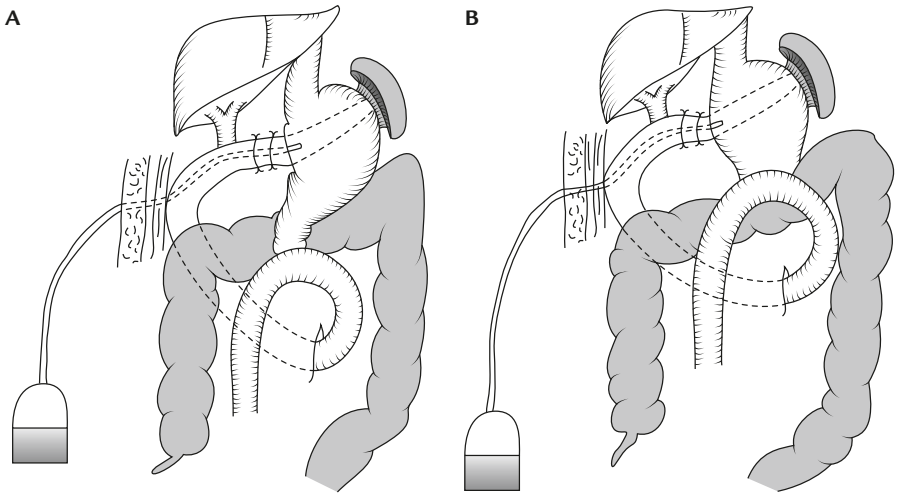

Figure. Illustration demonstrating methods of reconstruction of the pancreaticobilioduodenal or gastrojejunal anastomosis after pancreaticoduodenectomy, with insertion of the external pancreatic stent: (A) in pylorus-preserving pancreaticoduodenectomy; (B) in classical Whipple operation.

to the pancreatic stump with two 5-0 absorbable sutures, and was pulled out 3–4 weeks later when the anchoring sutures dissolved. If there was any resistance during removal of the stent, the procedure was aborted and repeated 2 weeks later until successful. Most external pancreatic stents were removed at the outpatient clinic. The size of the pancreatic stents used depended on the size of the pancreatic ducts. A number 3, 5 or 8 French paediatric feeding tube was used for a small, medium or large pancreatic duct, respectively.

Two Penrose drains were routinely placed at the subhepatic area and Morrison's pouch. Prophylactic antibiotics were routinely administered. The patients received no postoperative octreotide to prevent pancreaticojejunal anastomotic leakage. Pancreaticojejunal anastomotic leakage was diagnosed from operative findings at re-laparotomy. Pancreatic fistula was diagnosed when drainage fluid from Penrose drains contained amylase more than three times the serum amylase level after postoperative day 3, as suggested by the International Study Group on Pancreatic Fistula (ISGPF).[20]

Demographic data, details of operations, operative findings of the texture of the pancreatic remnant and size of the pancreatic duct, and postoperative complications of both groups of patients were compared using the χ^2, Fisher's exact and Student's *t* tests. Comparison of the qualitative data (i.e. gender, texture of the pancreatic remnant, etc.) was performed with the χ^2 or Fisher's exact test as appropriate. Comparison of the quantitative data (i.e. age, operation time, etc.) was performed with the Student's *t* test. A value of $p < 0.05$ was considered statistically significant.

Results

There were 28 patients in the non-stented and 45 in the stented group. The age ranged from 21 to 92 years (mean, 61.4; median, 63). Forty-three patients (58.9%) were male and 30 (41.1%) were female. The age, gender, urgency of operation, pathological diagnosis, texture of the pancreatic remnant, size of the pancreatic duct, operative time, operative blood transfusion, death rate, and hospital stay did not differ significantly between the two groups of patients. The stented group had a significantly higher number of patients with a history of previous abdominal surgery (18 *vs.* 3 in the non-stented group), pylorus-preserving operation (34 *vs.* 11 in the non-stented group), and reconstruction of the pancreaticojejunal anastomosis using the end-to-end method (45 *vs.* 21 in the non-stented group) (Tables 1–3).

Three uncomplicated pancreatic fistulae occurred in the stented patients, and leakage and fistulae occurred in six of the non-stented patients. Five patients in the non-stented group underwent re-laparotomy, with one death. There was only one re-laparotomy and no deaths in the stented patients. Indications for re-laparotomy in the non-stented patients were: massive bleeding after leakage of the pancreaticojejunal anastomosis in one patient (died); intra-abdominal collection of abscesses, with sepsis in two patients; obstruction of the gastrojejunal anastomosis in one patient; and stricture of the choledochojejunal anastomosis in one patient. The indication for re-laparotomy in the only patient in the stented group was intra-abdominal abscess collection and sepsis. Patients who had asymptomatic pancreatic fistulae (biochemical leakage with raised amylase levels in the drainage fluid, but no clinical symptoms) were all successfully treated by conservative management. This included maintenance of oral intake, protection of the skin from the digestive action of drainage fluid, and shortening of the Penrose drains at 2–3 weeks after the occurrence of pancreatic fistula, when the fistula tract was established. Leakage of the pancreaticojejunal anastomosis or pancreatic fistula, overall complications, and the re-laparotomy rate were significantly higher in the non-stented group (leakage or fistula 21.4% *vs.* 6.7%, overall complications 50% *vs.* 33.3%, and re-laparotomy 18% *vs.* 2.2%).

In patients who had external drainage of the pancreatic remnant (stented group), 24 (53.3%) had fibrotic pancreatic parenchyma and 21 (47.7%) had normal pancreas (Table 3). The pancreatic ducts were dilated (> 3 mm diameter) in 26 patients (57.8%). One (2.2%), 18 (40%) and 26 (57.8%) patients were stented with a paediatric feeding tube of size 3, 5 and 8 French, respectively. The pancreatic drainage volume from the external stent ranged from 80 mL to 600 mL/day (mean, 225 ± 114; median, 200). Duration of pancreatic stenting ranged from 15 to 107 days (mean, 37 ± 20; median, 35).

Discussion

Leakage of pancreaticojejunal anastomosis has long been recognized as a concern for surgeons who perform PD. Complications at or around the pancreaticojejunal anastomosis are the most frequent and dangerous following

Table 1. Demographic data

	External pancreatic drainage		*p*
	No ($n=28$)	Yes ($n=45$)	
Age, yr			NS*
Mean	60 ± 48	63 ± 16	
Median	65	63	
Range	21–84	33–92	
Gender			NS†
Male	16	27	
Female	12	18	
Previous abdominal operation	3	18	< 0.05‡
Elective operation	28	43	NS‡
Urgency of operation			
Emergency operation	0	2	
Type of operation			< 0.05†
Classical Whipple	17	11	
PPPD	11	34	
Pancreaticojejunal anastomosis			< 0.05‡
End to side	7	0	
End to end	21	45	
Pathological diagnosis			NS†
Ca ampulla of Vater	15	14	
Ca head of the pancreas	5	12	
Ca distal common bile duct	2	5	
Ca duodenum	2	1	
Other malignancies	2	6	
Other benign conditions	2	7	

*Student's *t* test; †χ^2 test; ‡Fisher's exact test. NS = not significant; PPPD = pylorus-preserving pancreaticoduodenectomy.

PD.[12] Subsequent haemorrhage after these complications may be fatal.[13,14] Several methods of constructing the pancreaticojejunal anastomosis have been advocated, none of which can completely eliminate the possibility of leakage. We had a patient who succumbed to massive bleeding after leakage of the pancreaticojejunal anastomosis following PD in late 2000. Since then, we have added an external pancreatic stent to drain the pancreatic remnant and have encountered fewer problems with the pancreaticojejunal anastomosis. Although we could not completely eliminate the occurrence of pancreatic fistulae, the incidence of this complication in the stented patients was remarkably low (6.7%). All three pancreatic fistulae in the stented patients were uncomplicated, with an output of 30–50 mL/day. The fistula was spontaneously closed within 2 weeks, whilst the external pancreatic stent was draining 200–300 mL/day of pancreatic juice. Furthermore, these minor pancreatic fistulae were treated successfully without parenteral nutritional support, and oral intake was maintained until the fistulae were spontaneously closed. Our study has confirmed the advantage of draining the pancreatic juice out of the body. The stented patients had a significantly lower rate of pancreatic stump problems and overall complications. Only one patient underwent re-laparotomy for intra-abdominal collection of abscesses since the introduction of external drainage of the pancreatic remnant. In our opinion, prevention of pancreaticojejunal anastomosis leakage following PD is an important means to prevent other related complications such as pancreatic fistula, intra-abdominal infection, intra-abdominal bleeding, delayed gastric emptying, and wound infection.

Table 2. Operative data and outcomes

	External pancreatic drainage		*p*
	No ($n=28$)	Yes ($n=45$)	
Operative time, min			NS*
Mean	480 ± 115	452 ± 93	
Median	480	420	
Range	270–705	300–780	
Operative blood transfusion, units			NS*
Mean	3.7 ± 2.4	4.2 ± 2.3	
Median	3.5	3	
Range	0–12	0–7	
Complications			< 0.05†
Leakage of pancreaticojejunal anastomosis or pancreatic fistula	6 (21.4%)	3 (6.7%)	
Wound infection	2	5	
Bile fistula	0	2	
Intra-abdominal collection	2	1	
Delayed gastric emptying	2	2	
Gastric outlet obstruction	2	0	
Acute coronary syndrome	0	1	
Gastrointestinal bleeding	0	1	
Overall complications	14 (50%)	15 (33.3%)	< 0.05‡
Re-laparotomy	5 (17.9%)	1 (2.2%)	< 0.05†
Death	1 (3.6%)	0	NS†
Hospital stay, d			NS*
Mean	27.5 ± 20.6	27.5 ± 14.6	
Median	23	21.5	
Range	10–92	11–73	

*Student's *t* test; †Fisher's exact test; ‡χ^2 test.

The idea of using an external pancreatic stent to prevent pancreaticojejunal anastomotic leakage can be traced back to the early days of PD.[21,22] The underlying reasons supporting the usefulness of an external pancreatic stent to protect the pancreaticojejunal anastomosis can be explained simply. Firstly, draining the pancreatic enzymes from the pancreaticojejunal anastomotic area prevents the digestive action of the remnant pancreas. Secondly, decompressing the jejunal limb results in lowering the tension at the anastomotic site which creates a better environment for healing. Thirdly, stenting of the pancreatic duct allows more precise placement of sutures during pancreaticojejunal anastomosis.[18] In our experience, the pancreatic ducts were found easily in all patients, without the need to stimulate pancreatic secretion by intravenous administration of secretin, as recommended by some investigators.[16] All except one normal pancreatic duct could be stented with a number 5 French paediatric feeding tube. The remaining normal pancreatic duct was stented with a number 3 French paediatric feeding tube. All dilated pancreatic ducts that were associated with chronic pancreatic fibrosis were stented with a number 8 French tube. Some investigators have shown that the rate of pancreaticojejunal anastomotic leakage or pancreatic fistula is high in patients with soft, fragile, normal pancreatic parenchyma.[15,23,24] Ohwada et al have recommended the use of external pancreatic stents in patients with small pancreatic ducts (< 2 mm in diameter).[25] Although anastomosis of the jejunal limb to the fibrotic pancreatic parenchyma in patients with a dilated pancreatic duct is

Table 3. Comparison of pancreatic texture and size of pancreatic duct and details of stented patients

	Non-stented patients, *n* (%) (*n* = 28)	Stented patients, *n* (%) (*n* = 45)	*p**
Pancreatic texture			NS
Normal parenchyma	12 (42.9%)	21 (46.7%)	
Chronic fibrotic pancreas	16 (57.1%)	24 (53.3%)	
Pancreatic duct			NS
Normal size (2–3 mm diameter)	13 (46.4%)	19 (42.2%)	
Dilated (> 3 mm diameter)	15 (53.6%)	26 (57.8%)	
Size of pancreatic stent (paediatric feeding tube)			
3 French	1 (2.2%)		
5 French	18 (40.0%)		
8 French	26 (57.8%)		
Volume of external pancreatic drainage, mL/day			
Mean	225 ± 114		
Median	200		
Range	80–600		
Duration of pancreatic stent, d			
Mean	37 ± 20		
Median	35		
Range	15–107		

*χ^2 test. NS = not significant.

claimed to be safe and seems to remove the need for external pancreatic drainage, we still suggest insertion of an external pancreatic stent in all patients to minimize the risk of pancreatic leakage.

Our treatment outcomes in patients who had external pancreatic drainage were obviously superior to those without external drainage, in terms of leakage of the pancreaticojejunal anastomosis, overall complications, and re-laparotomy rate. External drainage is performed using a simple paediatric polyvinyl chloride feeding tube, which is inexpensive and readily available in all hospitals. No complications related to the stent itself or method of stent insertion were observed in our patients. In addition, we did not administer postoperative octreotide to decrease pancreatic enzyme secretion and protect the pancreaticojejunal anastomosis as suggested by some investigators.[20,26,27] We believe that external drainage of pancreatic enzymes with a pancreatic stent is undoubtedly adequate, and the need to use this costly somatostatin analogue can be avoided.

In our study, the operative time of the non-stented and stented patients did not differ significantly. This supports the advantage of stent insertion in view of the simplicity of the procedure. Furthermore, we strictly emphasized careful and meticulous surgical techniques that resulted in a relatively prolonged operative time (mean of 480 ± 115 minutes in the non-stented and 452 ± 33 minutes in the stented patients). We would like to stress that, apart from external drainage of the pancreatic remnant, a faultless operative procedure enhances the outcome.[19]

The hospital stay of patients in our study was relatively prolonged, with a median of more than 3 weeks in both non-stented and stented patients. The explanations for this prolonged hospital stay may be as follows. Firstly, some patients came from rural areas and had low socioeconomic status, and we decided that early discharge might be harmful. Secondly, some patients were reluctant to go back home with an external pancreatic drain and waited for drain removal before discharge. Thirdly, we had a significant number of elderly patients (58% aged > 60 years, 30% > 70 years, and 12% > 80 years), and prolonged hospital stay was necessary in some of these patients. The duration of external pancreatic drainage was also relatively prolonged (median, 35 days). Theoretically, the external pancreatic drain can be safely removed when patients consume a regular diet, without pancreatic fistula. However, since we emphasized the security of the drain to the pancreatic stump during the early postoperative period, and used two anchoring stitches of 5-0 absorbable suture, we

had to wait until the anchoring sutures dissolved, which in our experience, took longer than 3 weeks.

Despite the superior outcome of the stented patients, we have to accept that the main drawback of this study is its non-randomized design. A recent prospective randomized trial has been carried out in Hong Kong, and the results also support the use of external drainage of the pancreatic duct to reduce pancreaticojejunostomy leakage after PD.[28] Furthermore, since our study lasted for 17 years, some factors may have strongly influenced the outcome and may be considered potential pitfalls of this study. We prefer performing end-to-end pancreaticojejunal anastomosis to other methods of management of the pancreatic stump because we believe that it is safe and can be performed easily. Last but not least, refinements of the surgical techniques and increasing experience of the surgical team are unquestionably important factors that contributed to a better outcome in the stented patients.

External drainage of the pancreatic remnant after PD is a practical and effective adjunct for prevention of pancreaticojejunal anastomotic leakage. When pancreatic fistula occurs after stent insertion, it is usually uncomplicated and can be treated successfully by conservative means. We recommend its routine use in patients who undergo PD, especially in centres with a low or medium surgical volume.

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