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Jejunal Loop Drainage Versus Direct Pancreatic Duct Drainage After Pancreatic Head Resection

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Abstract

Purpose. Perioperative mortality after pancreatic head resection has fallen to below 5% in high-volume centers, but dehiscence of the pancreatojejunostomy remains a major concern. Despite various methods of protection, insufficiency rates still range from 6% to 19%. External drainage of pancreatic juice from the anastomotic site has shown promising results in the last decade. We compared the morbidity and mortality of two widely used drainage systems.

Methods. The subjects were 143 patients who underwent pancreatic head resection, followed by jejunal loop drainage with the top of the drain being placed between the pancreatojejunostomy and hepaticojejunostomy in 89, and by direct drainage of the pancreatic duct in 54.

Results. The median age was similar in both groups. Pancreatic fistula developed in 3 (5%) patients with a pancreatic drain and 6 (7%) with a loop drain. Breakdown of the pancreatojejunostomy occurred in 1 (2%) patient with a pancreatic drain and 2 (2%) with a loop drain. The overall perioperative mortality was 0.7%. The surgical and medical complications and postoperative course were similar in the two groups.

Conclusion. The choice of drainage system did not impact on the number or severity of postoperative complications or survival, indicating that loop drainage is as safe and effective as direct pancreatic duct drainage.

Key words Pancreas · Resection · Drainage · Pancreatic juice

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Introduction

The number of pancreatic resections being performed for benign diseases of the pancreas, such as chronic pancreatitis or cystadenoma, and for neoplasms, has increased remarkably over the last three decades. This is attributable to an increasing incidence of pancreatic head adenocarcinoma in Western industrial countries[1] and to the improved availability of modern diagnostic tools such as contrast medium, enhanced multislice, abdominal computed tomography-scan, and magnetic resonance imaging (MRI), resulting in more cases of pancreatic head carcinoma being diagnosed. Moreover, better preoperative work-up, surgical techniques, and postoperative intensive care management have expanded the indications for pancreatic head resection to include elderly patients and those with advanced disease.[2,3] Despite widening the indications, perioperative mortality has decreased in high-volume centers during the last 25 years, from 25% to about 5%. Some single centers have even reported series of 0% mortality.[4–8] In contrast, the perioperative morbidity after pancreatic surgery remains high, at 18%–52%.[5–8] Several postoperative complications, such as delayed gastric emptying, wound infections, pleural effusions, and pneumonias are still reported frequently, but the frequency of dehiscence of the pancreatojejunostomy, which is the most serious surgical complication of pancreatic resection, has decreased.

Dehiscence of the pancreatojejunostomy leads to intra-abdominal abscess formation and may erode the close arterial vessels, such as the splenic or gastroduodenal artery, resulting in acute hemorrhage, requiring reoperation and resection of the pancreatic remnant.[9] Although the management of dehiscence of the pancreatojejunostomy has improved remarkably, recent reports still document an incidence of dehiscence ranging from 5% to 20%.[6,8,10,11]

Several methods of protecting the pancreatojejunostomy have been described. Ligation of the pancreatic duct[12,13] and occlusion with prolamin[14] or fibrin glue[15] have all been abandoned as methods of anastomotic protection in pancreatic head resection. Instead, concepts such as drainage of the pancreatic duct without a pancreatojejunal anastomosis,[16] internal stenting of the pancreatic duct,[17–19] and external drainage of pancreatic juice via a jejunal loop[20] have been implemented. Moreover, both intravenous and subcutaneous preparation of the somatostatin analogue, octreotide, have been widely used to reduce pancreatic secretion after pancreatic head resection.[4,5,21]

Since 1992, when Keck et al. reported placing a soft nasogastric tube into the draining jejunal loop and positioning it between the hepaticojejunostomy and pancreatojejunostomy to direct pancreatic juice from the anastomotic site,[20] this has been our standard procedure. This method not only drains the pancreatic juice but it also prevents distension of the possibly dilated draining jejunal loop. In 1999, investigators from the Technical University in Munich published their experience of placing a small drain directly into the pancreatic duct and fixing it at the cut surface of the pancreas to drain the pancreatic juice directly to the outside.[22] The results were convincing, so we also implemented this technique at our center; however, this pancreatic duct drain is much more expensive than the regular soft nasogastric tube and the method carries the theoretical disadvantage of not draining the possibly dilated jejunal loop from the pancreatic remnant and the common bile duct. Thus, we conducted this retrospective study to compare the outcome, anastomotic complications, and economic considerations of these two drainage systems.

Patients and Methods

Patients

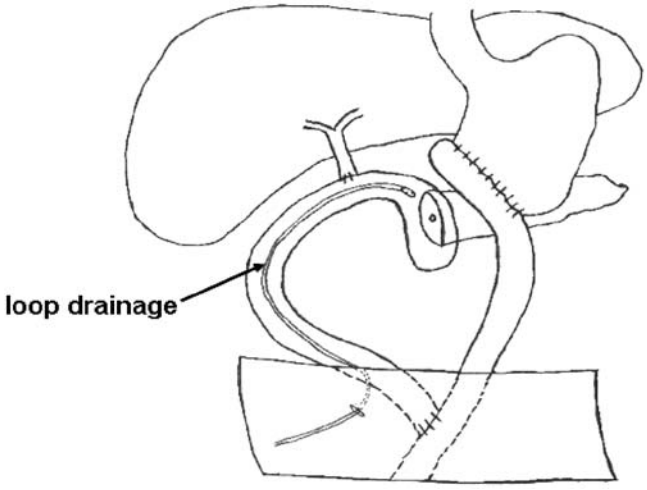
Between January 1999 and January 2001, 215 pancreatic resections were performed at Charité, Campus Virchow Clinic. Pancreatic head resection was performed for benign or malignant processes of the pancreas in 169 of these patients. We excluded 26 patients who underwent duodenum-preserving pancreatic head resection (DPPHR) and 7 patients without a drainage system for pancreatic juice. Finally, we analyzed 143 patients who underwent pancreatic head resection for chronic pancreatitis, adenocarcinoma of the pancreas, carcinoma of the papilla of Vater, distal bile duct carcinoma, adenoma of the papilla of Vater, neuroendocrine tumor, or colon carcinoma, infiltrating the pancreas. In 89 of these 143 patients, the pancreatic juice was drained from the remnant pancreatic area after the procedure by an external soft nasogastric tube drainage in the jejunal loop, and in 54 patients, the pancreatic juice was drained by a direct pancreatic drain. A pylorus-preserving pancreatic head resection was performed in 102 patients and a Kausch–Whipple procedure was performed in 41 patients. The Kausch–Whipple procedure was chosen when the pylorus seemed to be involved in a malignant process, or if prior surgery, such as a Billroth-II resection, necessitated it.

Data Collection

Preoperative laboratory values were collected 1–3 days before elective surgery, and included liver enzymes (aspartate aminotransferase, alanine aminotransferase, γ-glutamyl transferase, alkaline phosphatase, bilirubin), renal function (creatinine, urea), hematology (red blood cells, white blood cells, hemoglobin, platelets), coagulation tests (quick, partial thromboplastin time), and tumor markers (α-fetoprotein, carbohydrate antigen 19-9, and carcinoembryonic antigen). Data included the patient's age, sex, history of nicotine and alcohol abuse, surgical and medical history, histological-based diagnosis, clinical investigations before and after surgery, surgical variables such as the operation time, blood loss, intraoperative complications (bleeding, cardiopulmonary impairment, hypotension necessitating catecholamines), method of pancreatojejunal anastomosis and external drainage of pancreatic juice or bile, time in intensive care, volume of blood products transfused, type and time point of complications after surgery, time of initiation of enteral feeding, daily analysis of drainage fluid (amount, amylase, lipase), time of drain removal, mortality, and hospital stay after surgery.

Surgical Techniques

All surgical procedures were elective and done in the standard fashion, with en bloc dissection of the lymph nodes in the hepatoduodenal ligament, along the celiac trunk, and along the superior mesenteric artery for malignant diseases. We used a monopolar electric device for all resections and controlled arterial bleeding from the pancreatic remnant with a 6-0 Prolene stitch. After resection of the pancreatic head, the first jejunal loop was dissected and brought up through the mesocolon, followed by an end-to-side pancreatojejunostomy and end-to-side hepaticojejunostomy. The pancreatojejunostomy was performed either as a ductal mucosal to mucosal anastomosis (Cattell technique)[23] with Braasch's modification,[24,25] or as invagination of the jejunum (mattress technique).[26] Before the pancreatojejunostomy was closed, we inserted a soft nasogastric silicone tube for external drainage, as described previously,[20] in 89



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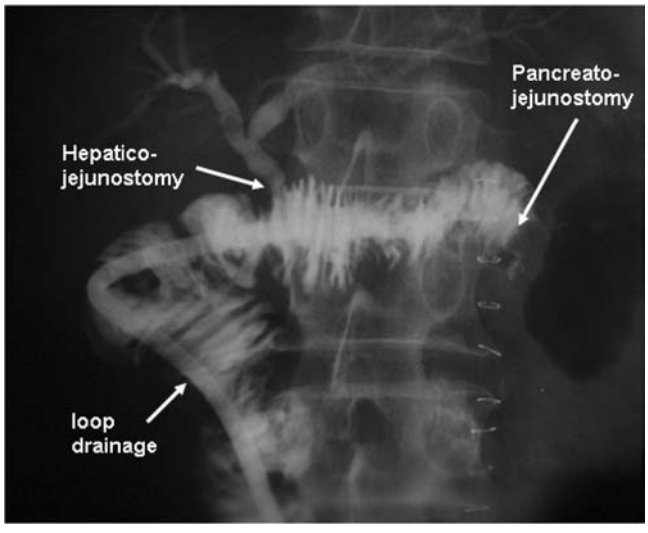
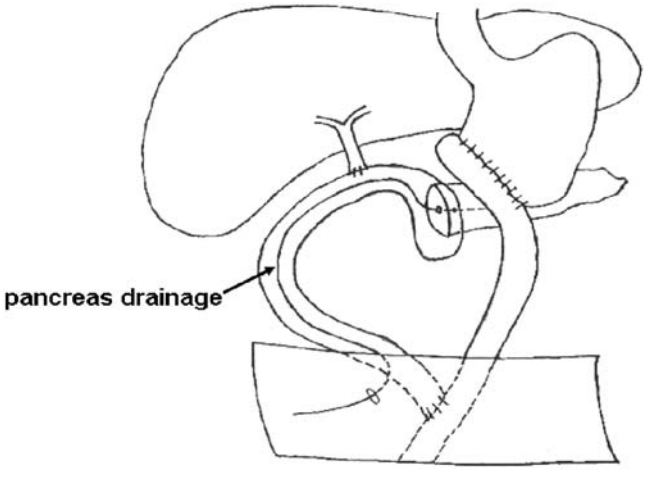


b

Fig. 1. a In situ placement of the soft nasogastric tube between the hepaticojejunostomy and the pancreatojejunostomy. **b** Regular visualization of the hepaticojejunostomy and the pancreatojejunostomy by X-ray examination with contrast medium. The contrast medium is inside the jejunal loop without any evidence of anastomosis leakage



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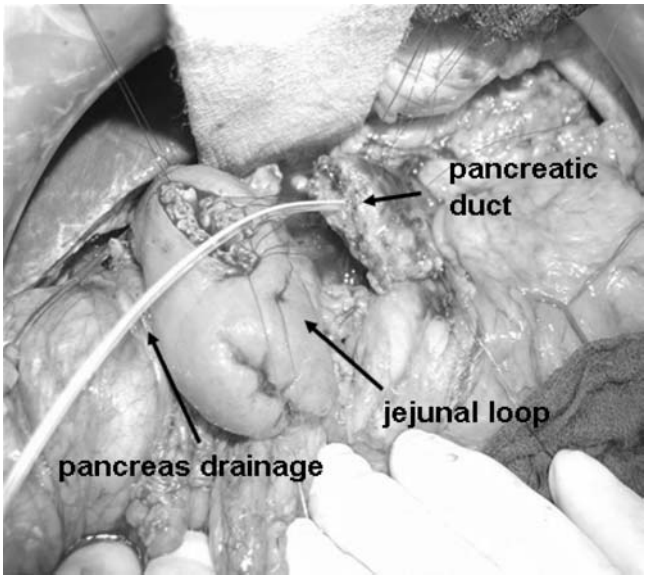

b

Fig. 2. a In situ placement of the drain with the top in the pancreatic duct of the remnant. **b** Intraoperative localization of the direct pancreatic drain in the pancreatojejunostomy

patients (Flocare nutrisoft M 14 Ch, 110 cm; Nutricia, Domdidier, Switzerland; Fig. 1a). This tube was placed in the jejunal loop between the pancreatojejunostomy and the hepaticojejunostomy. In the other 54 patients, we externalized a direct pancreatic duct drain, as described by Roder et al.[22] (Pancreasplus 6F, 65 cm; Pflugbeil, Zorneding, Germany; Fig. 2a). This tube was inserted about 5 cm into the pancreatic duct of the remnant and secured (Fig. 2b). Both drains were guided out of the jejunal loop used for the pancreatojejunostomy percutaneously after 20 cm, and secretions were drained by gravity suction. We checked all the soft nasogastric tubes with a contrast medium between postoperative day (POD) 8 and 12 and removed them if the anastomosis was viable (Fig. 1b). Direct pancreatic duct drains were not visualized. The direct pancreatic drain was introduced at our institution in 2000. Therefore, the patients in the early period of this study before 2000 were treated with a soft nasogastric tube and those in the latter period, after 2000, were treated with a direct pancreatic drain.

Gastrointestinal continuity was restored by standard Roux-en-Y retrocolic gastrojejunostomy (Kausch–Whipple) or pylorojejunostomy (PPPHR). To protect the gastric anastomosis, a nasogastric stomach tube was placed 10 cm aboral of the anastomosis into the jejunum. All patients had two intra-abdominal open drains (easy-flow) with their tips placed in the pancreatojejunostomy and hepaticojejunostomy. Finally, the abdominal wall was closed in two layers.

Perioperative Treatment

All patients received antibiotic prophylaxis with cefotiam 6 g/day and metronidazole 1 g/day for at least 3 consecutive days postoperatively. The intra-abdominal easy-flow drains were removed as soon as the patient was tolerating food. We measured the pancreatic enzymes, amylase and lipase, and bilirubin in the easy-flow drainage fluid for 5 consecutive days after surgery or for longer if there was pancreatic fistula.

Oral intake was resumed on POD 5, and the soft nasogastric tube was removed if the patients had no symptoms of delayed gastric emptying. Between POD 8 and 12, the loop drainage was visualized with contrast medium, and removed if there were no signs of leakage. Conversely, the pancreatic drainage was not visualized and was removed on POD 12.

Pancreatic Fistula, Biliary Fistula, and Perioperative Mortality

A pancreatic fistula was diagnosed by easy-flow drainage fluid with an elevated amylase and lipase level of >1 000 U/l from POD 5 to beyond POD 10 or breakdown of the pancreatojejunostomy with increased inflammatory markers, and local peritonitis with or without abscess formation. A biliary fistula was diagnosed by drainage fluid with a bilirubin level two times higher than the regular range for longer than 5 days or by breakdown of the hepaticojejunostomy with clinical signs of local peritonitis. Perioperative mortality was defined as death during initial hospitalization.

Statistical Analysis

All data were entered into a Microsoft Access database (Access for Windows XP; Microsoft, Seattle, WA, USA) and analyzed retrospectively. Data are expressed as medians, and as the range or mean and standard deviation. Survival analyses were done using the Kaplan–Meier method (log-rank test), and to test the null hypothesis we used the chi-square-test. All statistical analyses were performed using SPSS for Windows 11.0 (SPSS, Chicago, IL, USA). Independent variables were compared with the Mann–Whitney *U*-test and the influence of a given variable on the development of a pancreatic fistula and breakdown of the pancreatojejunostomy dehiscence were multivariately investigated with a Cox logistic regression model; evaluating the patients' age, sex, drainage system, operation time, intraoperative red packed cell transfusions, intraoperative blood loss, choice of resection (pylorus preserving vs Kausch–Whipple), pancreatic fistula, TNM classification system, resection margin status, and tumor differentiation. All tests were two-sided and *P* values of less than 0.05 were considered significant.

Results

Demographic Data

The pancreatic duct group (PD group) consisted of 36 men and 18 women with a median age of 59 years (range 34–77 years), and the loop drainage group (LD group) consisted of 46 men and 43 women with a median age of 61 years (range 27–86 years). The history of nicotine and alcohol abuse did not differ significantly between the groups (67% and 55% in the PD group; 49% and 37% in the LD group, respectively). The patients' preoperative condition was similar in the two groups, being good, fair, and poor in 16%, 23%, and 1% in the PD group and 6%, 27%, and 1% in the LD group, respectively. The median body weight was almost equal in the two groups, at 69 kg (range 44–110 kg) in the PD group and 71 kg (range 45–120 kg) in the LD group. The incidence of coexisting disorders such as diabetes mellitus (PD: 30%; LD: 19%), cardiac disorders (PD: 37%; LD: 27%), pulmonary disease (PD: 15%; LD: 15%), and hypertonus (PD: 42%; LD: 35%) did not differ significantly between the two groups. However, significantly fewer patients with a PD suffered from cholecystolithiasis ($P = 0.003$) than those with a LD (at 15% vs 26%, respectively); an unexplained finding. Comparison of preoperative laboratory values indicated a significantly higher mean concentration of hemoglobin ($P = 0.001$) in patients with a PD than in those with an LD, at 13.1 ± 0.2 vs 11.2 ± 0.4, respectively; Table 1.

Histopathological Diagnosis

Following a complete pathological work-up, the preoperative diagnosis was confirmed by a histopathological examination of all 143 resected specimens. Most (67%) of the patients had a malignant process in the pancreatic head and the remaining 33% had a benign disease.

In the PD group, 21 (39%) patients had adenocarcinoma of the pancreas, 17 (32%) had chronic pancreatitis, 6 (11%) had carcinoma of the papilla of Vater, 5 (9%) had distal bile duct carcinoma, 2 (4%) had adenoma of the papilla of Vater, and 2 (4%) had a neuroendocrine tumor. One of the remaining patients had colon carcinoma, which infiltrated the pancreas, necessitating pancreatic head resection. In the LD group, 43 (49%) patients had adenocarcinoma of the pancreas, 23 (25%) chronic pancreatitis, 11 (12%) distal bile duct carcinoma, 5 (6%) had an adenoma of the papilla of Vater, 1 (1%) had a neuroendocrine tumor, and 1 (1%) had a colon carcinoma infiltrating the pancreatic, necessitating pancreatic head resection. There were no significant differences between the two groups in distribution of the primary diagnosis or the pathohistological diagnosis (Table 2).

Table 1. Demographic data of the patients

Variable	Pancreas drain ($n = 54$)	Loop drain ($n = 89$)	P
Age, years (range)	59 (34–77)	61 (27–86)	NS
Sex			NS
Male (%)	36 (67)	46 (52)	NS
Female (%)	18 (33)	43 (48)	NS
Nicotine (%)	36 (67)	44 (49)	NS
Alcohol (%)	30 (55)	33 (37)	NS
Patient's condition			
Good (%)	41 (76)	64 (72)	NS
Fair (%)	12 (23)	24 (27)	NS
Poor (%)	1 (1)	1 (1)	NS
Median body weight, kg (range)	69 (44–110)	71 (45–120)	NS
Patients with preoperative symptoms (%)	54 (100)	87 (98)	NS
Diabetes mellitus (%)	16 (30)	17 (19)	NS
Cholecystolithiasis (%)	8 (15)	23 (26)	0.003
Cardiac symptoms (%)	20 (37)	24 (27)	NS
Pulmonary symptoms (%)	8 (15)	13 (15)	NS
Hypertonus (%)	23 (42)	31 (35)	NS
Papillotomy (%)	18 (33)	21 (23)	NS
Previous abdominal operations (%)	39 (72)	65 (73)	NS
Mean preoperative hemoglobin, g/dl	13.1 ± 0.2	11.25 ± 0.4	0.001
Mean preoperative white blood cell count, /nl	7.9 ± 0.4	7.1 ± 0.4	NS
Mean preoperative CRP, mg/dl	2.3 ± 0.5	2.0 ± 0.4	NS
Mean preoperative amylase, U/l	109.6 ± 21.2	73.9 ± 7.8	NS
Mean preoperative lipase, U/l	207.5 ± 63.7	99.8 ± 20.4	NS

POD, postoperative day; CRP, C-reactive-protein; CRP, C-reactive protein; NS, not significant

Table 2. Histopathological diagnoses

Diagnosis	Pancreas drain ($n = 54$)	Loop drain ($n = 89$)	P
Adenocarcinoma of the pancreas (%)	21 (39)	43 (49)	NS
Chronic pancreatitis (%)	17 (32)	23 (25)	NS
Carcinoma of the papilla of Vater (%)	6 (11)	5 (6)	NS
Distal bile duct carcinoma (%)	5 (9)	11 (12)	NS
Adenoma of the papilla of Vater (%)	2 (4)	5 (6)	NS
Neuroendocrine tumor (%)	2 (4)	1 (1)	NS
Carcinoma of the colon (%)	1 (2)	1 (1)	NS
Total	54 (100)	89 (100)	

Operative Procedures

According to recent studies, the rate of curative resection and survival after pylorus preserving pancreatic head resection (PPPHR) and Whipple procedure are comparable; however, PPPHR results in better postoperative gastrointestinal function.[27] Therefore, we adapted PPPHR as the standard procedure for both benign and malignant diseases in our center in 1998. In the PD group 47 (87%) patients underwent PPPHR and 7 (13%) underwent standard Whipple procedure, whereas in the LD group 55 (62%) patients underwent PPPHR and 34 (38%) underwent standard Whipple procedure. Although there was a trend toward more standard Whipple procedures in the LD group, there were no significant differences between the two groups.

All patients received the same intraoperative prophylactic antibiotic treatment and the median duration of the primary operation was 360 min. The distribution of the type of pancreatojejunal anastomosis used (Cattell vs mattress anastomosis) was almost equal in the two groups. Seventeen (32%) patients in the PD group and 43 (48%) in the LD group received red packed cell

Table 3. Operative details

Variable	Pancreas drain ($n = 54$)	Loop drain ($n = 89$)	P
Procedures			
PPPHR (%)	47 (87)	55 (62)	NS
Kausch–Whipple (%)	7 (13)	34 (38)	NS
Pancreatojejunal anastomosis			
Cattell (%)	29 (54)	40 (45)	NS
Mattress (%)	25 (46)	49 (55)	NS
Median operation time, min (range)	360 (240–645)	360 (220–740)	NS
Intraop. antibiotic administration (%)	54 (100)	89 (100)	NS
Intraop. red blood cell transfusion (%)	17 (32)	43 (48)	NS
Mean transfused intraop. red blood cells	0.2 (0–4)	1.1 (0–8)	0.027
Patients with intraop. fresh frozen plasma (%)	3 (5)	4 (4)	NS
Median blood loss, ml (range)	450 (0–2000)	600 (0–3000)	0.002
Intraop. complications (%)	4 (7)	5 (6)	NS
Catecholamines for treatment of hypotension (%)	2 (4)	2 (2)	NS
Cardiac arrhythmias (%)	1 (2)	2 (2)	NS
Intraop. hemorrhage (%)	1 (2)	1 (1)	NS

PPPHR, pylorus-preserving pancreatic head resection; intraop., intraoperative

Table 4. Concentration of amylase and lipase in both groups measured in easy-flow secretion over 5 consecutive days after pancreatic head resection

	POD 1	POD 2	POD 3	POD 4	POD 5	P
Amylase (U/l)						
PD	362	500	189	175	100	NS[a]
LD	429	237	322	170	34	
Lipase (U/l)						
PD	1081	1235	600	822	557	NS[b]
LD	811	877	490	290	323	

POD, postoperative day; PD, pancreas drain; LD, loop drain
[a] Amylase PD vs LD
[b] Lipase PD vs LD

transfusions intraoperatively; the mean number of transfusions being 0.56 (±1.16) in the PD group and 1.09 (±1.54) in the LD group ($P = 0.025$). The median blood loss was 450 ml in the PD group and 600 ml in the LD group; this difference being significant ($P = 0.002$). However, there was no difference in the rate of extended resections and the frequency of advanced cancers such as T4 carcinomas between the two groups (data not shown). Finally, the number and course of intraoperative complications, such as serious hypertension, cardiac arrhythmias, and severe intraoperative hemorrhage, were not significantly different in the two groups (Table 3).

Postoperative Course

The median time of commencement of oral feeding was similar, at 5 days in the PD group and 6 days in the LD group. There was no significant difference in the median number of days before the nasogastric stomach tube was removed in both groups (5 days). Intraoperatively placed easy-flow drains were removed after a median of 9 days in the PD group and 10 days in the LD group, respectively. During the first 5 postoperative days (PODs), we tested the drainage fluid for amylase and lipase as an early indicator of pancreatic fistula, and found no significant differences between the groups (Table 4). Intraluminal drains were taken out after a median 8 days in the PD group (range 5–30 days), and 13 days in the LD group (range 10–25 days). The pancreatic drain was removed earlier, on POD 8, because of dislocation. There were no signs of jejunal leakage after removal of the drainage tube. The median stay in the intensive care unit (ICU) was 3 days postoperatively in both groups, and the median number of packed red cell (PRC) transfusion was 0.5 in the PD group (range 0–14) and 0.8 in the LD group (range 0–20) (Table 5).

Hospital Stay and Survival

The median hospital stay was 21 days (range 12–62 days) in the LD group, and 21.5 days (range 11–148

Table 5. Postoperative course

Variable	Pancreas drain ($n = 54$)	Loop drain ($n = 89$)	P
Median day oral intake resumed	5 (3–10)	6 (2–20)	NS
Median day oral intake stopped	11 (6–46)	11 (5–30)	NS
Median day of stomach tube elimination	5 (2–15)	5 (1–24)	NS
Median day of easy-flow elimination	9 (5–42)	10 (5–35)	NS
Median day of drain elimination	8 (5–30)	13 (10–25)	NS
Median ICU stay postop., days	3 (1–19)	3 (1–14)	NS
Median number of PRC transfusions in ICU	0.5 (0–14)	0.8 (0–20)	NS
Median hospital stay, days	21 (12–62)	21.5 (11–148)	NS
Perioperative mortality (%)	0	1 (1)	NS

ICU, intensive care unit; PRC, packed red cells

Table 6. Postoperative surgical complications

Surgical complication	Pancreas drain ($n = 54$)	Loop drain ($n = 89$)	P
Pancreatic fistula (%)	3 (5)	6 (7)	NS
Reoperation (%)	1 (2)	2 (2)	NS
Biliary fistula (%)	1 (1)	1 (1)	NS
Wound infection (%)	4 (7)	14 (16)	NS
Delayed gastric emptying (%)	10 (18)	12 (13)	NS
Postoperative bleeding (%)	1 (2)	2 (2)	NS
Intra-abdominal abscess (%)	1 (2)	2 (2)	NS
Total (%)	11 (20)	27 (30)	NS

days) in the LD group. Of the total 143 patients, 142 were discharged and rehabilitated, resulting in an overall mortality rate of 0.7%. One of the LD group patients died of sepsis and multiorgan failure after breakdown of the pancreatojejunal anastomosis (Table 5). Survival analysis did not reveal a significant difference between the two groups for up to 48 months (data not shown).

Surgical and Medical Complications

During the primary hospitalization we observed 11 (20%) complications in the PD group and 27 (30%) complications in the LD group, without any significant differences. The most critical complication after pancreas head resection was pancreatic fistula, seen in 3 (5.5%) patients in the PD group and 6 patients (7%) in the LD group. One (2%) patient in the PD group and two (2%) in the LD group required reoperation for breakdown of the pancreatojejunostomy. One patient in the LD group (0.7% of all patients) died of sepsis and multiorgan failure. Six of the patients with a pancreatic fistula were treated conservatively. One (1%) patient from each group showed clinical signs of biliary fistula, but reoperation was not necessary. Wound infection developed in 4 (7%) patients in the PD group and 14 (16%) in the LD group, without a significant difference. Delayed gastric emptying developed in 10 (18%) patients in the PD group and 12 (13%) in the LD group. The incidence of postoperative bleeding and intra-abdominal abscess was 2% in both groups (Table 6).

Postoperative medical complications developed in 27 (50%) of the PD group and 47 (53%) of the LD group patients. The most common medical complication after operation was pleural effusion, which developed in 11 (20%) patients in the PD group and 16 (18%) in the LD group. There was no obvious difference in the incidence of medical complications such as cardiac arrhythmia, symptomatic transitory psychotic syndrome, urinary tract infection, acute renal failure, and sepsis, between the two groups (Table 7). The incidence of medical complications, rehospitalization, and reoperation observed in follow-up for up to 4 years did not differ significantly between the two groups (data not shown).

Risk Factors for Pancreatic Fistula

Demographic and treatment variables were examined by multivariate logistic regression analysis for their potential association with the development of pancreatic fistula. According to the multivariate analysis, the number of intraoperative red packed cell transfusions was associated with an increased risk of breakdown of the pancreatojejunal anastomosis ($P = 0.02$), whereas age, sex, drainage system, operation time, intraoperative

Table 7. Postoperative medical complications

Medical complication	Pancreas drain ($n = 54$)	Loop drain ($n = 89$)	P
Pleura effusion (%)	11 (20)	16 (18)	NS
Pneumonia (%)	3 (5)	6 (7)	NS
Cardiac arrhythmia (%)	3 (5)	6 (7)	NS
Symptomatic transitory psychotic syndrome (%)	2 (4)	5 (6)	NS
Urinary tract infection (%)	3 (5)	7 (8)	NS
Acute renal failure (%)	1 (2)	2 (2)	NS
Sepsis (%)	1 (2)	1 (1)	NS
Other (%)	3 (5)	4 (4)	NS
Total (%)	27 (50)	47 (53)	NS

blood loss, technique of resection (pylorus vs Kausch–Whipple), technique of suturing the pancreatojejunal anastomosis (Cattell vs mattress sutures), pancreatic fistula, TNM classification system, resection margin status, and tumor differentiation did not show significance.

Discussion

The perioperative mortality associated with pancreatic head resection has decreased in the last three decades from higher than 30% to less than 5%,[4–8,28] and in high-volume centers the number of pancreatic resections performed without perioperative mortality continues to increase. In 1990, Trede et al. reported a series of 118 patients[6] and in 1993 Cameron et al. reported a series of 145 consecutive resections, without perioperative mortality.[7]

Dehiscence of the pancreatojejunal anastomosis is the most serious complication after pancreatic head resection because it can trigger arterial bleeding, peritonitis and subsequent sepsis, or systemic inflammatory response syndrome (SIRS). In the past, multiple surgical innovations were tested for anastomotic protection. Apart from different suturing techniques for pancreatojejunostomy, external drainage of the aggressive pancreatic juice is an approved method with excellent results.[20] Inserting an intraductal pancreas stent seems to be a very effective way of keeping the potent pancreas juice from coming into contact with the anastomosis. In 1992, Biehl and Traverso reported finding no pancreatojejunal dehiscence in 24 dogs with plastic stents inserted after pancreas resection,[17] whereas dehiscence was frequently seen in 10 dogs without a stent. Furthermore, when the animals were killed 4 weeks postoperatively, the stented animals had lower rates of leak, occlusion, and stenosis. Yoshimi et al. reported their results of inserting an intraductal plastic stent for splinting the pancreatojejunostomy in 11 patients.[18] Although a pancreatic fistula developed in 4 patients, dehiscence did not occur and none required surgical reintervention. The advantages of direct pancreas drainage in 44 patients compared with a no-drainage system in 41 patients were reported by Roder et al. in a prospective study of 85 patients in 1999.[22] Patients with temporary, external drainage had significantly lower incidences of pancreatic fistula and pancreatojejunostomy insufficiency and a shorter hospital stay. The two (2.7%) patients who died were from the nonstented group. However, small tubes such as the drain used by the investigators from Munich carry a high risk of occlusion and dislocation.

An alternative system for draining pancreas juice away from the anastomosis is loop drainage. This system is similar to direct duct drainage, but the top of the drain is placed between the pancreatojejunostomy and the hepaticojejunostomy, and the juice is drained through the jejunal loop into a secretion bag outside the body. The advantage of this system lies in the design of the drainage of pancreas juice with loop secretion, and bile. Moreover, the drain can be visualized radiologically with contrast medium and it has a wider lumen, which prevents early occlusion. Its disadvantage is that the outlet from the jejunal loop if replaced can leak, resulting in jejunal fistula. However, Keck et al. reported a low perioperative mortality (1.3%) without any complications of this system.[20]

Our retrospective analysis confirmed these positive results of past reports of using a temporary stent or drainage system. The perioperative mortality in our series was 0.7%. The patients who died had received loop drainage and suffered pancreatojejunal anastomosis dehiscence with sepsis and multiorgan failure. Furthermore, pancreatic fistula developed in 9 (6%) patients and pancreatojejunal anastomosis breakdown developed in 3 (2%) patients, without a significant difference between the PD and LD groups. Interestingly, we noted that the patients in the LD group had significantly greater intraoperative blood loss ($P = 0.002$) and received more intraoperative red packed cell transfusions

($P = 0.025$) than those in the PD group. One possible explanation is that more of the LD group patients undergoing Whipple's procedure had undergone previous extensive abdominal surgery with resulting adhesions. Furthermore, the Whipple procedure is designed for advanced local processes of the pancreas and demands extensive surgery, possibly resulting in greater blood loss. The significantly lower preoperative hemoglobin levels ($P = 0.001$) in the LD group may be explained by the fact that many of these patients had tumor anemia and liver dysfunction caused by advanced malignancies. Another reason might relate to the fact that there were more women in the LD group than in the PD group. Univariate and multivariate analyses both revealed a significantly increased risk of breakdown of the pancreatojejunostomy in patients who were given more red packed cell transfusions intraoperatively ($P = 0.02$). However, the LD group did not have a higher incidence of anastomotic leakage despite the increased intraoperative blood loss, the implications of which remain unclear. Yeo et al. reported a series of 650 pancreaticoduodenectomies in which blood loss was a risk factor.[4] Conversely, Hosotani et al. found that the intraoperative risk factors for pancreatic leakage were anastomotic technique, pancreatic duct size, and texture of the pancreatic remnant.[8] Although we always use a drainage system to protect the anastomosis after pancreatic resection, some high-volume centers do not use a stent or drainage system and still achieve excellent results with low morbidity and mortality after pancreatojejunostomy[5] or pancreatogastrostomy.[29] Schoretsanitis et al. described a technique, used in eight patients, of pancreatoduodenectomy without a pancreatojejunal anastomosis,[16] in which the residual pancreatic duct was drained by external drainage for a median of 20 days, followed by removal of the drain when the juice output ceased. However, it remains unclear if pancreatic juice production ceases in all patients, and if long-term gastrointestinal function will profit from exocrine pancreatic production, which reaches the intestine for digestion.

In conclusion, our results show that external drainage is a safe method of protecting the pancreatojejunal anastomosis, which does not induce drainage complications. The choice of drainage system had no impact on the development of surgical or medical complications after surgery and did not adversely affect the postoperative course. Ultimately, the price difference in the two drainage systems could favor the soft nasogastric tube.

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