ORIGINAL ARTICLE

Preemptive wirsungostomy: a safe fistula for avoiding a dreadful fistula in elective or planned pancreatoduodenectomy

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Abstract

Background: High-risk pancreatic anastomosis can lead to a high mortality rate after PD due to the development of postoperative pancreatic fistula (POPF). Performing a wirsungostomy by externalizing the pancreatic duct is a poorly known alternative to anastomosis which could reduce the risk of POPF and the associated severe morbidity

Methods: We retrospectively evaluated patients who underwent primary wirsungostomy with PD from January 2007 to December 2021 in our tertiary referral center. Rates of morbidity and mortality with long-term pancreatic functions were studied.

Results: Sixty patients were included. The median Updated Alternative Fistula Risk Score (ua-FRS) was 52%, with 95% patients in the high-risk ua-FRS category and 88.3% patients with stage D risk of developing POPF according to the classification of the ISGPS. The mortality rate was 3.3%, and overall 90-day postoperative morbidity was 63.7% with 50% of patients developing major complications. Mean follow-up was 29.8 months. Twelve patients (20%) became diabetic and 35 patients (58.3%) had preserved pancreatic endocrine function

Conclusion: Preemptive wirsungostomy with PD could be an appropriate procedure for patients with high-risk pancreatic anastomosis. The high associated morbidity could be compromised by the low mortality and preservation of endocrine function compared to total pancreatectomy or severe POPF.

Received 4 December 2022; accepted 10 April 2023

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Introduction

Pancreaticoduodenectomy (PD) still represents one of the most challenging procedures in digestive surgery. Its morbidity remains high despite improvements in surgeons' skills and perioperative management.[1] Postoperative pancreatic fistula (POPF), the most frequent life-threatening complication developing after PD, has been classified into three groups (from A to C) according to clinical presentation and severity. Risks factors for POPF have been identified, including soft or steatotic pancreatic tissue, small pancreatic duct size, peroperative hemorrhage, and obesity. The identification of these risk factors has led to the development of several prognostic scores with the most widely validated score remaining the Fistula Risk Score (FRS).[2]

Many medical[3] and surgical strategies[4,5] have been described for avoiding or preventing POPF, such as anastomotic stenting or perioperative octreotide administration. However, clinically relevant POPF develops in 12% of patients after PD,[6] among which 3–5% of patients develop grade C POFP. Patients developing severe POPF require either interventional radiology or re-operation, with a re-operation mortality rate of 35%.[7]

Given the potential fatal outcomes of POPF, some authors have proposed performing total pancreatectomy (TP) instead of

PD in high-risk patients (patients with a high FRS or unsuturable remnant pancreas) in order to eliminate the risk of pancreatic fistula.[8] This option (prophylactic/upfront/primary TP) provides good results in terms of surgical outcomes in high volume centers,[9] except when performed in emergency (completion pancreatectomy) to treat severe POPF.[10] However, this procedure, creating an apancreatic state, can have long-term side effects inducing systemic complications with possible reduced quality of life (QoL): total exocrine pancreatic insufficiency and induced diabetes mellitus.[10] Therefore, another option for eliminating the risk of pancreatic anastomosis fistula could consist in not performing the anastomosis, but in contrast preserving the pancreatic tissue. In this light, externalizing the remnant pancreas, a procedure called wirsungostomy, was previously described in our center and by others[11,12] in cases of laparotomy for POPF. Wirsungostomy has been reported as a salvage procedure that eliminates digestive fistula (closure of jejunum or stomach) and drains the pancreatic stump by creating a pancreaticocutaneous fistula via silicone drainage; intubating if possible the main pancreatic duct. This technique has the advantages of shortening and simplifying reoperation in frail patients, but it can also preserve some endocrine function of the pancreas.

A handful of reports have suggested that wirsungostomy[13–17] could be performed during the initial surgical procedure among patients with high-risk POPF. However, minimal data is available to date. The aim of the present study was thus to describe a large, single-center experience of patients who underwent wirsungostomy with PD. We discuss the indications for wirsungostomy, postoperative outcomes, management of the external pancreatic drainage, and the long-term diabetes-related outcomes.

Methods

Study design

All patients having undergone PD between 2007 and 2021 were retrospectively examined from a prospectively maintained database at the University Hospital Center of Bordeaux, France. All patients who did not undergo pancreatic anastomosis during the PD were eligible for inclusion. Patients who underwent TP were not included.

Data collection

Patient data analyzed included demographic characteristics, tumor characteristics, perioperative data with a description of the pancreas, postoperative complications, delay between surgery and wirsungostomy removal, complications after wirsungostomy removal, and clinical features of pancreatic insufficiency.

The risk of POPF was retrospectively assessed using the Updated Alternative Fistula Risk Score (ua-FRS)[18] and the classification of the International Study Group of Pancreatic Surgery (ISGPS).[19] The ISGPS classification is composed of four stages: stage A, hard pancreatic texture and Wirsung duct diameter >3 mm; stage B, hard pancreatic texture and Wirsung duct diameter ≤3 mm; stage C, soft texture and Wirsung duct dimeter >3 mm; stage D, soft texture and Wirsung duct diameter ≤3 mm.

Definitions

Postoperative complications were classified according to the Clavien-Dindo (CD) classification[20] with major complications classified with scores ≥ IIIA. Post-pancreatectomy hemorrhage (PPH) and delayed gastric emptying (DGE) were defined according to ISGPS criteria.[21,22] Biliary leakage (BL) was defined according to the International Study Group of Liver Surgery (ISGLS) consensus.[23] Intra-abdominal fluid collection was diagnosed by computed tomography (CT) scan and defined as infected when the patient had recurrent episodes of fever or if bacteria were detected in samples.

Surgical indication and procedures

Indication

Preoperative diagnosis of pancreatic disease was assessed by CT scan, magnetic resonance imaging (MRI) and endoscopic ultrasonography with or without pancreatic biopsy. All indications for PD were discussed and approved in a multidisciplinary board meeting.

Dissection

PD was performed using the Whipple procedure as previously described.[24]

Management of the remnant pancreas

The pancreas was evaluated perioperatively at the end of the dissection time. We assessed pancreatic texture (soft or hard) with ability to undergo anastomosis (not fragile) or not (fragile), large (≥3 mm) or small (<3 mm) diameter of the main pancreatic duct, characterization of a potential pancreatitis (edema of the glands, inflammatory tissues, or necrotizing tissues).

The decision or not to perform the pancreatico-digestive anastomosis was taken by the senior surgeon and based on several local and general factors: BMI, the aforementioned evaluation of the pancreas and hemodynamic characteristics.

When the decision not to perform the anastomosis was taken, wirsungostomy was made after shortening the remnant pancreas in some cases. When the main pancreatic duct could be observed, the proximal third of the remaining pancreatic duct was cannulated with a thin polyethylene tube with lateral holes at one end (6–8 F Escat drain). The catheter was stitched to the remnant pancreas with a PDS®5/0 suture by two U-shaped interrupted sutures. The free end of the catheter was externalized to the left or right flank. The main pancreatic duct was not cannulated when the pancreatic duct was not observed or too thin. Instead, a 10 Fr silicone suction drain was systematically put in place close to the remnant pancreas and externalized to the left or right flank.

End of the procedure

The remainder of the procedure was according to the Whipple procedure; hepaticojejunostomy was performed on the first jejunal loop 70 cm upstream of the gastrojejunostomy.

Follow-up

Patients were monitored twice per postoperative day (POD). Nasogastric tube removal was on POD 2 or 3. No patients received octreotide during the postoperative period. Parenteral or enteral nutrition was initiated for malnourished patients as soon as possible according to the nutritional evaluation. A systematic CT scan was performed on POD 7 to check the drainage in case of intra-abdominal fluid collection or silent vascular complications.[25] The size of the remnant pancreas was retrospectively assessed on this CT scan.

Readmission was defined as a new hospitalization related to the PD and/or the wirsungostomy within the first 90 PODs. All patients underwent a postoperative evaluation at 1 month after surgery with clinical and biological examinations. Endocrine insufficiency was defined by fasting blood glucose $\geq$126 mg/dL and impaired glucose tolerance was diagnosed by glycated hemoglobin between 5.7% and 6.4%.[26] Clinically significant exocrine insufficiency was defined when symptoms (eg. steatorrhea and weight loss) resolved after pancreatic enzyme supplementation.[27] Long-term clinical pancreatic insufficiency and oncological status (recurrence of malignant disease) were assessed by telephonic interviews with the patients or the general practitioner in case of patient death.

The latest survival data were assessed on May 1st 2022 against national death registries (https://www.data.gouv.fr/fr/datasets/fichier-des-personnes-decedees/).

Postoperative management of the wirsungostomy

Postoperative clinical evaluation of the aspect and quantity of fluid in the Escat or suction drain was assessed every POD under hospitalization. Gentle flushing of the drain with 5 cc of sterile saline was performed daily during hospitalization. After postoperative discharge, the wirsungostomy was evaluated during the first postoperative evaluation at 1 month. When the fluid collected was clear and below 100 cc/day without recent history of fever, the drain was clamped and removed after a minimum of 8 weeks after surgery. Abdominal CT scan was not systematic before removal of the wirsungostomy; indication was based on clinical criteria (abdominal pain, fever, aspects of fluid infection). These criteria required opening of the wirsungostomy if it was still clamped. If the drain could not be clamped during the first postoperative evaluation, the patient underwent postoperative evaluations every 15 days until clamping and then removal.

Outcomes measures

The primary endpoints were overall 90-day postoperative morbidity and mortality rates. Secondary endpoints were length of stay, readmissions, wirsungostomy-related morbidity, and endocrine and exocrine functions of the pancreas during follow-up.

Statistical analysis

Quantitative data are expressed as mean ± standard deviation or as medians with ranges. Qualitative data are expressed as frequencies with percentages. Categorical variables were compared using the Chi-squared or Fischer's exact tests. The significance level retained was the classic 5% threshold ($p < 0.05$). Statistical analyzes were performed using GraphPad Prism v 9.0 (GraphPad, San Diego, CA, USA).

This study is a retrospective analysis of our monocentric prospective computed database. We did not require Ethical approval in this condition.

Results

Patient cohort

Among 1038 patients who underwent PD between 2007 and 2021, a total of 60 patients (5.8%) having undergone preemptive wirsungostomy were retrospectively included for study from a prospectively maintained database (Fig. 1).

Patient characteristics

The main characteristics of the cohort are found in Table 1. The main indication for PD was pancreatic adenocarcinoma (26.6%). Before surgery, 13 patients (21.7%) were diabetic including 3 (5%) under insulin treatment. The median preoperative ua-FRS was 52%, with 95% patients (57/60) in the high-risk ua-FRS category for the development of POPF (defined by ua-FRS >20%). Fifty-three patients (88.3%) were stage D, 6 (10%) were stage A, and 1 (1.67%) was stage C for risk of developing POPF according to the ISGPS classification.

Operative characteristics

All patients underwent PD with a mean surgery duration of 276 ± 79.41 min with a median bleeding of 675 mL (462.5–1200 mL). Indications for wirsungostomy are detailed in Table 2. The main pancreatic duct diameter was <3 mm in 53 patients (88.3%). The main pancreatic duct was cannulated by an Escat drain in 46 patients (76.7%) or a suction drain was put in place close to the remnant pancreas for the remaining 14 patients (23.3%).

Eight patients (13.3%) underwent portal vein resection and 1 patient (1.7%) underwent inferior vena cava resection and reconstruction with left nephrectomy for oncological margin purposes. One patient (1.7%) also underwent central hepatectomy with right colectomy with the PD for a high-volume gallbladder cancer. Median remnant pancreas size after resection was 7 cm (5–8 cm).

Short-term outcomes

Two patients (3.3%) died after surgery. One of these patients underwent PD for duodenal adenocarcinoma and

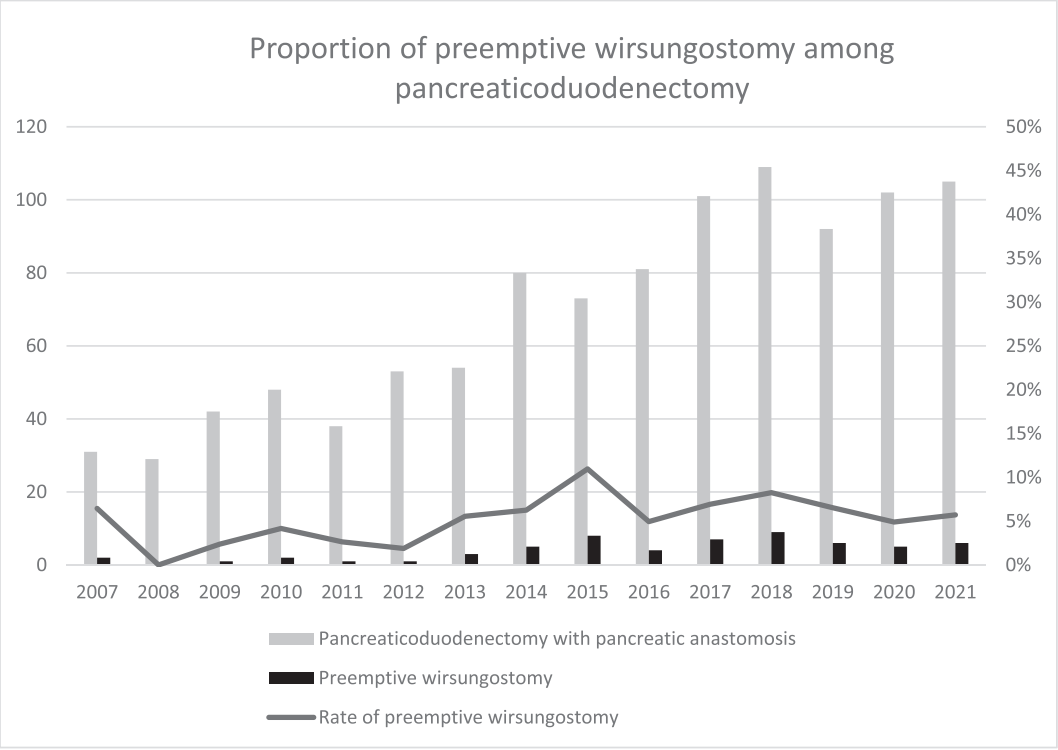

Figure 1 Rate of preemptive wirsungostomy according to the number of pancreaticoduodenectomy realized each year in our center

wirsungostomy with Escat drainage for a fatty pancreas. The patient underwent radiologic drainage of fluid collection before discharge on POD 24, and was readmitted on POD 88 for aspiration pneumonitis and died the same day. The other patient had surgery for a distal cholangiocarcinoma. The patient underwent portal vein resection and wirsungostomy with Escat drainage for necrotizing pancreatitis consecutive to endoscopic retrograde cholangiopancreatography. A biliary sepsis was resolved by antibiotherapy. The patient was discharged on POD 14 and was rehospitalized for bleeding in the Escat drain on POD 22. The CT scan showed hemoperitoneum with active bleeding from a hepatic artery pseudoaneurysm with portal thrombosis. The patient died of liver failure despite embolization on POD 24.

The overall 90-day postoperative morbidity rate was 63.3% (38/60). Morbidity is detailed in Table 3. The overall rate of morbidity was higher when the size of the remnant pancreas was $\leq$5 cm (60% vs 30%, p = 0.025). Thirty patients (50%) developed a major complication according to CD classification, with 17 patients (28.3%) developing grade IIIA complications, 3 patients (5%) grade IIIB complications, and 10 patients (16.7%) grade IV complications. Twenty-four radiological procedures had to be carried out after the PD: 18 (30%) radiologic drainages for abdominal fluid collection; 5 embolizations for bleeding events; 1 biliary drainage for grade B biliary leakage. Seven patients (11.7%) underwent relaparotomy: 3 for hemostasis; 2 for optimization of abdominal fluid collection drainage after failure of radiologic drainage; 1 for purulent peritonitis of unknown origin on POD 22; 1 for evisceration. Six (10%) of these seven cases of relaparotomy appeared to be related to the initial surgical management of the remnant pancreas. The mean length of stay was 22 ± 12.2 days. Twenty-seven patients (45%) were readmitted during the first 90 PODs. Short-term outcomes were not different comparing the first period of 9 years (n = 27) to the last 5 years (n = 33) (Table 4).

Management of the wirsungostomy

Concerning management of the wirsungostomy, the drain was removed within a median of 90 days after surgery. With experience we removed earlier the drain than we did at the beginning of our practice (in median, 120 days vs. 85 days, p = 0.02) (Table 4). The drain tends to be removed earlier when it was a suction drain compared to an Escat drain (in median, 64.5 days vs. 92.5 days, p = 0.09) (Table 6, supplementary files). The postoperative course was uneventful without any additional procedures for 75% patients, whereas wirsungostomy removal was complicated in 15 patients (25%) with 14 abdominal fluid collections in the pancreatic area; eight collections were infected. Cystogastrostomy was carried out in 10 patients (16.7%); 7 (11.7%) were performed by endoscopy and 3 (5%) by surgery. The median delay between surgery and cystogastrostomy was 5.5 months (3–17 months). The morbidity rate of these interventions was 10% (1/10) without associated mortality. This patient developed a fistula after pancreaticogastric anastomosis requiring medical treatment only.

Table 1 Patients, tumor characteristics and peroperative data of patients having wirsungostomy

Characteristics and data	Value[a]
Male sex	46 (76.7%)
Age, median (IQR), y	68 (68–74)
ASA score of III-IV	18 (30%)
Body mass index, median (IQR) m/kg^2	27.3 (25–29.8)
Operative indications	
Malignant indications	51 (85%)
Pancreatic adenocarcinoma	16 (26.7%)
Distal cholangiocarcinoma	10 (16.7%)
Adenocarcinoma of the vater ampulla	11 (18.3%)
Pancreatic GIST	2 (3.3%)
Duodenal adenocarcinoma	4 (6.7%)
Others	4 (6.7%)
	4 (6.7%)
Benign indications	9 (15%)
IPMN	5 (8.3%)
Serous cystadenoma	1 (1.7%)
Ampulloma	1 (1.7%)
Chronic pancreatitis	2 (3.2%)
Intraoperative data	
Wirsung size ≤3 cm	53 (88.3%)
Pancreas remnant size, median, IQR, cm	7 (5–8)
Mean operative time, mean ± SD	276 ± 79.41
Intraoperative blood loss, median (IQR), mL	675 (462.5–1200)
Intraoperative blood transfusion	12 (20%)

Abbreviations: SD, standard deviation; ASA, american society of anesthesiologists; IQR, interquartile range.
[a] Data represent number (percentage) of patients unless otherwise indicated, GIST: gastrointestinal stromal tumor, IPMN: Intraductal papillary mucinous neoplasm.

Table 2 Indications for preemptive wirsungostomy

Indications	Values[a]
Fatty pancreas	35 (58.3%)
Pancreatitis	19 (31.7%)
Pancreatic atrophy	4 (6.7%)
Hemodynamic instability	2 (3.3%)

[a] Data represent number (percentage) of patients.

Follow-up

The mean duration of follow-up was 29.8 ± 26.7 months. Among 46 patients candidates to adjuvant treatment, 23 (50%) underwent postoperative chemotherapy and 22 patients (47.8%) had a malignant recurrence during follow-up. Concerning pancreatic insufficiencies, 12 (20%) patients became diabetic with an additional 16 patients (27.7%) requiring insulin treatment compared to before PD (Table 5). Fifty-three patients (88.3%) had clinical exocrine pancreatic insufficiency.

Table 3 Postoperative outcomes in the first 90 POD after pancreaticoduodenectomy with wirsungostomy

Characteristics	Value[a]
Overall mortality	2 (3.3%)
Overall morbidity	38 (63.3%)
Grade ≥ IIIa	30 (50%)
Grade IIIa	17 (28.3%)
Grade IIIb	3 (5%)
Grade IV	10 (16.7%)
Collection	22 (36.7%)
Abdominal collection	21 (35%)
Parietal collection	1 (1.7%)
Delayed gastric emptying	2 (3.3%)
Grade A	0
Grade B	1 (1.7%)
Grade C	1 (1.7%)
Vascular events	12 (20%)
Pseudoaneurysm without hemorrhage	2 (3.3%)
Post-pancreatectomy hemorrhage	6 (10%)
Grade A	0
Grade B	4 (6.7%)
Grade C	2 (3.3%)
Portal gastropathy	1 (1.7%)
Porto-mesenteric veinous thrombosis	3 (5%)
Biliary leak	3 (5%)
Grade A	2 (3.3%)
Grade B	1 (1.7%)
Grade C	0
Pancreatitis of the pancreas remnant	1 (1.7%)
Evisceration	2 (3.3%)
Inhalative pneumopathy	2 (3.3%)

[a] Data represent number (percentage) of patients.

Discussion

We report here the largest cohort of patients having undergone wirsungostomy with PD in a context of high-risk pancreatic anastomosis; almost 90% of our patients had a stage D risk of developing POPF. Despite a high 90-day postoperative morbidity rate (63.3%), we show a low rate of surgical reintervention for pancreatic complications (10%) with a satisfactory overall recovery in 97% (58/60) patients and a low mortality rate (3.3%).

A previous study on the management of grade C POPF reported a rate of 26.5% relaparotomy and indicated a 35.9% rate of mortality in this particular sub-group of POPF.[7] Our results

Table 4 Preoperative and postoperative and outcomes according to the experience of our procedure

Characteristics and data	2007–2016 (n = 27) [a]	2017–2021 (n = 33)[a]	p
Male sex	18 (66.7)	28 (84.9)	0.12
Age, median (IQR), y	68 (62–74)	67 (60.5–74)	0.93
ASA score of III-IV	9 (33.3)	9 (27.3)	0.77
Body mass index, median (IQR), m/kg^2	26.2 (23.9–29)	28.9 (26.1–31)	0.1
ua-FRS, median (IQR), %	52 (43–62)	52 (46–62)	0.97
Indications for wirsungostomy			
Fatty pancreas	17 (62.9)	18 (54.6)	0.6
Pancreatitis	6 (22.2)	13 (39.4)	0.17
Intraoperative data			
Wirsung size ≤3 cm	23 (85.2)	30 (90.9)	0.69
Pancreas remnant size, median, IQR, cm	6.25 (5–8)	7 (5–7.75)	0.53
Mean operative time, mean ± SD	310 ± 100	260 ± 63.5	**0.04**
Overall mortality on POD 90	0	2 (6.1)	0.49
Overall morbidity on POD 90	17 (62.9)	23 (69.7)	0.78
Grade ≥ IIIa	12 (44.4)	20 (60.6)	0.29
Length of stay, mean ± SD	23.3 ± 7.9	20.8 ± 15.1	0.43
Readmission	14 (51.9)	19 (57.6)	0.59
Removal of drain, median (IQR), days	120 (81.5–137)	85 (40.5–99)	**0.02**
Exocrine insufficiency	24 (88.9)	29 (87.9)	>0.99
Endocrine insufficiency	13 (48.2)	12 (36.4)	0.43

Abbreviations: SD, standard deviation; ASA, american society of anesthesiologists; IQR, interquartile range; POD 90: postoperative day 90.
[a] Data represent number (percentage) of patients unless otherwise indicated.

Table 5 Pancreatic insufficiency outcomes at the last follow-up

	Before PD[a]	After PD[a]	P value
Endocrine insufficiency			
Diabetic patients	13 (21.7%)	25 (41.7%)	**0.019**
Diabetes mellitus without insulin treatment	10 (16.7%)	6 (10%)	0.28
Diabetes mellitus with insulin treatment	3 (5%)	19 (31.7%)	**0.0002**
Exocrine insufficiency	0	53 (88.3%)	**<0.0001**

Abbreviations: PD, pancreaticoduodenectomy.
[a] Data represent number (percentage) of patients.

thus indicate that wirsungostomy could be a valuable alternative surgical procedure in patients with high-risk pancreatic anastomosis. Indeed, our aim in using the wirsungostomy procedure was to decrease the short- and long-term morbidity and mortality of PD associated with severe POPF by performing wirsungostomy in selected patients only.

The wirsungostomy procedure remained rare (5.8%) and was indicated for specific cases. For instance, this technique was chosen when the pancreas was inflammatory, necrotic, soft and fatty, i.e. difficult or impossible to suture, in patients with high BMI or having unstable hemodynamic operating conditions. Only a handful of authors have already described this procedure in first line and the studies involved only a small number of patients.[13–17] Wirsungostomy has been primarily described as a rescue procedure for controlling POPF requiring relaparotomy,[12] with poor outcomes due to the bad conditions of the patients. Overall and in contrast given our low mortality/reintervention rates reported here, we think wirsungostomy deserves consideration for indication in the first-line management of high-risk pancreatic anastomosis. Indeed, indication of wirsungostomy could be essentially evaluated intraoperatively, but also preoperatively through validated fistula risk scores.[2,18,19,28–30]

We reached our objective concerning mortality. Grade C POPF is the worst situation after PD. Even if risks factors are identified, high-risk POPF remains a major issue for the pancreatic

surgeon.[31] Furthermore, the risk of developing grade C POPF after PD is between 3% and 5%[32] and is associated with a high mortality between 36.7 and 50%.[33,34] We report here a much lower mortality after the wirsungostomy procedure than in the context of when patients develop grade C POPF. In fact, approximately 9/10 of our patients were at high risk of developing POPF according to the uaFRS and ISGPS classification. Ninety percent of patients had a soft pancreas or pancreatitis, and 88% patients had a main pancreatic duct <3 mm; the latter a well-known risk factor for grade B or C POPF.[35] Combining a final recovery rate of 97% with a low mortality rate, wirsungostomy clearly provides a solution in selected cases of high-risk POPF. However, the price to pay could be the associated high rate of morbidity.

Our morbidity rate reaching 63.7% remains a major concern. However, over half of the post-operative complications were related to abdominal fluid collections requiring radiologic drainage (CD IIIa). Two factors could explain this. Firstly, our center had a strict recommendation for drainage of any fluid collection after pancreatic surgery in order to prevent infection or vascular complications. Secondly, this high rate of fluid collection was related to drainage problems when cannulation of the main pancreatic duct was not possible and even when drains were carefully placed. Considering that abdominal drainage is a minimally invasive procedure with a low rate of related morbidity, abdominal fluid collections caused by the wirsungostomy strategy could be expected and tolerated. Indeed, in our study the aim of the wirsungostomy procedure was the reduction in relaparotomy rate for grade C POPF (with a high associated morbidity rate). We only performed 7 (11.7%) early relaparotomies for complications without any mortality. Regarding late management, only three patients required cystogastrostomy by laparotomy, whereas seven were carried out by endoscopic drainage. Finally, 80% patients did not require surgical reintervention after wirsungostomy during follow-up, including almost 50% patients who did not require any kind of interventional procedure. These results contrast with those of Hasegawa et al.[17] regarding their two-stage pancreatojejunostomy. The authors systematically performed wirsungostomy followed by relaparotomy in order to perform the pancreatic anastomosis. Overall, pancreatic fistula developed in 58% of patients, including 16 with grade B/C POPF.

Our experience led to improvement in our technique via attempting to mitigate the morbidity. Initially, we optimized the drainage by externalization mainly to the right flank in a more direct way than to the left flank. We also decided to shorten the remnant pancreas adequately enough to maintain endocrine function and reduce exocrine secretions. However, our analysis showed that shortening the pancreatic tail actually led to an increase in morbidity and so we discontinued this procedure. In addition, we became systematic in positioning the omentum to cover the vessels to prevent bleeding as proposed by others.[36] We additionally avoided extensive dissection of the pancreatic tail and were able to ligate the splenic artery for cases of challenging dissection to avoid bleeding complication. Finally, we were systematically very proactive with respect to any events and agreed to re-hospitalize patients and to perform radiologic re-drainage to avoid morbidity related to fluid collection.

The main long-term value of this procedure was that 60% of patients had preserved endocrine function. A recent review[37] reported that the overall mean proportion of new-onset diabetes mellitus after PD was 16%. Our result was higher with 16 (27.7%) patients developed insulin-dependent diabetes after wirsungostomy. One explanation could be that among these 16 patients, half of them had a fatty pancreas with an atrophic remnant. The Escat drain thus could have induced some inflammation and reduced pancreatic secretions. Loss of exocrine function is unavoidable with the wirsungostomy procedure but could easily be supplemented by oral treatments once feeding is restored or recovered after cystogastrostomy.

The main alternative to preemptive wirsungostomy in patients undergoing PD is TP. Some authors have proposed this procedure in selected cases[9,38] as it can prevent POPF and other related complications, such as DGE and PPH,[10] and has been associated with a low readmission rate after discharge (approximately 4%).[8] Admittedly, our post-wirsungostomy readmission rate after discharge was high (45%) and we report a substantial complication rate after Escat drain removal (25%). However, these complications can be resolved by antibiotherapy or procedures under local anesthesia, and thus can be somewhat compensated for by our high rate of preserved endocrine function. Furthermore, wirsungostomy systematically allows for spleen preservation, whereas TP more frequently involves associated splenectomy due to difficulty in preserving spleen vascularization. Preserving the spleen reduces the occurrence of spleen removal-related infectious complications.[39] Finally, the most interesting future alternative to wirsungostomy to consider is TP with islet autotransplantation (TP-IAT); thus carrying the advantages of TP while preventing diabetes.[40] A recent randomized trial comparing in case of high-risk anastomosis, PD with TP-IAT, showed an increased rate of grade 2 complications in case of PD and although patients with TP-IAT were at higher risk to be diabetic, it allowed a good metabolic control and sustained C-peptide production over time.[41] However, the indication of TP-IAT for malignant pancreatic neoplasms is still under debate[42] and is thus leaving a place for wirsungostomy in the field of high-risk pancreatic surgery.

An additional alternative to preemptive wirsungostomy is the injection of a glue into the residual pancreatic stump as described by Mazzaferro et al.[43] This injection is followed by a continuous suture and 2 passive drains are placed around the remnant pancreas. Although the safety of this technique has been demonstrated, it triples the risk of diabetes at 1 and 3 years due to neoprene-induced pancreatic fibrosis[43] without benefit on overall morbidity and mortality clearly established.[44]

Our study has several limitations. The retrospective study of data from a prospectively maintained database can result in some

missing data. An evaluation of QoL was not available which could have provided more information on the effects of readmission, external drainage management, and preserved endocrine function. We opted not to compare wirsungostomy to other strategies for high-risk pancreatic anastomosis because we wished first to focus on the results of this procedure; which is still poorly described to date. However, a future comparison of different surgical strategies for patients at high-risk of POPF would be valuable and add to our current results. Indeed, comparing the results of wirsungostomy with those of total pancreatectomies and PD with high-risk anastomosis would be relevant. The results of such work could be used to design a randomized trial to define the best strategy to choose.

In conclusion, preemptive wirsungostomy with PD could be a supplementary tool for the management of patients with high-risk pancreatic anastomosis. Despite the high morbidity rate of the procedure here, we believe it could be lowered with experience and technical modifications, such as drainage optimization, avoiding devascularization of the pancreatic tail, and being extremely proactive in the postoperative period.

Acknowledgments

The authors thank J. Butterworth for editing the English of the manuscript.

Funding sources

None.

Conflict of interest

None to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.hpb.2023.04.003.