Clinical Science

Surgical treatment of severe pancreatic fistula after pancreaticoduodenectomy by wirsungostomy and repeat pancreatico-jejunal anastomosis

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KEYWORDS:
Pancreatic fistula; Pancreatoduodenectomy; Outcomes; Surgery

Abstract

BACKGROUND: After pancreaticoduodenectomy, severe pancreatic fistula may require salvage relaparotomy in patients with largely disrupted pancreaticojejunal anastomosis. Completion pancreatectomy remains the gold standard but yields high mortality and severe long-term repercussions. The authors report the results of a pancreas-preserving strategy used in this life-threatening condition.

METHODS: Two hundred fifty-four pancreaticoduodenectomies with pancreaticojejunal anastomosis were performed between 2005 and 2011; 21 patients underwent salvage relaparotomy for grade C pancreatic fistula. Largely dehiscent pancreaticojejunal anastomoses were dismantled in 16 patients. Four patients underwent completion pancreatectomy, whereas in 12 patients detailed here, the remaining pancreas was preserved and drained by wirsungostomy with exteriorization or closure of the jejunal stump. Repeat pancreaticojejunal anastomosis was later planned to preserve pancreatic function.

RESULTS: One patient died of recurrent hemorrhage on day 1 after wirsungostomy (8.3%). All but 1 survivor developed postoperative complications, and 3 needed reoperation before hospital discharge. The median hospital stay was 62 days (range, 29 to 156 days). After a median delay of 130 days (range, 91 to 240 days) from salvage relaparotomy, repeat pancreaticojejunostomy was attempted in 10 patients and was successful in 9 (1 completion pancreatectomy was performed). One patient died postoperatively (10%). Long-term endocrine function was unaltered in 66% of patients who benefited from this conservative strategy.

CONCLUSIONS: This pancreas-preserving strategy yielded a whole mortality rate of 17% for largely disrupted pancreaticojejunal anastomosis requiring salvage relaparotomy. It compares favorably with systematic completion pancreatectomy and achieved preservation of remnant pancreatic function in 75% of patients.

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Pancreatectomy (PD) is a common and safe procedure, with reported operative mortality rates of <5%. Nevertheless, postoperative morbidity rates remain high, reaching 51% in a recent multicenter French trial.1–6 Improvements in diagnostic and interventional radiologic tools have contributed to the success of conservative
management for pancreatic fistula (PF). However, PF can lead to bleeding from eroded adjacent vessels (mainly arteries) or be associated with severe pancreatitis, peritonitis, and sepsis. All these conditions may preclude this nonoperative strategy, necessitating urgent salvage relaparotomy with high postoperative mortality. Although some authors have suggested that surgical conservative management without pancreatic resection is the treatment of choice in this setting, our team and others pointed out that completion pancreatectomy remains indicated in patients with severe sepsis or major complications associated with PF. Nevertheless, total pancreatectomy is responsible for substantial metabolic abnormalities, including severe brittle diabetes, responsible for late deaths by hypoglycemia. Because PF after PD may occur after the resection of benign or premalignant pancreatic lesions with long-term survival, pancreatic exocrine function after PD is a major concern after PD. Completion pancreatectomy, by suppressing exocrine function, induces postoperative malabsorption, liver steatosis, osteopenia, diarrhea, and weight loss. All these complications can occur despite mandatory substitutive enzyme lifelong treatment.

The aim of this study was to report the results of an original strategy of preserving pancreatic function for the treatment of severe PF after PD in rare but life-threatening situations requiring urgent relaparotomy. This strategy included urgent pancreas-sparing salvage relaparotomy, performing drainage and wirsungostomy and preserving both endocrine and exocrine pancreatic function. Thereafter, delayed restorative laparotomy was planned to reconstruct the pancreaticojejunostomal anastomosis.

Methods

Pancreatoduodenectomy and data collection

This new conservative strategy for severe PF requiring relaparotomy has been used as a 1st-choice procedure at our center since November 2005. The medical files of all patients who underwent relaparotomy for severe PF after PD between November 2005 and September 2011 were reviewed. Patients treated with the conservative strategy were prospectively added to a database and are reported here. The study was approved by the institutional review board of Saint Antoine Hospital (Paris, France).

All patients underwent formal PD, including gastric antrectomy. Child’s reconstruction was used with the first jejunal limb pulled up behind the transverse colon and anastomosed to the pancreas with an end-to-side ducto-mucosa pancreaticojejunostomy. An end-to-side choledochojunostomy was then constructed 20 cm downstream, and an antecolic end-to-side gastrojejunostomy was placed 60 cm downstream of the biliary anastomosis. Two tubular nonaspirative rubber drains were left in the vicinity of the pancreaticojejunal anastomosis. The left drain was placed in front of the left colic angle and exteriorized in the left flank. The right drain passed behind the hepatic pedicle to drain also the biliary anastomosis and was exteriorized through the right flank. Amylase was systematically measured on postoperative days 1, 3, and 5, and drains were removed on day 5 if no PF was detected.

Management of pancreatic fistula

A conservative strategy was initially adopted, including total parenteral nutrition, intravenous somatostatin or its subcutaneously delivered analogues, and percutaneous drainage of accessible abdominal collections very likely infected. Antibiotics were targeted according to bacteriologic samples. In patients with abdominal or gastrointestinal hemorrhage, 3-phase abdominal computed tomography, interventional angiography, and interventional upper gastrointestinal endoscopy were performed.

Urgent salvage relaparotomy was indicated in the following cases: deteriorating general condition despite maximal supporting care, ongoing bleeding after failure or contraindication of radiologic endovascular procedures, septic intra-abdominal collections inaccessible to percutaneous drainage, suspected peritonitis by visceral perforation, and necrosis. This initial relaparotomy secured hemostasis of bleeding vessels and carried out complete exploration of the abdominal cavity, checking all previous anastomotic sites, and ensured debridement of all necrotic and septic tissues and collections. A limited disruption of the pancreaticojejunostomy was treated by drainage of the leakage. Pancreatic anastomosis was considered as not preserveable when the disruption exceeded one third of the circumference of the suture line or when a segmental necrosis of the pancreatic stump was likely to prevent its secondary healing.

Indications for completion pancreatectomy were restricted to the following situations: (1) extended necrosis of the left pancreatic remnant; (2) opening of the main pancreatic duct not found despite careful exploration of a largely disrupted pancreaticojejunostomy; and (3) splenic lesions requiring arterial ligation to ensure hemostasis. In all other cases, the pancreas-preserving strategy was favored.

Pancreas-preserving strategy with wirsungostomy

Salvage relaparotomy and wirsungostomy. After complete dismantling of the largely dehiscent pancreaticojejunostomy, the jejunal stump was either exteriorized through the incision or closed using a linear stapler (Fig. 1). A short resection (1 to 2 cm) of a necrotic segment of the pancreatic stump was performed when necessary, and the pancreatic duct was cannulated with a thin polyethylene tube with distal and lateral holes (Trans-cystic drain; Coloplast Porges, Paris, France), whose diameters (CH/FR 5/7 to 8/10) were chosen congruent with the main pancreatic duct. This drain was fixed with nonabsorbable stitches on the
main pancreatic duct wall and was placed behind the hepatic pedicle and exteriorized in the right flank to facilitate early postoperative drainage by declivity. The hepaticojejunostomy, if also partially disrupted, was drained by a rubber T-tube inserted through the anastomosis. When the disruption involved more than half of the biliary anastomosis, it was dismantled, and the proximal jejunal segment between pancreatic and biliary anastomosis was resected and closed by stapler with complete external biliary drainage. The pancreatic stump was also drained by 2 tubular silicone drains exteriorized in both flanks. The stapled jejunal stump was reinforced by a hemostatic running suture and fixed to the aponeurosis during anterior abdominal wall closure to allow spontaneous direct secondary enterocutaneous fistula in case of impaired healing. A feeding jejunostomy was constructed for enteral nutrition, started postoperatively as soon as possible. Somatostatin or its analogues were systematically used to decrease pancreatic secretion until the removal of the 2 silicon drains performed when their output was nil or without PF (amylase level in the effluent <3-fold amylasemia).

**Delayed restorative laparotomy.** The delayed restorative procedure was scheduled ≥3 months after salvage relaparotomy. The pancreatic polyethylene tube still in place was used as a guide to find the pancreatic stump and the main pancreatic duct. The proximal end of the jejunum was freed from the abdominal wall and used to construct the repeat end-to-side duct-to-mucosa pancreaticojejunal anastomosis. A redo choledochojejunal anastomosis was associated when indicated. Two tubular nonaspirating drains were placed around the pancreatic anastomosis.

**Definition of postoperative morbidity**

PF was defined and graded according to International Study Group for Pancreatic Fistula classification.\(^{18}\) Postoperative bleeding was defined according to International Study Group for Pancreatic Fistula criteria.\(^{19}\) Sepsis was defined as the presence of both infection and systemic inflammatory response. Shock was defined as a mean arterial blood pressure <70 mm Hg after adequate fluid resuscitation and requirement for catecholamine infusion. Pulmonary complications included pneumonia, pleural effusion requiring drainage, and sustained mechanical ventilation. Acute renal failure was defined by increase of serum creatinine level ≥2 times the preoperative level. Postoperative peritonitis was suspected in the presence of peritoneal tenderness, abdominal pain, and fever of >38.5 °C and was confirmed at surgery. Intra-abdominal abscess was defined as purulent infected collection requiring drainage and wound infection as purulent discharge requiring specific local care. The onset of postoperative diabetes was defined as increased doses of antidiabetic drugs >1 month from hospital discharge. Diarrhea was defined as ≥3 bowel movements per day and used as a clinical marker of exocrine insufficiency. Follow-up data on diabetes and diarrhea were obtained through medical records review or patient contact.

**Data analysis**

Data are expressed as median (range) or mean ± SEM unless otherwise indicated.

**Results**

**Patient characteristics**

In the studied period, 254 PDs were performed at our center, and 21 patients (8.3%) underwent relaparotomy for severe grade C PF, including 3 patients referred for postoperative complications after PD performed at another center. Five patients were surgically drained for limited disruptions of the pancreatic anastomosis, and 4 necessitated completion pancreatectomy. These 9 patients, of whom 2 died postoperatively after completion pancreatectomy, are not detailed here. The median age of the 12 remaining patients treated by wirsungostomy was 63 years (range, 28 to 78 years). There were 11 men and 1 woman. Two patients were American Society of Anesthesiologists grade I, 6 grade II, and 4 grade III. Eight patients (67%) underwent PD for malignant tumors. Patient characteristics at PD are summarized in Table 1. Indications for salvage relaparotomy (Table 2) were ongoing life-threatening hemorrhage (n = 7) (after previous briefly efficient percutaneous embolization of a bleeding pseudoaneurysm of the gastroduodenal artery stump in 2 patients), peritonitis (n = 3), and worsening of the patient’s condition with persisting septic shock (n = 2) despite optimal supporting care.
Surgical findings of the 12 patients who underwent salvage relaparotomy and wirsungostomy are detailed in Table 3. The median delay between pancreatic resection and reoperation was 11 days (range, 5 to 34 days).

**Salvage relaparotomy and wirsungostomy**

One patient (8.3%) died of recurrent hemorrhage on day 1 after first relaparotomy, demonstrating rupture of the venous splenoportal confluence. He died despite successful initial surgical hemostasis and a second salvage operation on postoperative day 1 (patient 8).

Eleven patients developed postoperative complications (92%): 1 recurrent fatal hemorrhage, 4 acute renal insufficiencies, 4 pulmonary infections, 2 blood septicemias treated by broad-spectrum antibiotics, and 1 postoperative malnutrition. Three patients underwent reoperation during hospitalization after salvage relaparotomy: 1 for tracheotomy after 14 days of mechanical ventilation, 1 for surgical drainage of a wound infection because of jejunal stump fistulization on postoperative day 17, and 1 patient for recurrent fatal hemorrhage.

Total parenteral nutrition was replaced by continuous enteral nutrition as soon as possible (on postoperative days 2 to 4). All surviving patients resumed oral nutrition after a median delay of 20 days (range, 7 to 45 days) from salvage relaparotomy.

The median length of hospital stay after salvage relaparotomy for survivors was 62 days (range, 29 to 156 days), with a median stay of 39 days (range, 2 to 152 days) in the intensive care unit.

Four patients required specific procedures for late complications: 2 radiologic drainages of intra-abdominal collections (1 because of reopening of the jejunal stump and 1 because of incomplete drainage of the pancreatic secretion by the wirsungostomy), 1 endoscopic placement of a nasoenteral feeding tube after loss of the feeding jejunoscopy, and 1 surgical drainage of a wound abscess.

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**Table 1** Patient characteristics and intraoperative findings at initial pancreaticoduodenectomy

<table>
<thead>
<tr>
<th>Patient no./sex/age (y)</th>
<th>ASA grade</th>
<th>Diagnosis</th>
<th>Pancreas consistency</th>
<th>Diameter of main pancreatic duct (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/M/64</td>
<td>I</td>
<td>Ampullary carcinoma</td>
<td>Hard</td>
<td>4</td>
</tr>
<tr>
<td>2/M/60</td>
<td>II</td>
<td>Ampullary carcinoma</td>
<td>Normal</td>
<td>Unknown</td>
</tr>
<tr>
<td>3/M/64</td>
<td>III</td>
<td>CDDW</td>
<td>Hard</td>
<td>6</td>
</tr>
<tr>
<td>4/M/65</td>
<td>III</td>
<td>Cholangiocarcinoma</td>
<td>Soft</td>
<td>Unknown</td>
</tr>
<tr>
<td>5/M/78</td>
<td>II</td>
<td>IPMN</td>
<td>Hard</td>
<td>5</td>
</tr>
<tr>
<td>6/M/28</td>
<td>I</td>
<td>Islet-cell carcinoma</td>
<td>Soft</td>
<td>4</td>
</tr>
<tr>
<td>7/M/70</td>
<td>II</td>
<td>Pancreatic duct carcinoma</td>
<td>Hard</td>
<td>4</td>
</tr>
<tr>
<td>8/M/67</td>
<td>II</td>
<td>Ampullary adenoma</td>
<td>Soft</td>
<td>4</td>
</tr>
<tr>
<td>9/M/64</td>
<td>II</td>
<td>Pancreatic duct carcinoma</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>10/F/77</td>
<td>III</td>
<td>Ampullary adenoma</td>
<td>Soft</td>
<td>5</td>
</tr>
<tr>
<td>11/M/78</td>
<td>III</td>
<td>Pancreatic duct carcinoma</td>
<td>Hard</td>
<td>7</td>
</tr>
<tr>
<td>12/M/68</td>
<td>I</td>
<td>Cholangiocarcinoma</td>
<td>Soft</td>
<td>2</td>
</tr>
</tbody>
</table>

ASA = American Society of Anesthesiologists; CDDW = cystic dystrophy of the duodenal wall developing in heterotopic pancreas; IPMN = intraductal papillary mucinous neoplasm.

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**Table 2** Patients’ clinical status at salvage relaparotomy

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Organ failure</th>
<th>Cardiac failure</th>
<th>Respiratory failure</th>
<th>Renal failure</th>
<th>Septic shock</th>
<th>Indication for relaparotomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Septic shock</td>
<td>Septic shock</td>
</tr>
<tr>
<td>2</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td></td>
<td>Peritonitis</td>
</tr>
<tr>
<td>3</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td></td>
<td>Hemorrhage</td>
</tr>
<tr>
<td>4</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td>Septic shock</td>
</tr>
<tr>
<td>5</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td></td>
<td>Hemorrhage</td>
</tr>
<tr>
<td>6</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td>Hemorrhage</td>
</tr>
<tr>
<td>7</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td></td>
<td>Hemorrhage</td>
</tr>
<tr>
<td>8</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td></td>
<td>Hemorrhage</td>
</tr>
<tr>
<td>9</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td>Peritonitis</td>
</tr>
<tr>
<td>10</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
<td>Peritonitis</td>
</tr>
<tr>
<td>11</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td></td>
<td>Hemorrhage</td>
</tr>
<tr>
<td>12</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td>Hemorrhage</td>
</tr>
</tbody>
</table>

*Digestive hemorrhage.
Intra-abdominal hemorrhage.
Pancreaticoduodenectomy and the first 4 reinterventions were performed at another hospital before referral.
Bleeding through abdominal drains was the first indication for laparotomy, but a colon perforation was found intraoperatively.
Significant weight loss was observed postoperatively, with a mean body mass index of 23 kg/m² before restorative laparotomy compared with 26 kg/m² before initial PD.

Delayed restorative laparotomy

At restorative laparotomy, the pancreatic intraductal drain was still in place in 7 patients, with a median output of 282 mL/day (range, 60 to 500 mL/day); 3 patients had their drains dislodged, with productive external PFs (200 mL/day) in 2 of them.

Restoration of pancreatic digestive continuity by repeat pancreaticojejunostomy was attempted in 10 of 11 surviving patients after a median delay of 130 days (range, 91 to 240 days) from salvage relaparotomy. Indeed, 1 patient developed several intra-abdominal collections treated by sequential radiologic drainages with progressive complete atrophy of the pancreatic remnant and spontaneous closure of wirsungostomy. In 1 patient, the pancreatic remnant was

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Peritonitis</th>
<th>Pancreatitis</th>
<th>Pancreateicojejunal anastomosis (% of dehiscence)</th>
<th>Hepaticojejunal anastomotic leak</th>
<th>Active hemorrhage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No</td>
<td>No</td>
<td>&gt;50%</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>Localized</td>
<td>Partially necrotic</td>
<td>&gt;50%</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>No</td>
<td>No</td>
<td>33%–50%</td>
<td>No</td>
<td>Yes‡</td>
</tr>
<tr>
<td>4</td>
<td>Diffuse</td>
<td>Partially</td>
<td>&gt;50%</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>No</td>
<td>Partially</td>
<td>33%–50%</td>
<td>Yes†</td>
<td>Yes‡</td>
</tr>
<tr>
<td>6</td>
<td>No</td>
<td>Partially</td>
<td>33%–50%</td>
<td>No</td>
<td>Yes‡</td>
</tr>
<tr>
<td>7</td>
<td>No</td>
<td>Partially</td>
<td>&gt;50%</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>Localized</td>
<td>Edematous</td>
<td>&gt;50%</td>
<td>No</td>
<td>Yes‡</td>
</tr>
<tr>
<td>9</td>
<td>Diffuse</td>
<td>No</td>
<td>&gt;50%</td>
<td>Yes‡</td>
<td>No</td>
</tr>
<tr>
<td>10</td>
<td>Localized</td>
<td>No</td>
<td>33%–50%</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>11</td>
<td>No</td>
<td>No</td>
<td>33%–50%</td>
<td>No</td>
<td>Yes†</td>
</tr>
<tr>
<td>12</td>
<td>Localized*</td>
<td>Edema</td>
<td>&gt;50%</td>
<td>No</td>
<td>Yes‡</td>
</tr>
</tbody>
</table>

*Colon perforation found during laparotomy and treated by loop colostomy.
†Drainage with T-tube.
‡Anastomosis dismantling and external biliary drainage.
¶Gastroduodenal artery origin of bleeding.
§Hepatic artery origin of bleeding.
*Splenic artery origin of bleeding.
‖Portal vein or splenoportal junction origin of bleeding.
soft and hardly suturable, and a completion pancreatectomy was performed (patient 11). In all other 9 patients, the pancreatic parenchyma was estimated to be hard or fibrous by the surgeon. The median duration of intervention was 293 minutes, estimated blood loss was 587 mL, and 4 patients needed blood transfusions. Table 4 summarizes intraoperative findings and additional procedures performed.

Three patients (30%) presented with complications: 2 with PFs responsible for intra-abdominal abscesses drained percutaneously and 1 with extensive mesenteric ischemia leading to death on postoperative day 3 in a patient whose left colic angle appeared already ischemic at restorative laparotomy, requiring a segmental colic resection (patient 10) (Table 5).

**Long-term results**

Postoperative mortality of the whole pancreas-preserving procedure was 17% (2 of 12). Nine patients (75%) benefited from a complete procedure with repeat pancreaticojejunos-tomy. Table 5 shows long-term outcomes. Within a median follow-up period of 15 months (range, 2 to 51 months), 2 patients were readmitted for symptoms or complications related to the pancreas-preserving strategy (readmissions due to cancer recurrence were not considered). All but 1 patient were still taking pancreatic enzymes, but only 3 had chronic diarrhea. All patients before cancer recurrence reduced their weight loss to <8% of their pre-PD weight. Long-term endocrine function was unaffected in 6 of 9 survivors (66%) who underwent complete procedures preserving the left pancreatic remnant. Only 1 patient developed postoperative diabetes mellitus, treated with oral therapy. Two patients under oral therapy for type 2 diabetes mellitus before PD required insulin therapy.

**Comments**

The Achilles’ heel of PD remains the pancreatic anasto-mosis, inconstant healing of which can lead to PF development. Whether performed with the stomach or with the jejunum, there is no significant difference in the rate of PF, and PF rates did not decrease significantly in recently published series. Thus, PF rates reported by centers specializing in pancreatic surgery still vary from 2.1% to 25%. According to International Study Group for Pancreatic Fistula classification definition, the rate of PF was 17% after PD at our center in patients prospectively included in a multicenter study. Therefore, PF remains the major cause of morbidity and mortality after PD and increases both hospital stays and costs of treatment.

When PF occurs, conservative treatment is considered efficient in 40% to 70% of patients. When PF occurs, conservative treatment is considered efficient in 40% to 70% of patients. When PF occurs, conservative treatment is considered efficient in 40% to 70% of patients. When PF occurs, conservative treatment is considered efficient in 40% to 70% of patients. When PF occurs, conservative treatment is considered efficient in 40% to 70% of patients. When PF occurs, conservative treatment is considered efficient in 40% to 70% of patients. When PF occurs, conservative treatment is considered efficient in 40% to 70% of patients. When PF occurs, conservative treatment is considered efficient in 40% to 70% of patients.

Largely dehiscent pancreaticodigestive anastomoses (for us, more than one third of the anastomoses) have to be dismantled. Completion pancreatectomy is frequently performed in this situation. It is associated with splenectomy in 50% to 100% of reported cases.
preservation is here indeed demanding because of local inflammatory lesions. Although van Berge Henegouwen et al.\textsuperscript{12} reported no mortality in their series of salvage completion pancreatectomy, other teams have reported mortality rates of 23\% to 80\%.\textsuperscript{9,28,30–36} We reported a 37\% mortality rate with this strategy favored in our department before 2005.\textsuperscript{11} Furthermore, brittle diabetes induced by total pancreatectomy severely impairs the quality of life of survivors, with frequent deep hypoglycemia. Parsaik et al.\textsuperscript{13} reported episodic hypoglycemia in a series of 141 total pancreatectomies in 79\% of patients, and 41\% of patients experienced severe hypoglycemia. Lethal hypoglycemia occurred in 1 of our patients who underwent completion pancreatectomy and was reported in 3\% of total pancreatectomies by Billings et al.\textsuperscript{15} We therefore changed our policy in 2005, embarking on a pancreas-preserving strategy.

This technique, based on preservation of the pancreatic remnant and wirsungostomy, is simpler, faster, and less hemorrhagic at salvage relaparotomy than completion pancreatectomy in these frequently hemodynamically unstable patients. It can be performed in emergency by less experimented surgeons. It preserves splenic function. The 8\% mortality rate observed here compares favorably with the 37\% mortality rate previously observed at our center after systematic completion pancreatectomy in these salvage relaparotomies. Hemorrhage occurring in >10\% of PDs and strongly related to local sepsis and anastomotic leakage\textsuperscript{1,37} constituted the most frequent indication (58\%) for salvage relaparotomy, whereas ongoing sepsis because of insufficient drainage of the pancreatic leak accounted for only 42\% of indications. Thus, efficient drainage of the PF by surgical or percutaneous drains did not prevent arterial erosions and bleeding. It is noteworthy that only 1 patient experienced postoperatively rebleeding among 7 patients with active bleeding at salvage relaparotomy. We therefore do not consider arterial hemorrhage as justifying by itself pancreatectomy completion, as suggested by others.\textsuperscript{38} A 28\% mortality rate using a similar technique of wirsungostomy in case of severe PF requiring salvage relaparotomy was recently reported.\textsuperscript{23} Our lower 8.3\% mortality rate might be explained by a more selective use of this conservative procedure. Indeed, within the study period, we still performed completion pancreatectomy in 4 of 21 patients (19\%) who underwent salvage relaparotomy for PF.

The external drainage of a disconnected main pancreatic duct has been initially used in other settings, such as severe pancreatic trauma,\textsuperscript{39} hemodynamic instability, or pancreatic texture precluding pancreatic anastomosis after PD.\textsuperscript{40} This wirsungostomy has been more recently reported for the management of PF after PD.\textsuperscript{23} The long-lasting external drainage of pancreatic secretion was efficient in our series, with only 2 patients requiring additional percutaneous drainage of intra-abdominal collections before reconstruction. Furthermore, before delayed reconstruction, 9 patients (81\%) still had productive PFs drained through the tube or its tract, an indication of preserved pancreatic exocrine function. The protein loss induced by this long-lasting pancreatic discharge is likely to be responsible for the observed weight loss before reconstruction. It must be carefully compensated by adapted intake. Alternative options to conserve the left pancreas are pancreatic occlusion or transformation of the dehiscence pancreaticojejunal anastomosis in repeat pancreatico-gastrostic anastomosis.\textsuperscript{36} The 1st option yields a risk for pancreatitis and recurrent PF and does not preserve exocrine function. We remain reluctant to use the 2nd option reported by Bachellier et al.\textsuperscript{16} in 4 patients. It necessitates gastric opening and extended mobilization of an inflammatory pancreas, which might be problematic in this localized peritonitis.

The management of the opened jejunal stump remains to be better defined. Its exteriorization as jejunostomy is the safest option and was initially favored in this series. It necessitates a sufficient length of available jejunal loop (20 to 30 cm) between the pancreatic and biliary anastomosis (systematically performed in PD for this purpose at our center). This proximal stoma is theoretically not productive, but a bilio-intestinal reflux always requires bags. Closure of the jejunal stump, even fixed under the incision, was responsible in 2 patients for localized collections by leakage. The best option might be closure on a small decompressing drain, allowing delayed spontaneous closure after drain withdrawal. This latter was successfully used in the last 4 patients.

Delayed reconstruction was not performed in the series reported by Denost et al.\textsuperscript{23} This team removed the ductal drain after a delay of 2 to 11 months, when pancreatic discharge drying occurred spontaneously or after intraductal injection of Neoprene. Our policy was quite different, fearing the long-term consequences of pancreatic atrophy induced by definitive ductal obstruction on both exocrine (immediately) and endocrine (long-term)\textsuperscript{13–15} functions. Restoration of pancreatico-digestive continuity was possible in 90\% of cases by repeat pancreaticojejunostomy. A minimal delay of 3 months was respected to reduce the complexity of the procedure because of adhesions. Dissection of the pancreatic stump was guided by the ductal drain still in place in most cases and was always achieved without major difficulty. Intraoperative transfusions of red blood cells were used in only 40\% of cases, and the median duration of the procedure was <5 hours. Interestingly, the drained pancreatic stump was always harder than observed at initial PD or salvage relaparotomy. Nevertheless, the risk for postoperative PF (22\%) did not differ from that of initial PD, but all were benign and healed without reoperation (grade A or B). The sole postoperative death accounted for a 10\% mortality rate of restorative laparotomy. This death was related more to poor vascular and general status of the patient than to the restorative procedure itself.

This pancreas-preserving strategy therefore appears attractive. Its mortality rate of 17\%, for largely dehiscent pancreatico-jejunal anastomosis requiring salvage relaparotomy, compares favorably with systematic completion
pancreatectomy. It achieves preservation of the left pancreas and its function in 75% of patients.

References