Selection of Pancreaticojejunostomy Techniques According to Pancreatic Texture and Duct Size

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Hypothesis: Selection of proper pancreaticojejunostomy techniques according to pancreatic texture and the main duct size reduces the pancreatic fistula rate.

Design and Patients: Data from 50 consecutive patients undergoing pancreateoduodenectomy with 3 different anastomotic techniques prospectively used according to pancreatic texture and the main duct size were analyzed. Duct-invagination anastomosis was selected for pancreata with a small duct (n=34 [29 with a soft texture and 5 with a hard texture]). Stitches between the stump parenchyma and the jejunal seromuscular layer were added to this anastomosis procedure only for the hard pancreata. Pancreata with a large duct were reconstructed with a conventional duct-to-mucosa anastomosis (n=16).

Setting: A university hospital department of digestive surgery.

Results: The morbidity was 40% (20 of 50 patients) in this series. Four patients (8%) with a soft pancreas and a small duct developed a pancreatic stump leak after duct-invagination anastomosis, but all of them were removed without sequelae. No pancreatic anastomotic leak was seen in this series, which resulted in no mortality, no remnant pancreatectomy, and only 1 relaparotomy in the consecutive 50 patients.

Conclusion: The proper selection of pancreatic reconstruction techniques according to our criteria may reduce the pancreatic fistula rate, eliminate risky pancreatic anastomotic leaks, and result in excellent outcomes for those undergoing pancreateoduodenectomy.

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In recent years, pancreateoduodenectomy has been performed with an operative mortality of less than 5% in many large-volume centers. However, this operation is still associated with a high incidence of postoperative morbidity, approaching 50%. A pancreatic fistula is the most important complication, from which approximately 80% of patient deaths result. The incidence of a pancreatic fistula varies from 5% to 25% in most series. A recently published article of a large series of pancreatic resections demonstrated that this incidence did not change in the past decade.

See Invited Critique at end of article

Because the definition of pancreatic fistula has not been standardized, most series included pancreatic-enteric anastomotic leaks (pancreatic anastomotic leaks [ALs]) and extravasation of pancreatic secretions from the pancreatic stump (pancreatic stump leaks [SLs]) as pancreatic fistulas. An AL is a risky complication that possibly leads to life-threatening complications, including pancreatic abscesses, subsequent sepsis, and massive hemorrhage, because this pancreatic fistula is activated by a concomitant leak of the enteric contents. In contrast, an SL is usually clinically unimportant and can be removed without sequelae. Therefore, distinctive analysis of these 2 pancreatic fistulas and prevention of ALs are important.

In an attempt to prevent pancreatic fistulas, we prospectively used 3 different anastomotic techniques according to pancreatic texture and the main duct size since November 30, 1998. In the present study, we report the results of our 50 consecutive pancreateoduodenectomies.

Patients and Methods

Patients

Between November 30, 1998, and September 6, 2001, 50 consecutive patients underwent standard Whipple resection (n=31) or pylorus-preserving pancreateoduodenectomy (n=19) at...
Kobe University Hospital, Kobe, Japan. There were 35 men and 15 women, and their mean age was 61.9 years (range, 35-82 years). Their conditions included pancreatic cancers (n = 11), ampullary cancers (n = 10), pancreas cystic tumors (n = 9), chronic pancreatitis (n = 8), duodenal cancers (n = 5), bile duct cancers (n = 4), gastric cancers (n = 2), and pancreatic aneurysms (n = 1). In this series, 20 (40%) of the patients had diabetes mellitus preoperatively. The median preoperative serum albumin and total cholesterol levels in these 50 patients were 3.4 g/dL (range, 1.4-3.8 g/dL) and 168 mg/dL (4.34 mmol/L) (range, 35-298 mg/dL [1.42-7.71 mmol/L]), respectively.

SURGICAL PROCEDURES

All surgical procedures were performed by 2 senior surgeons (Drs Suzuki and Kuroda). The pancreas was transsected using an ultrasonic dissector (CUSA System; Cooper Medical Devices Corp, Mountainview, Calif) at the lowest vibration level in all patients. The principle of ultrasonic dissection is as follows: crushing the parenchyma with differentiation and preservation of nonparenchymal tissue, including branch ducts and small blood vessels, based on their water content differences. Therefore, the fibrotic pancreas is relatively hard to transect. Based on the difficulty or ease of the ultrasonic dissection, the pancreata were divided into 2 groups (soft texture and hard texture).

Reconstruction was achieved using 1 jejunal loop with an end-to-side pancreaticojejunosotomy, an end-to-side hepatico-jejunostomy, and a gastrojejunostomy, according to the Child procedure. A transanastomotic catheter was placed in the pancreatic duct in all patients. Pancreatic anastomoses were created using 3 different techniques. The strategy of pancreatic transection and reconstruction is shown in Figure 1. For 29 pancreata with a soft texture and a small duct (diameter, ≤5 mm), the duct-invagination technique was chosen. Details of this unique technique are shown in Figure 2. During transection with an ultrasonic dissector, even branch pancreatic ducts were identified, ligated, and divided. The main duct was easily exposed (>1 cm), and a small-caliber pancreatic catheter was inserted into the duct and fixed with 2 absorbable suture ligations. Subsequently, pancreatic duct invagination could be easily performed through a 10-gauge intravenous catheter passed through the jejunum. The main duct was anchored to the adjacent serosa, and 3 mL of fibrin glue was sprayed to the pancreatic stump. No pancreatic parenchymal stitches were placed during the procedures. For pancreata with a hard texture and a small duct (n = 5), this duct-invagination anastomosis was performed in the same way but followed by placing stitches between the stump parenchyma and the jejunal seromuscular layer. Meanwhile, pancreata with a dilated duct (diameter, >5 mm) (n = 16), all of which had a hard texture, were reconstructed with a hand-sewn duct-to-mucosa technique with 8 to 12 interrupted stitches of 5-0 or 6-0 polydioxanone absorbent monofilament sutures and a 2-layer anastomosis.

POSTOPERATIVE MANAGEMENT AND ASSESSMENTS

Intravenous hyperalimentation and protease inhibitors were routinely used perioperatively in all patients in this series. Erythromycin lactobionate and octreotide were not administered.

The level of fluid amylase from a closed drain placed near the pancreatic anastomosis was determined on days 1 and 7. A pancreatic fistula was diagnosed when the fluid amylase concentration was greater than 3 times the serum concentration on postoperative day 7, regardless of the discharge volume. In patients with a pancreatic fistula, 20 mL of contrast medium (Urografin) was introduced through a transanastomotic bile stent into the jejunal loop for a follow-through radiographic study to rule out AL. Unless an intraperitoneal leak of the contrast medium around the pancreaticojejunosotomy site was seen, the pancreatic fistula was considered an SL, not an AL.

RESULTS

The median (range) operative time and blood loss were 515 (285-975) minutes and 1215 (312-5050) mL, respectively. Four patients (8%) developed a pancreatic fistula in this series (Table). All of these patients underwent the duct-invagination procedure for reconstruction of their soft pancreases and had a small duct (4 [14%] of 29 patients). No pancreatic fistula was seen in the patients with a hard pancreas. The fistulas seen in this series, however, were all SLs and were removed without sequelae within 21 days. No ALs were seen in this series. As a result, no remnant pancreatectomy was performed among the 50 patients. Only 1 patient underwent a relaparotomy on day 1 for postoperative bleeding; the other 49 patients were discharged from the hospital without a relaparotomy. There was no in-hospital mortality.

Other complications included 6 wound infections (12%), 4 cases of cholangitis (8%), 3 bile leaks (6%), 3 cases of delayed gastric emptying (6%), 2 liver abscesses (4%), 2 intraperitoneal abscesses (4%), and 1 gastrojejunostomy ulcer (2%). The morbidity was 40% (20 of 50 patients) in this series.

COMMENT

The incidence of pancreatic fistula varies from 5% to 25% after pancreaticoduodenectomy in most series. Among the pancreatic fistulas, ALs caused by disruption between the pancreatic main duct and the jejunum can lead to serious sequelae, including pancreatic abscesses, subsequent sep sis, and massive hemorrhage. Several published studies enrolled ALs and SLs (which are extravasations of pancreatic secretions from the pancreatic stump into the pancreatic fistula), presumably because their differential diagnosis is difficult in many cases. In studies that defined the pancreatic fistula as the persistent drainage of more than 30 or 50 mL/d of amylase-rich fluid after postoperative day 7 or 10, respectively, pancreatic fistulas are thought to include considerable percentages of ALs because most SLs are expelled from the pancreatic fistula group. In fact, none...
of our 4 fistulas discharged more than 50 mL/d of fluid. On the other hand, if a more liberal definition is used, eg, fluid discharge with an amylase concentration of more than 3 times the serum concentration regardless of the discharge volume, even a clinically unimportant SL that can be removed without sequelae belongs to a category of pancreatic fistulas. In this study, we tried to diagnose these 2 pancreatic fistulas distinctively by jejunal loop fluoroscopy with contrast medium introduced through a bile duct stent. However, no AL was diagnosed in our 50 consecutive pancreatoduodenectomies, and only 4 SLs were detected, which spontaneously closed in a short period.

Reconstruction of soft pancreata is strongly associated with a pancreatic fistula. Recent data from The Johns Hopkins Hospital, Baltimore, Md, demonstrated that the pancreatic fistula rate was 0% for those with a hard pancreas and 25% for those with a soft pancreas. Also, in our series, all 4 pancreatic fistulas developed in the soft texture group (14% of 29 patients). This may be interpreted by 3 risk factors of the soft pancreas. First, most soft pancreata have a small duct, in which secure duct-to-mucosa anastomosis is difficult. Second, a soft pancreas is more easily injured directly or via ischemia by stitches placed between the pancreatic cut end and the seromuscular layer of the digestive tract. Third, a soft pancreas has a good exocrine function, secreting more pancreatic juice rich in proteolytic enzymes.

The key to excellent outcomes after pancreatoduodenectomy is certainly a reduction in the incidence of ALs. To reduce risky ALs for soft pancreas with a small duct, we developed a duct-invagination anastomosis technique. This easy technique can be completed in less than 10 minutes and does not need experienced hands. We filled up the space between the pancreatic stump and the jejunal serosa with 3 mL of fibrin glue to avoid injury or ischemia of the stump, possibly caused by the parenchyma stitches. However, 4 SLs eventually occurred in this group. Although this incidence (4 [14%] of 29) after soft pancreas reconstruction was not high, placing stitches between the stump parenchyma and the jejunal seromuscular layer instead of fibrin glue sealing should be examined in a further study. On the other hand, for pancreata with a hard

![Figure 2. Pancreatic duct-invagination anastomosis. A, After pancreatic transection with an ultrasonic dissector, a 5F pancreatic catheter is inserted into the exposed main duct and fixed with 2 absorbable sutures. B and C, Subsequently, pancreatic duct invagination could be performed through a 10-gauge intravenous catheter passed through the jejunum. C, The main duct was anchored to the adjacent serosa. D and E, Fibrin glue was sprayed on the pancreas stump (arrow). No pancreatic parenchymal stitches were placed during the procedures. F, In addition, the pancreatic catheter is fixed to the jejunal wall in Witzel fashion.](https://archsurg.jamanetwork.com/)

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Pancreatoduodenectomy has been considered a formidable operation. We consider simply that prevention of ALs likely results in excellent outcomes of this operation and makes this operation as safe as other abdominal surgical procedures. Our selection of the proper pancreatic anastomotic techniques according to pancreatic texture and duct size may reduce the pancreatic fistula rate, eliminate risky ALs, and result in excellent outcomes for those undergoing pancreatectoduodenectomy.

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