The Best Choice to Achieve Zero Complications after Pancreatoduodenectomy

Shinji Osada, Hisashi Imai, Yoshiyuki Sasaki, Itaru Yasufuku, Ryuichi Asai, Yoshihisa Tokumaru, Takuji Sakuratani, Kazuhiro Yoshida

Surgical Oncology, Gifu University School of Medicine, Gifu, Japan
E-mail: sting@gifu-u.ac.jp

Received September 30, 2010; revised January 21, 2011; accepted January 26, 2011

Abstract

Pancreatoduodenectomy (PD) has been performed commonly, but the occurrence of pancreatic fistula (PF) is a critical trigger of complications, which are potentially life threatening, and is also associated with markedly prolonged hospitalization. Many techniques have been proposed for connecting the pancreatic stump with the gastrointestinal tract, stomach vs. jejunum, etc. Among the risk factors for PF, such as general patient factors or disease-related factors, the most important is the texture of the remnant pancreas. Surgical technique might be one improvable aspect that can reduce the pancreatic leakage rate, therefore; various methods of managing the pancreatic remnant have been studied. Methods of reconstruction between the remnant pancreas and the intestine include end-to-side with/without duct-to-mucosa anastomosis or end-to-end invagination styles, and arguably, anastomosis of the remnant pancreas with the stomach is also another method. Here, we review several trials for safety and methods of treating the pancreatic stump after PD, and demonstrate our experiences.

Keywords: Pancreatoduodenectomy, Reconstruction, Pancreateojejunostomy, Pancreatic Fistula, Pancreateoenteric Anastomosis

1. Introduction

The indications for pancreatoduodenectomy (PD) have expanded to encompass a broad spectrum of periampullary tumors including both malignant and benign lesions, chronic pancreatitis, and, occasionally, trauma. The occurrence of pancreatic fistula (PF) is a critical trigger of complications such as intra-abdominal abscess and hemorrhage, which are potentially life threatening, and is also associated with markedly prolonged hospitalization. Many techniques have been proposed for connecting the pancreatic stump with the gastrointestinal tract but despite some success, problems remain, especially with a soft pancreas gland with a small duct [1]. Most of the large PD series have reported rates of PF of over 10% [1-4]. Risk factors for PF depend upon 1) general patient factors, including age, sex, jaundice and nutrition; 2) disease-related factors, including pancreatic duct size, pancreatic texture, and pathology; and 3) procedure-related factors, including blood loss, operative time, and anastomotic method [5]. Among these risk factors, the most important might be the texture of the remnant pancreas. Indeed, the occurrence of PF rises to nearly 20% in cases of soft pancreatic texture, despite an occurrence rate of 5% in cases of hard pancreatic tissue [2-4]. Because surgical technique might be one improvable aspect that can reduce the pancreatic leakage rate, various methods of managing the pancreatic remnant have been studied. Methods of reconstruction between the remnant pancreas and the intestine include end-to-side with/without duct-to-mucosa anastomosis or end-to-end invagination styles, and arguably, anastomosis of the remnant pancreas with the stomach is also another method. Here, we review several trials for safety and certain methods of treating the pancreatic stump after PD.

2. Anastomosis Methods with Pancreas

2.1. Pancreateojejunostomy

PD consists of mainly two types of reconstruction procedures for the remnant alimentary tract: Billroth I (Imanaga method) with gastrojejunostomy, pancreateojejunostomy, and choledochojejunostomy; and Billroth II (Whipple and/or Child method) with pancreateojejunostomy or choledochojejunostomy and gastrojeju-
nostomy. Billroth I reconstruction has been most commonly performed because it is conceivable that the passage of food through the entire remnant upper small intestine is more physiologically normal, and the mixture of food with bile is similar to that in normal subjects. In fact, hepatobiliary and gastrointestinal dual scintigraphy has demonstrated satisfactory mixing of bile and food [6].

Billroth I reconstruction also enables endoscopic study of the patency of the pancreatic and bile ducts in conjunction with evaluation of exocrine function [7]. However, another study demonstrated no benefit to nutritional status and quality of life after Billroth I [8]. Furthermore, in consideration of early postoperative complications, more frequent anastomotic failure of the pancreatojejunostomy using the Billroth I method has been reported than with other procedures [9]. Although the cause of this failure remains unclear, the angularity of the jejunal loop might be related to these problems [10] and, as described previously, we suspect the mixture of bile and pancreatic juice-induced enzyme activation to be associated with damage to the tissue [11]. Delayed gastric emptying (DGE), which is critical for the determination of nutritional status, has also been a concern following Billroth I reconstruction. The cause of DGE has been indicated to relate not only to anastomotic leakage [12] but also to disruption of the gastroduodenal neural connection by PD or to residual pancreatic fibrosis [13]. However, a disadvantage of Billroth II reconstruction is that bile leakage tends to occur more frequently [14]. In fact, bilogastric reflux after the type II operation is problematic in the late postoperative period [15]. As a consequence, abnormal motility of the afferent jejunum due to dietary moderation induces bile status, resulting in a high prevalence of bile leakage.

Continuous duct-to-mucosa anastomosis was described as being safer and as having a significantly lower leakage rate [16,17]. However, a prospective randomized clinical trial found it to be favored in low-risk patients with a dilated pancreas duct or firm fibrotic pancreas, whereas the invagination technique was better for high-risk patients with small ducts or a soft friable pancreas [18]. In addition, in an analysis of the occurrence of PF in pancreatojejunostomy, 40% originated from the parenchyma or a small side branch duct and appeared to be as common as duct-to-mucosa anastomosis [19]. In particular, for a soft pancreas, no pancreatic duct dilatation is usually detected; thus, duct-to-mucosa anastomosis might be difficult.

2.2. Pancreatogastrostomy

Since several retrospective studies reported that pancreatogastrostomy (PG) reduces the occurrence of PF after PD [20,21], there has been trend toward increasing use of this type of anastomosis. However, the results of a prospective randomized trial comparing PG with pancreatojejunostomy showed that the overall incidence of PF was 11.7%, and the condition occurred with similar frequency after pancreatojejunostomy (11.1%) and after PG (12.3%) [20,22]. Length of postoperative hospital stay also did not differ between the two procedures. Because the objective safety of PG was not supported by the data from these prospective studies and meta-analysis [23], the best method for dealing with the pancreatic stump after PD remains in question. In addition, disadvantages of PG have been identified, including an increased incidence of DGE and of pancreatic duct obstruction due overgrowth by the gastric mucosa [13]. In theory, PG has several advantages over pancreatojejunostomy as the preferred method of reconstruction after PD. First, a low incidence of pancreatic leakage seems likely because the anastomosis is made with the thick and richly vascular gastric wall. Second, PG is known to suppress activation of proteolytic enzymes. Enterokinase in particular is required to convert trypsinogen to the active form, trypsin, and is present in small intestine mucosa but not in gastric mucosa. This activation also requires a neutral pH. Therefore, even if leakage does occur, it does not lead to life-threatening complications because the pancreatic enzymes are hardly activated.

Indeed, a comparative clinical study found that PG is safer than pancreatojejunostomy, particularly with regard to the incidence of PF [20,21]. However, questions remain regarding the long-term endocrine and exocrine function of the pancreas after PG. Available data on hormone levels indicate that endocrine function appears to be equal, but exocrine function appears to be worse after PG than after pancreatojejunostomy [24], resulting in severe atrophic changes in the remnant pancreas [25]. Therefore, pancreatojejunostomy may be preferable to maintain activation of the pancreatic enzymes for more physiologic digestion and absorption.

3. Reducing Problems of Anastomosis with the Pancreas Stump

In the past several years, increased intraoperative blood loss has been recognized as a predictive factor for PF [26, 27]. Because an adequate blood supply to the stump of the pancreas is critical to wound healing, the next step leading to a successful anastomosis [28], postoperative infusion planning must be supported. The use of somatostatin analogue has also been focused on to prevent PF [29], but its use is still not accepted as a consensus [30, 31]. The risk of developing a PF is known to be significantly associated with the final histopathological diagno-
sis of the resected specimen, with lower risk in adenocarcinoma and higher risk in cystic neoplasms or disease originating from the bile duct [32,33]. This might be due to the fact that pancreatic adenocarcinoma usually obstructs the main pancreatic duct, causing duct dilatation and distal inflammation. Included as a possibility is cancer occurring in chronic pancreatitis, where a fibrotic hard remnant pancreas is easily anastomosed, but a soft pancreas remains at risk of PF due to its fragility and its secretion of a high amount of pancreatic juice [18].

Many surgeons have used a stent across the pancreaticoenterostomy to prevent PF, and a stent may be useful for diversion of pancreatic juice from the pancreatic anastomotic site, decompression of the remnant pancreas, and patency of the main pancreatic duct. Reported findings show no significant difference between internal and external stenting [34], whereas placement of drainage tube was associated with a clearly lower PF rate compared with nonstented patients [3]. Due to the concern about length of hospital stay, shorter postoperative length is not only considered a predictor of less-invasive surgical procedures but also forces evaluation of the necessity of wound treatment or external tube placement. Potential complications associated with stent removal are also argued because local peritonitis after stent removal has been reported [35]. To reduce postoperative complications, placement of a stent may be critical, and the internal type might be better than external, then internal lost tube might be best.

4. Novel Modified Reconstruction Method

4.1. Background

As suggested by the pathogenesis of the congenital choledochal cyst, reflux of pancreatic juice into the biliary tree could have an adverse effect on the bile duct wall. In particular, lyssolecithin, which is converted from bile lecithin by pancreatic juice components including phospholipase A, causes severe cellular injury. Phospholipase A itself is activated by lyssolecithin, and these enzymes strongly interact. In Child’s type reconstruction, one of the most common reconstruction methods, the hepatojjunostomy site is several centimeters distal to the pancreaticojejunostomy site. Once leakage develops at the hepatojjunostomy site, the presence of pancreatic juice will exacerbate the leakage problem. A similar problem occurs with the Whipple method, in which the hepatopancreato-jejunostomy anastomoses are reversed. Thus, the association of pancreaticojejunostomy with life-threatening postoperative complications can be explained by the enzyme activation theory. Therefore, the safest type of anastomosis is one in which the mixture of pancreatic and biliary enzymes is contained, such as in a jejunoojejunostomy. A novel modified type of reconstruction, the separated loop (SL) method, which prevents pancreatic leakage and critical secondary complications, has been well tolerated (Figure 1).

Biliary or pancreas duct drainage tubes are not necessary, and just one drainage tube is placed that is pulled out within 4 days after surgery to reduce intra-abdominal infection induced by long-term tube placement [36]. The full details were described previously [11].

4.2. Outcome

The SL method, as a Billroth II reconstruction, was evaluated at a single institution by comparison to PG or the Imanaga method, as Billroth I reconstructions, according to postoperative patient condition determined from blood test values and complications incurred [11, 37]. Of 107 patients undergoing PD, 31 were selected for PG, 26 for the Imanaga method, and 38 for the SL method. PG was achieved with an invagination anastomosis, which was constructed with two layers of interrupted sutures from an anterior gastrotomy and a pancreatic duct tube exiting through the stomach and abdominal wall.

There were no significant differences between PG and the Imanaga and SL methods in terms of mean total blood loss, operation time, or changes in patient body
weight. However, DGE was the most frequent cause of morbidity and was observed exclusively among patients undergoing PG (12.9%). Of the patients undergoing the Imanaga method, 19.2% showed a high amylase level in their drainage fluid, with 3.7% mortality due to abdominal bleeding after postoperative day 52. In 6.5% and 5.2% of the patients undergoing PG or the SL method, respectively, a high amylase level was detected, but no problematic clinical events were observed. No patient required re-operation. Compared with the IM method and PG, values of postoperative blood tests were more favorable for the SL method. The postoperative condition of our patients who underwent SL reconstruction was good, suggesting that this method reduces the incidence of serious complications immediately after surgery. In the SL method, suturing of the anterior outer layer can lead to pancreas injury, especially with soft pancreas tissue; therefore, in recent cases, the anterior layer is made in single for incomplete invagination (Figure 2). Before beginning anterior layer suturing, two transpancreatic U-sutures are placed with 4-0 PDS suture. The U-suture needle is inserted from the anterior outside of the jejunum about 1 cm distal to the cut edge and is then withdrawn from the inside of the jejunum lumen. Ligation of the U-suture leads the pancreas stump into the jejunum with no strain on the edge of the pancreas. We experienced no PF in 12 other patients with incomplete invagination of the pancreas stump. And patients who survive for long periods after standard pancreatojejunostomy might be at risk of developing secondary choledochal or pancreatic cancer, as observed in patients with anomalous arrangement of the pancreaticobiliary ductal system [38]. Thus, the SL reconstruction method could potentially prevent both short-term postoperative complications and future secondary carcinogenesis. A greater number of cases must be accumulated to confirm our findings and determine long-term outcomes.

5. Conclusion

Certain reports have shown no clear evidence for or against one particular method of pancreaticoenteric anastomosis [39,40]. The choice of pancreatic anastomotic method might be based on individual experience and adherence to basic principles such as good exposure and visualization; fine, nonstrangulating suture placement to produce a patent, watertight anastomosis; and preservation of the blood supply [41]. As long as PD is performed, the argument for safety should be continued, and for even non-expert surgeons or in cases of soft pancreas texture, a favorite method that causes the surgeon no anxiety will be chosen. There is still no agreement as to which of the reconstruction methods is best, but early-term observation after PD indicates that the SL method might be superior to the other methods.

6. References


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