Pancreatic Anastomosis: Challenges and Outcomes

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Abstract

**Background and aims:** The foundation of the pancreatojejunostomy was popularized in 1935 by Whipple and colleagues. Despite significant progress in the surgical technique and perioperative management, morbidity of this procedure remains to be considerably high. Postoperative pancreatic fistula (POPF) has been one of the major factors for morbidity and even mortality following pancreaticoduodenectomy and pancreaticoenteric anastomosis. This review will focus on various techniques, their modifications, shortcomings and complication in the management of pancreaticoenteric anastomosis.

**Material and methods:** A search of various surgical guidelines, prospective randomized controlled trials, systemic Meta analysis, and case series was performed with regards to surgical techniques and complication in the management of a pancreaticoenteric anastomosis.

**Discussion:** The major concern of a pancreaticojejunostomy (PJ) is post operative pancreatic leak. Various techniques have been used historically to stop the leakage. Even with the modifications these methods have similar complication rates, so the next factor that should be considered while choosing a PJ method would be related to the individual operator’s experience. A pancreaticogastrostomy is the other alternative that was introduced into practice relatively recently and the advent of the laparoscopic and robotic technologies in surgery has provided a newer domain to pancreatic surgery.

**Conclusion:** As post-operative pancreatic fistula (POPF) is a major source of morbidity and mortality surgeons should continue to use the familiar anastomotic technique and interchange of these techniques during surgery will result in decrease incidence of pancreatic fistula when done by experienced surgeons.

**INTRODUCTION**

In 1909, Kaush performed the first successful resection of peripancreatic carcinoma which comprised of two staged operation done 6 weeks a part [1]. First a cholecystojejunoscomy was performed, followed by a second operation that included resection of the head of the pancreas along with the pylorus of the stomach and the first and second portions of the duodenum. The operation was completed with a gastroenterostomy, closure of the distal common bile duct, and anastomosis of the remaining pancreas to the 3rd part of the duodenum. This was the foundation of the pancreatojejunostomy which was popularized in 1935 by Whipple and colleagues [2].

Allan Whipple described the procedure in a single step operation in 1940 [3] and they later on included a pancreaticojejunostomy in 1942 [4]. Waugh and Clagett modified this operation to the current single staged procedure in 1946 [5]. Despite significant improvement in postoperative complications, post operative pancreatic fistula (POPF) has been one of the major factors for morbidity and even mortality following pancreaticoduodenectomy. Over the course of the last few decades there has been a numerous modification to pancreaticoenterostomy techniques in order to reduced the incidence of post operative pancreatic fistula (POPF) which has been described by an international study group (ISGPF) of pancreatic surgeons as drain output of any volume occurring on or after post-operative day 3 with amylase content at least three times that of serum amylase levels [6].

**SURGICAL TECHNIQUES**

Basically two major techniques, Pancreaticojejunostomy (PJ) and Pancreaticogastrostomy (PG), are used in anastomosis of the pancreatic remnant to the gastrointestinal tract.

**Pancreaticojejunostomy**

Pancreaticojejunostomy (PJ) can be further classified into two categories; end-to-side duct-to-mucosa (DM) and end-to-end (dunking) techniques.

**Duct to mucosa technique:** This duct-to-mucosa anastomosis was originally described by Warren and Cattell [7]. This technique is performed by using continuous or interrupted monofilament absorbable sutures. Ability to place precise sutures in the interrupted technique has led to the widespread use of the technique. Following duct to mucosa anastomosis a second layer of anastomosis is done between the seromuscular layer of the jejunal and the capsule of the pancreas [8].

Unlike the dunking method less pancreatic mobilization is
required in this technique leading to the belief by some that there is less chance of anastomosis leak [9,10]. As the duct to mucosa technique prevents direct contact of the pancreatic juice with the cut end of the pancreas it helps in healing of the mucosa and protects the anastomosis [11-13]. In a report by Z'graggen and colleagues using this technique, POPF was seen in 2.1% of 331 patients who underwent pancreatic head resection [14].

The construction of a duct to mucosa anastomosis could be technically more demanding and more time consuming as the small caliber of the pancreatic duct will make the anastomosis difficult [15]. So a microscopic technique has been advocated by Greene [16].

The end to end pancreaticojejunostomy (Dunking technique): This technique includes the invagination of the pancreas inside the jejunum. The capsule of the pancreas is anastomosed with the jejunum without a pancreatic ductal anastomosis with the jejunal mucosa. This anastomosis is technically less challenging [17]. The disadvantage of the technique is that complete pancreatic mobilization is required so the blood supply of the anastomosis can get compromised leading to a high risk of leakage.

Berger and colleagues sought to compare rates of POPF at the PJ with the use of the invagination technique versus the duct-to-mucosa technique to test the hypothesis that use of the duct-to-mucosa technique would lead to a decreased POPF rate, showed that fewer fistulas with invagination compared with duct to mucosa Pancreaticojejunostomy (24% vs. 12%, P<0.05) [18].

Various modifications of Pancreaticojejunostomy:

Blumgart U Suture Technique: One of the modifications which have shown reduce rate of POPF popularized by Memorial Sloan Kettering Cancer Center by putting transpancreatic U-suture technique with a duct-to-mucosa anastomosis described by and originally created by Dr. Leslie Blumgart [19].

In this technique an outer layer of polyglactin sutures are inserted full-thickness anterior-to-posterior through the pancreas with subsequent seromuscular horizontal mattress stitches on the jejunum, followed again by a full-thickness posterior-to-anterior bite coming up through the pancreas. Care is taken not to pass the needle through the pancreatic duct which can be confirmed per operative by stenting pancreatic duct with infant feeding tube and taking stitches. The u-stitches are not tied yet, and a duct-to-mucosa anastomosis is then created with 5.0 polydioxanone interrupted suture. The seromuscular sutures are then tied bringing the jejunum into close apposition anteriorly on the pancreas; however the suture is not yet cut. Lastly, the sutures with the needles still on are used to create an anterior seromuscular bite on the jejunum with the needle being brought through the pancreas under the previous knots. The sutures are then tied again, thus imbricating the jejunum over the entire pancreas.

In the study done by Grobmyer et al. [20], of 187 patients with PJ anastomosis constructed by this technique, the authors report an overall POPF rate of 20.3%; most of them were ISPGF Grade A. Similarly, Kleespies and colleagues have shown significantly decreased leak rate with the Blumgart anastomosis (13% vs. 4%, P=0.032) [21].

Proponents of this technique argue that the transpancreatic sutures minimize radial forces on the anastomosis, and that it is relatively quick to construct and easy to teach to trainees.

Heidelberg techniques of end to side Pancreaticojejunostomy: In this technique propagated by Büchler MW and colleagues [22] anastomosis is done in four layers with the jejunum opened with care to ensure that the jejunal opening is a little smaller in length than the superoinferior extent of the pancreatic remnant thus, the completed anastomosis is an end to side duct to mucosa anastomosis with an outer seromuscular and inner full thickness layer (Figure 1).

In series by Büchler MW et al. [23], of 331 pancreatic head resections, they had observed a 2% pancreatic fistula rate and the mortality rate was 0%. Similarly, study done by Shrikhande SV et al. [24], with series of 123 pancreaticoduodenectomies documented a 3.2% pancreatic fistula rate and an overall mortality of 3.2% but fistula related mortality was only 0.8%.

Peng's binding technique for Pancreaticojejunostomy: In this the distal 3 cm of the jejunal loop to be used for anastomosis are averted and the mucosa ablated either by electro coagulation or by topical treatment with 10% carbolic acid followed by immediate rinsing in 75% ethanol and normal saline. The proximal 3 cm of the pancreatic stump is then Anastomosed to just the mucosa of the jejunum. The treated 3 cm of jejunum are then rolled out and intussuscepted back over the pancreas, sutured into place, and lastly a catgut tie is looped around the entire circumference of the anastomosis 1 cm from the cut edge of the pancreas. The authors reported a 0% POPF rate after the completion of 150 cases using this anastomosis, with an overall morbidity of 31.3% and a mean hospital stay of 19.8 ± 5 days [25]. However, a prospective trial by Casadei R et al. [26], of 69 binding PJ patients compared to 52 conventional PJ historical control patients demonstrated significantly shorter hospital stay in the conventional PJ patients. Soft pancreatic texture was significantly associated with POPF; however no significant difference in the rate of POPF between binding and conventional PJ anastomosis.
was seen. Hence, binding PJ remains one of many options for creation of the pancreatic-enteric anastomosis.

**Pancreatico gastrotomy**

An alternative to pancreaticojejunostomy is anastomosis of the pancreatic remnant to the stomach, pancreaticogastrostomy. Since the pancreatic remnant remains in close approximation to the stomach it creates a tension free anastomosis and less prone to ischemia because of good vascular supply [27] (Figure 2). We always recommend performing anterior gastrostomy while doing pancreaticogastrostomy.

Proponent convey other advantage of PG anastomosis as easy to perform, no luminal discrepancy in size, lower pH prevents complete activation hence less chance of leak rate [28-30].

A prospective randomized trial conducted by Bassi and co-workers, in which 151 patients with soft pancreatic glands were randomized to PG or end-to-side PJ anastomosis [31]. Pancreatic fistula occurred in 13% of PG patients and 16% of PJ (P=NS); however post-operative fluid collections, delayed gastric emptying, and biliary fistulae were significantly less in the PG group.

A prospective randomized multi-center trial by Topal and colleagues from Belgium randomizing 329 patients to PJ or PG after pancreaticoduodenectomy, in which patients were stratified by pancreatic duct diameter (≤ 3 or >3 mm), reported significantly more POPF in the PJ group than the PG group (19.8% vs. 8%, OR 2.86, 95% CI: 1.38-6.17, P=0.002) [32]. In a meta-analysis of PG versus PJ trials noted that there was no superiority of either technique and surgeons should continue to use the technique with which they are most familiar with [33,34].

**Challenges**

Factors affecting choice of type of anastomosis depends upon:

1. Pancreatic parenchyma texture: soft or hard
2. Size of main pancreatic duct: < 3 mm or more than 3 mm.

The challenge with pancreaticojejunostomy is the disparity between the two organs that is being anastomosed. A hollow organ is to be anastomosed with a solid organ and the basic difficulty with this anastomosis is that the parenchyma of the pancreas is not uniform in texture and the duct is small, usually only 1 to 3 cm and often eccentric [35]. Pancreatic anastomotic leaks can lead to formation of intra abdominal abscesses which might require percutaneous or open surgical drainage procedures which in itself is a challenge [36].

**Role of pancreatic stent: Interior or external**

Stenting of pancreatic duct prevents accumulation of pancreatic secretion in the pancreatic stump hence might decrease the incidence of pancreatic fistula. Ductal stenting either internal or external drainage have been proposed. Randomized controlled study done by Winter et al. [37], have shown that internal pancreatic duct stenting does not alter the rate of POPF. However, study done by Poon et al. [38], have shown that external drainage of pancreatic stent had a significantly lower pancreatic fistula rate compared with the no stent group (6.7% vs. 20%, P=0.032), and on multivariable analysis absence of stenting was a significant risk factor for POPF. Meta-analysis performed by Xiong et al. [39], found that placement of internal or external stents in the pancreatic duct after pancreaticoduodenectomy did not reduce the incidence of POPF.

**DISCUSSION**

As it is very evident that the major concern of a pancreaticoenteric anastomosis is post operative pancreatic leak, various techniques have been used historically to stop the leakage including: ligation of the duct of pancreas [40], closure of the duct using rubber or fibrin glue application [41], fibrin glue around the pancreaticojejunal anastomosis [42] and various modifications on anastomosing techniques, among them Roux-en-Y reconstruction with pancreaticojejunostomy [43] and pancreaticogastrostomy [44] are the common anastomotic variants. To minimize leak rates many technical variations of pancreaticojejunostomy have been suggested, few are tabulated below (Table 1).

Also numerous minor modifications to pancreatic ductal stenting and suture techniques have been suggested for each of the categories discussed above, but none of the methods has been demonstrated to be superior to the others [45,46].

As these various pancreaticoenteric reconstruction methods have similar complication rates, the next factor that should be considered while choosing a PJ method would be reproducibility or feasibility because PJ leakage rates are shown to be related to the individual operator’s experience [47].

A duct to mucosa pancreaticojejunostomy technique is preferable for fibrotic firm pancreas with dilated ducts whereas end-to-end invagination is advisable in a soft pancreas with non-dilated ducts. No defined limit for pancreatic duct dilatation has been established and 3 mm is the general cutoff. A soft pancreas has higher chance of leakage and duct stenosis so it blemishes the main advantage of duct to mucosa pancreaticojejunostomy.

Randomized controlled trials conducted to identify a better method for performing PJ have failed to discover a technique...
surgical techniques during surgery will result in decrease incidence of pancreatic fistula when done by experienced surgeons.

Table 1: Technical modifications of pancreaticojejunostomy to prevent against anastomotic leak.

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<thead>
<tr>
<th>Modification</th>
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<tr>
<td>Omental wrapping</td>
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<td>Vicryl mesh wrapping</td>
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<tr>
<td>Duct to mucosa end to side pancreaticojejunostomy</td>
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<tr>
<td>Purse string dunking</td>
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<tr>
<td>End to side between pancreatic duct and Roux-en-Y-jejunum</td>
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<tr>
<td>Roux-loop duct-to-mucosa</td>
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<td>Duct-to-mucosa anastomosis (non-stented method)</td>
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<tr>
<td>Modified dunking pancreaticojejunostomy</td>
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<tr>
<td>Use of pancreatic duct splint</td>
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<tr>
<td>Pancreatic cut back till bleeding occurs</td>
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<td>Serosal overlap of jejunum</td>
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As discussed already a pancreaticogastrostomy is the other alternative that was introduced into practice relatively recently. Apart from the commonly practiced duct to mucosa anastomosis or stenting no other major modifications have been proposed to this technique [50]. Various studies have reported lower overall leak rates in pancreaticogastrostomy when compared to Pancreaticojejunostomy [51-54]. However the RCTs conducted to test the two most preferred techniques (pancreaticojejunostomy vs pancreaticogastrostomy) have varied results [55]. So it is important to analyze the methods that minimize the rate of anastomotic leakage following pancreaticenteric anastomosis. It is evident from the above discussion that occurrence of a pancreatic fistula after surgery increases the overall length of hospital stay, morbidity and mortality of the patient [56,57].

Although not related to the method of anastomosis per se, the advent of the laparoscopic and robotic technologies in surgery has provided a newer domain to pancreatic surgery. Study done in Robotic vs laparoscopy vs open pancreaticoenteric anastomosis shows that robotic-assisted pancreatic surgery can be performed safely in a high-volume center with perioperative outcomes comparable to those of open surgery. Although long operative time is a concern with this technique advances in robotic technology and increasing experience may improve long operative times [58].

There has been widely used of well validated Fistula Risk Score (FIS) which has been proposed by Callery MP et al. [59], and have shown to be effective to predict the chance of a POPF [60].

CONCLUSION

Post-operative pancreatic fistula (POPF) is a major source of morbidity and mortality. Despite many studies, none of technique has been shown to definitively be the solution to the problem. Surgeons should continue to use the familiar anastomotic technique and interchange of these techniques during surgery will result in decrease incidence of pancreatic fistula when done by experienced surgeons.

REFERENCES


