Review Article

Minimally invasive pancreaticojejunostomy techniques: a literature review

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Abstract: Pancreaticoduodenectomy (PD) is a procedure utilized to surgically remove pancreatic, duodenal, and distal bile duct cancers. Recent technological advancements have allowed surgeons to extend minimally invasive techniques to this complex operation. Due to the advanced technical skill required to perform minimally invasive anastomoses, there are multiple various techniques currently being employed to successfully complete the pancreaticojejunostomy (PJ), the highest risk anastomosis. It is unknown whether any specific PJ anastomotic technique is associated with improved outcomes. A literature search was conducted using keywords: "laparoscopic pancreaticojejunostomy", "robotic pancreaticojejunostomy", and "minimally invasive pancreaticoduodenectomy (MPD)". Articles were excluded from this review if they did not meet two essential criteria: (I) adequate description of the minimally invasive PJ technique and (II) patient outcome data. Articles that did not describe anastomotic technique, had small numbers of patients, did not report outcomes, or included comparison between open and minimally invasive procedures were excluded. Eight articles meeting our search criteria were reviewed. Each of them described a different minimally invasive PJ technique. The information was organized by one-layer versus two-layer, end-to-end versus end-to-side, suture type, and special suture techniques. There was no difference in outcomes based on minimally invasive PJ technique. Though a number of centers now perform MPD, the PJ anastomotic method with the fewest complications and best outcomes remains undetermined. An international registry could be used to gather a sufficient volume of data to answer this important question.

Keywords: Minimally invasive pancreaticoduodenectomy; pancreatic cancer; pancreaticojejunostomy; anastomotic techniques

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Introduction

Background

Pancreaticoduodenectomy (PD), also known as "the Whipple", is a procedure utilized to surgically remove pancreatic, duodenal, and distal bile duct cancers, among other surgical diagnoses. The procedure is technically demanding even when performed via an open approach pancreaticoduodenectomy (OPD). The traditional open approach dates back to the 19th century, with the first recorded OPD-like surgery performed by Dr. Alessandro Codivilla in 1898. Then in 1935, Dr. Allen O. Whipple refined the resection to its present-day steps. He eventually went on to perform a total of thirty-seven OPDs during his career, making pancreatic surgery a realistic possibility and improving surgical techniques (1).

Recent interest in minimally invasive pancreaticoduodenectomy (MPD) has been sparked by technological advances such

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as laparoscopic hand ports, improved tissue dissectors and vessel sealing devices, as well as innovations in suture material and stapling devices (2). Gagner and Pomp described the first MPD in 1994 for chronic pancreatitis (3). Their pancreaticojejunostomy (PJ) used three intracorporeal sutures: two silk stay sutures on either side of the duct-to-mucosa anastomosis, one Monocryl suture at the posterior pancreatic duct to the jejunal mucosa, and finally a glue sealant for the anterior portion of the anastomosis (3). As surgeons have grown more comfortable with minimally invasive surgical procedures, the desire to extend the benefits of the minimally invasive approach to patients with pancreatic cancer has increased.

Given the increasing number of centers now offering MPD, we sought to compare methods of minimally invasive PJ and associated outcomes to determine if one method is associated with superior results. Additionally, the purpose of this review was to catalog and compare currently reported techniques for creating a PJ during MPD.

Materials and methods

Literature search

We conducted a detailed iterative literature search using keywords: "laparoscopic pancreaticojejunostomy", "robotic pancreaticojejunostomy", and "minimally invasive pancreaticoduodenectomy". All retrieved abstracts were reviewed to confirm they met selection criteria. Additional references from each selected abstract were then reviewed to ensure that no appropriate articles were missed. This process was repeated until no additional papers were identified. The PubMed online database was used to identify and retrieve articles over a date range of 2007–2019.

Selection criteria

Peer-review journal articles were selected if they reported MPD techniques and outcomes, both laparoscopic and robotic, with an emphasis on the PJ anastomotic technique. To ensure adequate experience in the technique among the authors, we excluded case series with small numbers of patients. We excluded articles comparing outcomes between OPD and MPD as they did not generally present detail on operative technique.

Data collection

Data regarding PJ anastomotic technique was collected: single- versus double-layer, jejunal orientation, invagination versus duct-to-mucosa, suture technique, and suture material. Outcome variables collected included: median operative time, estimated blood loss, number of lymph nodes harvested, R0 resection rate, hospital length of stay (LOS), post-operative pancreatic fistula (POPF) rate, morbidity, and mortality.

Results

Literature search results

Our literature search produced eight articles with thoroughly defined descriptions of the PJ anastomosis published from 2007 to 2019 (*Table 1*). All articles were descriptive case series of single institution experiences. Four articles retrospectively analyzed prospectively collected data, one retrospectively collected data, and three did not comment on method of data collection. All publications analyzed in this review used a laparoscopic approach, rather than robotic. The number of patients included in the selected publications ranged from 17 to 238. The most common diagnoses are listed in *Table 1* and include ampullary cancer, intraductal papillary mucinous neoplasm (IPMN), and pancreatic ductal adenocarcinoma (PDAC).

Seven of the selected articles describe similar patient selection criteria, and one does not detail patient selection (4). Surgeons were more likely to offer the minimally invasive approach to patients with tumors or cystic lesions located in the ampulla, second portion of the duodenum, or distal common bile duct. Obesity, large tumor size, location and type of tumor were also noted to affect patient selection in the majority of the articles. The American Society of Anesthesiologists (ASA) grading scale was used in the patient selection process as well, with some authors limiting MPD to ASA class 1 and 2 (5). Evidence of metastatic disease was a uniform exclusion criterion. Vascular involvement by tumor was seen as an exclusion criterion for a minimally invasive approach by most authors early in the learning curve, however, one paper does include laparoscopic venous reconstruction in their patient sample (6). Medical history of severe cardiorespiratory disease, prior major abdominal operations, or pancreatic trauma were among other listed exclusion criteria.

PJ techniques

Each selected article describes a unique method to create

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Table 1 References meeting inclusion criteria for review

Authors	Year	Journal	Robotic/laparoscopic	Number of cases	Most common indication for resection
Palanivelu *et al.*	2007	*Journal of the American College of Surgeons*	Laparoscopic	42	Ampullary carcinoma
Palanivelu *et al.*	2009	*Journal of Hepatobiliary Pancreatic Surgery*	Laparoscopic	75	Ampullary carcinoma
Kendrick *et al.*	2010	*The Archives of Surgery*	Laparoscopic	62	PDAC
Honda *et al.*	2013	*Journal of the American College of Surgeons*	Laparoscopic	17	IPMN
Edil *et al.*	2014	*Journal of Laparoendoscopic & Advanced Surgical Techniques*	Laparoscopic	19	PDAC
Khatkov *et al.*	2017	*Pancreatology*	Laparoscopic	162	PDAC
Karatepe *et al.*	2018	*Journal of the Pancreas*	Laparoscopic	42	PDAC
Cai *et al.*	2019	*Surgical Endoscopy*	Laparoscopic	238	Ampullary adenocarcinoma

PDAC, pancreatic ductal adenocarcinoma; IPMN, intraductal papillary mucinous neoplasm.

the anastomosis between pancreas and jejunum. We describe the techniques in detail, arranged in order of increasing complexity in *Table 2*.

Single-layer techniques

The first paper examined reports an end-to-end, single-layer PJ which we found to be the simplest form of anastomosis (7). They used interrupted 4-0 non-absorbable monofilament (polypropylene) sutures to circumferentially sew the cut end of the pancreas to full-thickness bites of the jejunum opened at its end. The pancreas and main pancreatic duct were thus invaginated into the jejunal end and no stent was used. Out of 42 total cases, they reported a 7.1% POPF rate, 28.6% morbidity, and 2.4% 30-day mortality.

The second article describes a similar technique, however the jejunum is oriented with the anti-mesenteric side facing the cut end of the pancreas and the remainder of the jejunum forming a single loop to accommodate the other anastomoses (5). Non-absorbable 2.0 sutures were placed circumferentially in an interrupted fashion to create an invaginated end-to-side PJ anastomosis. Again, no stent was used in this single-layer technique. POPF was reported in 13.0% with 43.9% morbidity and 5.0% 90-day mortality.

The final article describing a single layer technique used a novel type of suture, barbed V-Loc™ (Medtronic, Minneapolis MN, USA) (8). V-Loc™ is a type of monofilament absorbable suture which has dual-angle barbs that allow the suture to pass smoothly through the tissue but prevent it from sliding backwards. This suture can be used without the need to tie knots intracorporeally. In this technique, a posterior row of a running 4-0 barbed V-Loc™ suture is placed between the seromuscular layer of the jejunum and the posterior aspect of the pancreatic body in an end-to-side orientation. Next, an appropriately-sized pediatric feeding tube is first placed within the pancreatic duct (most commonly used size is 5 Fr), and then a small enterotomy is made in the jejunum and the feeding tube is passed into the intestine until it is equally distributed. Then a single-layer anastomosis is finally completed by running the same 4-0 barbed suture in a continuous fashion anteriorly. This technique was associated with 5.0% POPF rate, 22.0% morbidity, and 3.0% 90-day mortality.

Two-layer techniques

The first article to describe a two-layer technique illustrates a modified invaginated, end-to-side PJ technique (7). They begin by creating a posterior layer using interrupted 3-0 nonabsorbable monofilament suture (polypropylene) to connect the posterior pancreatic capsule to the seromuscular layer of jejunum in an end-to-side fashion. They then create a large enterotomy that equals the length of the transected

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Table 2 Summary of PJ techniques

Authors	Layers	Orientation	Anastomosis	Stent	Suture technique	Suture material (inner)	Suture material (outer)
Palanivelu *et al.*	Single	End-to-end	Invaginated	(–)	Interrupted	N/A	4-0 Non-absorbable monofilament (Prolene)
Khatkov *et al.*	Single	End-to-side	Invaginated	(–)	Interrupted	N/A	2-0 Non-absorbable monofilament
Edil *et al.*	Single	End-to-side	Invaginated	(+)	Running	N/A	4-0 Absorbable monofilament barbed (V-Loc™)
Palanivelu *et al.*	Two	End-to-side	Modified invaginated	(–)	Interrupted (outer); running (inner)	4-0 Absorbable monofilament (PDS)	3-0 Non-absorbable monofilament (Prolene)
Kendrick *et al.*	Two	End-to-side	Duct-to-mucosa	(+)	Interrupted	5-0 Absorbable braided (Vicryl)	3-0 Non-absorbable braided (Silk)
Karatepe *et al.*	Two	End-to-side	Duct-to-mucosa	(+)	Running (outer); interrupted (inner)	5-0 Absorbable monofilament (PDS)	4-0 Absorbable monofilament barbed (V-Loc™)
Cai *et al.*	Two	End-to-side	Duct-to-mucosa	(+)	Running (outer); interrupted (inner)	5-0 Absorbable monofilament (PDS)	4-0 Nonabsorbable monofilament (Prolene)
Honda *et al.*	Two	End-to-side	Duct-to-mucosa	(+)	Interrupted (outer); running (inner)	5-0 Absorbable monofilament (Maxon)	4-0 Nonabsorbable monofilament (Nespilene)

PJ, pancreaticojejunostomy.

pancreatic body and an inner layer is performed using 4-0 absorbable monofilament suture (PDS) with suture bites incorporating both the pancreatic parenchyma and the pancreatic duct. A second inner layer incorporates the upper aspect of the pancreatic duct and pancreatic parenchyma creating a hybrid between invagination and duct-to-mucosa techniques. Finally, an anterior layer of non-absorbable monofilament is placed between the pancreatic capsule and seromuscular layer of the jejunum. No stent is placed. In this series, POPF rate is 6.7%, with morbidity and 30-day mortality reported at 26.7% and 1.3%, respectively.

The next publication included in this category is the first to describe a duct-to-mucosa anastomosis (9). They use an outer layer of interrupted 3-0 nonabsorbable braided (silk) suture and an inner layer of 5-0 absorbable braided (Vicryl) suture to create their anastomosis. They used an 8 cm Silatuc tube as an anastomotic stent. Of note, these authors do not routinely use operative drains. They note an 18.0% POPF rate with 42.0% morbidity and 1.6% in-hospital mortality.

The final series in this section also uses a barbed V-Loc™ suture device to create their two-layer, duct-to-mucosa PJ (10). In their technique, a 4-0 barbed V-Loc™ suture is used to create a continuous running posterior layer between jejunum (seromuscular) and posterior pancreatic capsule. A pancreatic stent is then placed into the main pancreatic duct and a small jejunal enterotomy (5 mm). The inner layer consists of 5-0 absorbable monofilament (PDS) sutures placed in interrupted fashion 0.5–1.0 cm apart, incorporating both pancreatic parenchyma and pancreatic duct, both posteriorly and anteriorly. Finally, another anterior layer of 4-0 barbed V-Loc™ suture is used to complete the anastomosis, placing the sutures 5–7 mm apart. POPF was reported in 21.0% of patients, of which 14.3% were grade A ("biochemical leak"), 4.8% grade B, and 2.4% grade C. Their post-operative complication rate was only 23% and they reported no deaths.

Special suturing techniques

Two papers selected for this review describe novel suturing techniques. In one, the anastomotic technique is called "Bing's Anastomosis" (11). They describe a duct-to-mucosa, end-to-side PJ with four layers of suturing. The first layer consists of a running 4-0 nonabsorbable monofilament (polypropylene) suture of approximately 25 cm in length

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Table 3 Surgical outcomes

Authors	Pts	Age	Operative time	Blood loss	Lymph nodes	R0 resection, %	Hospital LOS (days)	POPF, %	Morbidity, %	Mortality, %	Mortality type
Palanivelu *et al.*	42	61 [28–70]	370 [270–640]	65 [35–395]	13 [8–21]	–	10.2 [8–28]	7.1	28.6	2.4	30-day
Khatkov *et al.*	162	66±10.4	415 [240–765]	200 [50–2,100]	18 [11–29]	85.6	15 [4–63]	13.0	43.9	5.0	90-day
Edil *et al.*	19	63.2 [20–81]	367 [260–576]	–	14 [8–22]	97.4	–	5.0	22.0	3.0	90-day
Palanivelu *et al.*	75	62 [28–76]	357 [270–650]	–	–	87.4	8.2 [6–42]	6.7	26.7	1.3	30-day
Kendrick *et al.*	62	66±12	368 [258–608]	240 [30–1,200]	15 [6–31]	89.0	7 [4–69]	18.0	42.0	1.6	In-hospital
Karatepe *et al.*	42	56±7	339 [280–415]	–	–	–	8.1 [6–34]	21.0	23.0	0	In-hospital
Cai *et al.*	238	65.2 [13–84]	358 [220–495]	–	–	–	10.2 [5–19]	21.4	36.1	0.4	90-day
Honda *et al.*	17	68 [34–86]	462 [341–656]	126 [0–350]	13 [8–21]	–	–	17.6	47.1	–	–

between the posterior wall of the pancreas and the seromuscular layer of the jejunum. However, the suture is not tied down, but is left loose and temporarily clipped for later utilization in the procedure. A stent is then placed to bridge the pancreatic duct and a small jejunal enterotomy. The posterior aspect of the inner layer is a figure-of-eight stitch using 5-0 absorbable monofilament (PDS) suture in duct-to-mucosa fashion. The posterior polypropylene layer is then pulled tight as the figure-of-eight PDS suture is tied down to reduce tension. The anterior aspect of the inner layer is a running layer of 5-0 absorbable monofilament (PDS) suture between the pancreatic duct and the anterior wall of jejunum. Finally, the most anterior layer uses the same posterior Prolene suture in running fashion between the pancreatic capsule and the seromuscular jejunum. As this layer is completed and tied, both the first and fourth layers are pulled tight to complete the anastomosis. The authors describe results from using this technique in 238 patients, with POPF noted in 21.4% of patients, with 17.6% grade A ("biochemical leak"), 3.4% grade B, and 0.4% grade C. Overall morbidity was 36.1% and 90-day mortality was only 0.4.

The final article reviewed illustrates a novel device called a "Haenawa" used to assist the creation of the PJ (4). For background, the authors explain that a "Haenawa" in Japanese means a special fishing trawl line which consists of a number of fishhooks. This paper details a special device made up of a plastic bar and a sponge. The device is place above and below the pancreatic anastomosis and hold the sutures in place during the creation of the PJ. The outer layer consists of approximately five or six interrupted 4-0 nonabsorbable monofilament sutures (Nespilene) from the seromuscular part of the jejunum to the pancreas. The stitches are placed in anterior-to-posterior fashion through the jejunum and posterior-to-anterior full-thickness bites through the pancreas. The sponge portion of the device sits atop the pancreas and holds the sutures in place while the inner layer is completed. The inner layer is completed using 5-0 absorbable monofilament (polyglyconate) suture in continuous fashion. Stents are used for small pancreatic ducts and avoided in dilated ducts. Once the inner layer is completed, the outer layer sutures are sequentially separated from the device and tied down in a cranial to caudal direction. The authors report a 17.6% POPF rate with this technique and an overall morbidity of 47.1%. Mortality is not reported.

Surgical outcomes

Key surgical outcomes from the literature are summarized

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in *Table 3*. Median operative times were similar between all techniques and ranged from 339 to 462 minutes. The shortest reported operative time was 220 minutes (2 hours, 40 minutes) (11) and the longest was 765 minutes (12 hours, 45 minutes) (6). Estimated blood loss was low with median reported volumes of only 65 to 240 (range, 0–2,100) milliliters (4-6,9). Unplanned conversion to an open procedure was reported in eight articles and ranged from 0% to 7.6% (5-9,11). Reasons for conversion varied from uncontrolled hemorrhage, severe peripancreatic adhesions, and unexpected SMV involvement. Overall, the median hospital LOS was also similar among the various publications and extended from 7 to 15 [4–69] days (5-7,9-11).

The oncologic success of MPD in these case series appears similar to OPD. The average number of lymph nodes harvested ranged from 13 to 18 [6–31] (4-6,8,9) while R0 resection rates were 85.6% to 97.4% (6-9). One paper reported 95% patient follow-up with a mean follow-up time of 36.5 months and were able to demonstrate 30% 5-year survival and a median survival of 49 months (5).

Morbidity ranged from 22.0% to 47.1% and included biliary anastomotic leak, delayed gastric emptying, deep vein thrombosis, bowel obstruction, and surgical site infection. POPF rates varied moderately from 5.0% to 21.4% and papers differed in whether they discriminated between ISPGF grades A, B, and C in their reporting. For example, Kendrick *et al.* (9) reports an 18% pancreatic anastomotic leak rate but does not detail the severity of the leaks, while Cai *et al.* (11) reports a 21.4% POPF rate but specifies that 17.4% were grade A (biochemical leak) and only a small number were more severe (3.4% grade B and 0.4% grade C).

Post-operative mortality rates were reported in all but one case series (4) and ranged from 0% to 5.0%. Three measures of mortality were reported: in-hospital, 30-day, and 90-day mortality. In-hospital mortality varied from 0–1.6% (9,10), 30-day mortality varied from 1.3–2.4% (5,7), and 90-day mortality ranged from 0.4% to 5.0% (6,8,11). Of note, most post-operative deaths reported in these eight papers were attributed to complications arising from sequelae of POPF.

Discussion

Without a doubt, the advent of MPD is a landmark development in terms of surgical technique. With further technical development and experience, patient access to this approach could significantly increase. Today, MPD is seldomly performed except at a few institutions by those who are technically sound and well-versed in the operation. This literature review describes several techniques used to create a minimally invasive PJ. Unfortunately, there is not enough evidence to determine which specific technique results in superior outcomes. All data related to PJ technique is currently in the form of case series, with no comparative studies found. Additionally, retrospective reviews often focus on report a wide variety of different patient outcomes leading to a lack of consistency in the data.

In general, MPD shows promise in terms of sound oncologic resections, reasonable operative times, and minimal blood loss. Pancreatic fistula remains the most challenging complication to reduce and is the most common operative complication leading to subsequent mortality. Standardizing PJ technique in such a way as to reduce POPF rates could have a dramatic impact on morbidity and mortality for this technically challenging procedure. Global outreach and data collaboration between surgeons performing this operation could be initiated and an international registry created. As additional data is collected, it may be possible to improve and standardize operative techniques.

Conclusions

MPD is a landmark development in the technical evolution of minimally invasive surgery. This literature review summarizes the diverse PJ techniques for the MPD procedure. The PJ is the most technically difficult anastomosis while POPF is the most challenging complication of MPD. Any reduction in POPF rates would lead to a significant improvement in morbidity and mortality for patients. MPD is safe and feasible in multiple case series, however, collaborative data collection and comparative studies are needed to determine which PJ technique has the lowest POPF rate and superior outcomes.

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References

1. Are C, Dhir M, Ravipati L. History of pancreaticoduodenectomy: early misconceptions, initial milestones and the pioneers. HPB (Oxford) 2011;13:377-84.
2. Ammori BJ. Pancreatic surgery in the laparoscopic era. JOP 2003;4:187-92.
3. Gagner M, Pomp A. Laparoscopic pylorus-preserving pancreatoduodenectomy. Surg Endosc 1994;8:408-10.
4. Honda G, Kurata M, Okuda Y, et al. Laparoscopic pancreaticoduodenectomy: taking advantage of the unique view from the caudal side. J Am Coll Surg 2013;217:e45-9.
5. Palanivelu C, Jani K, Senthilnathan P, et al. Laparoscopic pancreaticoduodenectomy: technique and outcomes. J Am Coll Surg 2007;205:222-30.
6. Khatkov I, Izrailov R, Tyutyunnik P, et al. One hundred and forty five total laparoscopic pancreatoduodenectomies: a single centre experience. Pancreatology 2017;17:936-42.
7. Palanivelu C, Rajan PS, Rangarajan M, et al. Evolution in techniques of laparoscopic pancreaticoduodenectomy: a decade long experience from a tertiary center. J Hepatobiliary Pancreat Surg 2009;16:731-40.
8. Edil BH, Cooper MA, Makary MA. Laparoscopic pancreaticojejunostomy using a barbed suture: a novel technique. J Laparoendosc Adv Surg Tech A 2014;24:887-91.
9. Kendrick ML, Cusati D. Total laparoscopic pancreaticoduodenectomy: feasibility and outcome in an early experience. Arch Surg 2010;145:19-23.
10. Karatepe O, Yazici P, Battal M. The utility of V-Loc suture device for pancreaticojejunostomy in laparoscopic pancreaticoduodenectomy. JOP J Pancreas (Online) 2018;19:190-6.
11. Cai Y, Luo H, Li Y, et al. A novel technique of pancreaticojejunostomy for laparoscopic pancreaticoduodenectomy. Surg Endosc 2019;33:1572-7.

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