ORIGINAL ARTICLE

Barbed Suture for Pancreatic Anastomosis during Pancreaticoduodenectomy Decreases Incidence of Clinically Significant Pancreatic Fistula

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ABSTRACT

Background Pancreatic leak continues to be a high cause of morbidity during pancreaticoduodenectomy (PD). Barbed suture is being utilized in many clinical applications due to ease of use and potential higher burst strength of anastomoses. To date, no studies have looked at the impact of utilizing barbed suture in pancreatic reconstruction during pancreaticoduodenectomy. **Methods** A retrospective analysis was performed of all pancreaticoduodenectomy cases performed by a single surgeon from 2015-2018 at a tertiary care regional medical center. Pancreatic anastomosis was performed as a pancreaticojejunostomy in an end to side fashion; an outer layer of mattress Vicryl™ suture was utilized first followed by inner running layer V-lock™ (barbed) suture. No stent was utilized during anastomosis. Fistula rates were recorded in accordance with the International Society of Grading of Pancreatic Fistula (ISGPF) descriptions. **Results** A total of 49 consecutive pancreaticoduodenectomy performed by a single surgeon were examined. 22 patients had elevated amylase levels (44.9%) Of these, 20/49 Grade A (40.8%), 2/49 Grade B (4.1%), 0/49 Grade C (0%). **Conclusion** Barbed suture utilization is a reliable and safe method of pancreaticojejunostomy creation during pancreaticoduodenectomy. This technique has a low incidence of clinically relevant pancreatic fistula and is easily producible.

INTRODUCTION

Pancreaticduodectomy (PD), or the Whipple procedure, is the treatment of choice for many malignant and benign diseases in the head of the pancreas. It has also long been shown to have a mortality rate of 3-5% at high volume centers and a morbidity rate of 30-50% [1]. One of the most significant causes of morbidity with this surgery is leaking at the pancreatic anastomosis. In order to normalize pancreatic leak definitions, The ISGPF, standardized the definition of leak defined by Bassi C, et al. [2].

Output *via* surgically placed drain (or percutaneous drain) of any measurable volume of drain fluid on or after postoperative day 3, with amylase content equal or greater than 3 times the serum value.

The ISGPF, breaks the fistula grades down as presented in **(Figure 1)**.

Pancreatic fistula is the most common complication of a Whipple procedure. Previous studies of pancreatic fistulas after Whipple range from 11-63% [3, 4, 5, 6, 7, 8, 9]. Consensus for acceptable fistula rate at high volume centers is approximately 25% [3, 10, 11, 12, 13]. Furthermore, there have been studies that show that the clinically relevant pancreatic fistula rate (grade B or C) was 16% for PD [11].

There are several techniques for pancreatic anastomosis during PD, most common worldwide being the pancreaticojejunostomy (PJ). There are several published techniques for this anastomosis [9, 14, 15]. The pancreatic duct is often sutured to the jejunal mucosa with the pancreatic body oversewn to the serosa, also known as the duct-to-mucosa technique. Or, the pancreas is sewn directly to the jejunum with the entire end of pancreas invaginated into the jejunum. Pancreatic stents are used based on surgeon preference [16]. Traditionally these anastomoses are created with a hand or instrument tied suture by the surgeon using either an interrupted or running suture technique. A previous study by Edil et al. compared the use of barbed suture to standard suture and the rate of pancreatic leak; the study reported a decreased leak rate and shorter operative time during laparoscopic PD using the barbed suture [10]. However, this study only investigated with laparoscopic cases despite that the majority of PD procedures in the United States are done as an open procedure. This case showed that pancreatic leak rates were improved with the use of barbed suture. It remains unclear in the literature regarding pancreatic leak rates for open pancreaticojejunostomies using a barbed suture compared to a traditional, non-barbed suture.

Many studies have been published investigating pancreaticojejunostomy technique and fistula rate; however, there is no significant difference has been

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Keywords Pancreatic Fistula; Pancreaticoduodenectomy
Abbreviations PD Pancreaticoduodenectomy; ISGPF International Society of Grading of Pancreatic Fistula; PJ pancreaticojejunostomy; NGT Nasogastric Tube; GI Gastrointestinal; POD Postoperative Day
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found. According to many studies, the primary leaks stems from the soft and delicate nature of the pancreatic tissue and small pancreatic duct size lead to tearing of suture through the tissue and ultimately fistula formation [5, 6, 16]. Furthermore, a meta-analysis showed that there was no significant difference between the duct to mucosa anastomosis and invagination technique leak rate, however there was a slight decrease in clinically relevant fistula with the invagination technique [17, 18]. The theory behind the barbed suture for the PJ anastomosis is that less tension is placed on the anastomosis. There are no knots to tie leading to less stress on the pancreatic duct/ paranchyma resulting in lower fistula rates.

The purpose of this study is to review the leak rates at an institution in which barbed sutures are used.

METHODS

An Institutional Review Board approved the study. All charts of patients that received pancreaticoduodenectomy were reviewed from a single, high volume, tertiary care medical centre over a two-year period from 2015 to 2018. Specifically, the charts were reviewed for post-operative abdominal drain amylase levels. The medical center collects abdominal fluid amylase at a minimum of post-operative day 1 and 3 and pancreas leaks were recorded and graded per ISPGF definitions. A total of 50 patients received pancreaticoduodenectomy during the study period and 49 patients were included in the study. One patient did not have abdominal drain amylase levels in their medical record post-operatively.

All of the pancreaticojejunostomies were created in the same manner. The pancreatic anastomoses are performed in an end to side fashion using the invagination technique. An infant Nasogastric Tube (NGT) is used to identify and preserve the main pancreatic duct. The posterior wall of the pancreas is first sutured to the duodenum in a horizontal mattress 2-0 vicryl suture to create the invagination. Next, the 3-0 barbed suture is used to secure the posterior and anterior walls of the pancreas to the jejunum, in a running fashion. Travel distance of approximately 0.3 cm is taken with approximately 0.5 cm of pancreatic tissue included in each suture. Jejunal stitches include the mucosa and serosa. At least one stitch of the posterior suture is made sure to be inside the main pancreatic duct. The distal ends of the barbed suture are then clipped after tightening according to manufacturer recommendations. The invagination technique closure is then completed, after removing the infant NGT, by suturing through the pancreas and the anterior wall of the jejunum completing the horizontal mattress stitch with the vicryl suture. The pancreaticojejustonomy is the first anastomosis created and drains are placed at the end of the procedure **(Figure 2)**.

The primary endpoints of the study is pancreatic fistula rate and grade of the leak, 95% confidence intervals for rates were also calculated and compared to the literature.

RESULTS

A total of 49 pancreaticojejunostomies were included in our study data. **Table 1** summarizes the pancreatic fistula rate based on ISPGF grade.

Figure 1. ISGPF Grading for Pancreatic Fistula [2].

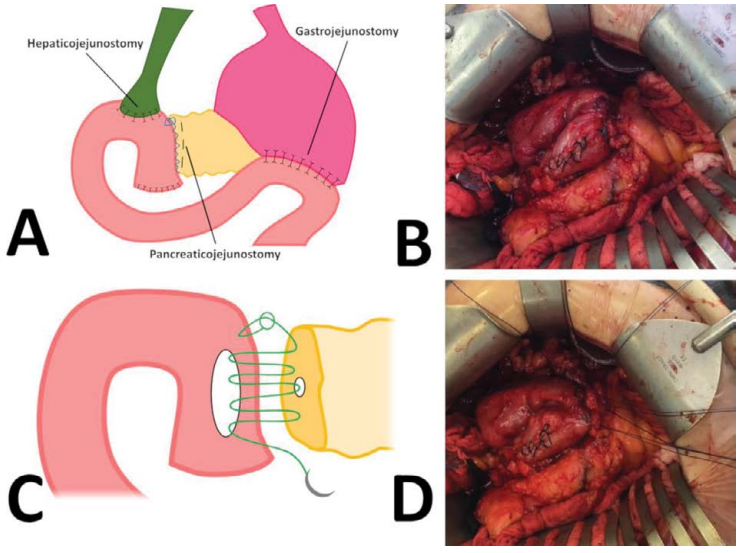

Figure 2. Above are representations of the pancreaticojejunostomy using barbed suture.
(A) Represents the completed PJ with 2 layers of barbed suture, posterior and anterior, with the invaginating horizontal mattress sutures.
(B) Operative image of completed PD using barbed suture with the invagination technique.
(C) Represents the posterior running barbed suture. Clips are placed per manufacturer recommendations.
(D) Operative image of posterior running barbed suture stitch with clips.

Table 1. Pancreatic fistula rates by ISPGF grade with 95% Confidence Interval.

Grade	Patients (n=49)	Rate	95% CI
No Leak	27	55.10%	41.2% to 69.0%
A	20	40.80%	27.1% to 54.6%
B	2	4.10%	0% to 9.6%
C	0	0.00%	-

Of the 49 patients, 22 (44.9%, 95% CI: 31.0%-58.8%) patients had elevated amylase levels 3 times serum level on post-op day 3 or later that met the ISGPF definition of pancreatic fistula. Of these, 20/49 Grade A (40.8%) and required no further intervention, 2/49 Grade B (4.1%) requiring further management, 0/49 Grade C (0.0%) that required major intervention or mortality.

Both of the patients with Grade B fistula required percutaneous drainage and the leaks resolved. The first patient had their surgical drain removed Postoperative Day (POD) [5]. The drain amylase was elevated, but the patient was not having any symptoms. The patient then developed a fluid collection around the pancreas that required percutaneous drainage on POD [9]. The second patient that required a percutaneous drain had one placed on POD [14] alongside the surgically placed drain. The surgical drain did not drain the fluid collection and the new drain as well as the surgical drain had an increased amylase. Both patients have had their percutaneous and surgical drains removed with no further complications.

DISCUSSION

Historic published articles suggest that a pancreatic fistula rate after pancreaticoduodenectomy at high volume centers of around 25% is acceptable [8, 11]. However, the range is up to 64% depending on the study [7]. The presented study reports a fistula rate of 44.9% (22/49). This overall fistula rate is higher than other high volume centers, however, it is within the range of published fistula rates. Importantly, the clinically relevant (grade B or C) fistula rate in our study was 2/49, or 4.1%, which is lower than the published rate of 16% [11].

There are several factors that increase pancreatic fistula rate and most pancreatic surgeons agree that pancreatic texture and duct size are important factors. Softer texture and smaller ducts tend to have higher fistula rates [5, 7, 11]. In addition, there have been a multitude of anastomotic techniques developed, none of which are superior in decreasing pancreatic fistula rate [8]. The majorities of these techniques rely on hand-tied anastomoses and require at least a moderate amount of pancreatic handling. Utilizing barbed suture for the pancreaticojejunostomy allows for minimal pancreatic handling and manipulation and does not rely so heavily on hand tying. The duct to mucosa technique is still widely used and relies on multiple hand tied suture of pancreatic duct directly to the jejunal mucosa. The physical motion of tying a traditional suture may allow for a sawing motion on the pancreatic duct with the suture leading to compromise. The technique also relies on multiple sutures to hold the anastomosis. Using the barbed suture eliminates the need for knot tying on very delicate tissue.

The V-Loc™ suture has been studied in GI anastomosis and has been found to be safe and effective in laparoscopic surgery [17, 18, 19]. DeBlais et al. showed that running barbed suture time and cost of material was significantly lower than traditional interrupted suture [18]. The time to complete the pancreaticojejustomy is not directly recorded at our institution, nor has it been readily reported in the literature and a direct comparison cannot be made. However, for similar reasons as in bowel anastomoses, the theory of fewer sutures used and fewer knots tied decreasing the time to create the anastomosis would apply to the use of barbed suture in pancreaticojejunostomy.

The majority of leaks in our study were grade A (40.8%), requiring no further intervention and we had two grade B leaks (4.1%). These results are similar to, or slightly improved upon, those reported in the literature. We believe that it is due to the nature of the barbed suture. It allows for more delicate handling of the pancreatic tissue, however, it does not allow for the watertight nature of interrupted duct to mucosa anastomosis of more traditional methods.

CONCLUSION

Pancreatic leaks after Pancreaticoduodenectomy provides patients significant morbidity. According to our findings, barbed suture for pancreaticojejunal anastomosis in pancreaticoduodectonomy is a safe and effective method. In particular, using the barbed suture with an invagination technique, our study showed that the rate of clinically significant pancreatic leaks (grade B or C) was reduced.

Conflicts of Interest

All named authors hereby declare that they have no conflicts of interest to disclose.

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