

The Effect of Circular Modified Blumgart Anastomosis for Pancreaticoduodenectomy

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ABSTRACT

Introduction : Postoperative pancreatic fistula (PF) is a severe complication of pancreaticoduodenectomy (PD). Although modified Blumgart anastomosis (mBA) has been reported to be superior to conventional methods, it does not sufficiently reduce the rate of postoperative PF. The aim of the present study was to evaluate the effect of our newly introduced anastomotic technique, mBA with circular jejunal seromuscular sutures (circular stitch mBA), on the postoperative PF rate.

Methods : We reviewed 60 patients who had undergone PD via mBA with horizontal jejunal seromuscular sutures (horizontal suture mBA) ($n = 38$) or circular stitch mBA ($n = 22$) technique for pancreatojejunostomy at The Jikei University Hospital from January 2013 through November 2019. We analyzed patients' pancreatic and operative factors to detect the risk factors of postoperative PF and assessed the factors related to horizontal suture mBA and circular stitch mBA group.

Results : Patients with postoperative PF ($n = 13$, 21.7%), when compared via univariate and multivariate analysis with patients without postoperative PF ($n = 47$), were more likely to have pancreatic ductal adenocarcinoma (84.6% vs. 46.8%, $p < 0.05$) and horizontal suture mBA anastomosis (92.3% vs. 55.3%, $P < 0.05$). Patients who had undergone circular stitch mBA, compared with patients who had undergone horizontal suture mBA, had a significantly lower postoperative PF rate (4.5% vs. 31.6%, $p < 0.05$) and shorter operative time (480.5 vs. 565.5 minutes, $p < 0.05$).

Conclusions : Circular stitch mBA is a safe and simple technique for pancreatojejunostomy to reduce the postoperative PF rate, operative time, and intraoperative blood loss.

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Key words : modified Blumgart anastomosis, pancreaticoduodenectomy, pancreatojejunostomy, postoperative pancreatic fistula

INTRODUCTION

Pancreaticoduodenectomy (PD) is the standard treatment for both benign and malignant lesions of the periampullary region. Although the mortality rate after PD has substantially decreased, the major cause of morbidity after PD is postoperative pancreatic fistula (PF)¹⁻³, which affects

13% to 41% of patients^{4,5}. Postoperative PF is associated with severe postoperative sequela, including hemorrhage due to the rupture of a pseudoaneurysm, intra-abdominal abscess, and delayed gastric emptying, and can cause long-term hospitalization and delay adjuvant chemotherapy, if needed.

To minimize the incidence of postoperative PF, numer-

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ous anastomotic techniques for pancreatojejunostomy (PJ) have been proposed. One technique is modified Blumgart anastomosis (mBA)^{6,7}, with which the rate of postoperative PF is reportedly lower than with conventional anastomotic procedures^{8,9}. To minimize the rate of PF after PD, we have performed mBA with a horizontal mattress suture for jejunal seromuscular stitches (horizontal suture mBA) since 2013 and modified this method with circular seromuscular stitches on the jejunum (circular stitch mBA) in 2018. The aim of the present study was to assess the risk factors of postoperative PF and to validate the effects of circular stitch mBA on PJ.

MATERIAL AND METHODS

Patient selection

From January 2013 through November 2019, 60 patients have undergone elective open PD with mBA at The Jikei University Hospital. The techniques we have used for PD have been horizontal suture mBA since 2013 and circular stitch mBA since January 2018. Therefore, horizontal suture mBA was performed for 38 patients, and circular stitch mBA was performed for 22 patients. We reviewed demographic, pancreatic, and operative factors and short-term outcomes of these patients.

Operative procedure

For most patients, subtotal stomach-preserving PD was performed. The stomach was divided approximately 3 cm proximal to the pylorus, and more than 95% of the stomach was preserved. If the patient had malignant disease, lymph node dissection was performed along the common hepatic artery, the hepatic artery, and the superior mesenteric artery. When suspected or definitive tumor invasion was observed, concomitant portal vein resection was performed. For most of the cases, pancreatic transection was performed with electrocautery. For any bleeding from the pancreatic stump, hemostasis was obtained with several stitches made via fine needles or with coagulation via electrocautery. A retrocolic modified Child's method was used for end-to-side PJ and end-to-side hepaticojejunostomy. An antecolic side-to-side gastrojejunostomy was then performed approximately 40 cm distal to hepaticojejunostomy. After Braun anastomosis was performed, 1 or 2 closed drains were placed in the foramen of Winslow and near the

site of PJ. An external pancreatic duct stent was placed in all patients.

Horizontal suture mBA

Two to three double-armed 3-0 polypropylene sutures were placed through the seromuscular layer of the jejunal posterior wall from back to front in the direction of the short axis and were followed by penetrating sutures through the pancreatic stump (Fig. 1 A). Duct-to-mucosa anastomosis with interrupted 5-0 polydioxanone sutures was then completed, and an external pancreatic duct stent was placed. Next, the seromuscular sutures were placed from back to front in the direction at the anterior wall with the same needles used for penetrating sutures (Fig. 1 B). All sutures were tied on the ventral wall of the jejunum to cover the pancreatic stump (Fig. 1 C).

Circular stitch mBA

Three seromuscular sutures were placed in a circular manner on the jejunal posterior wall and were followed by penetrating sutures through the pancreatic stump (Fig. 1 D). The duct-to-mucosa anastomosis and the pancreatic duct stent placement were performed in the same way as for horizontal suture mBA. The remaining seromuscular sutures were placed on the anterior wall of the jejunum in a circular shape using each suture (Fig. 1 E). Finally, all the sutures were tied in the same manner as for horizontal suture mBA (Fig. 1 F).

Definition of postoperative PF

The definition of postoperative PF was based on the consensus classification of the International Study Group on Pancreatic Fistulas¹⁰.

Statistical analysis

All values are expressed as the mean \pm standard deviation. For univariate analysis, variables were analyzed with the χ^2 test if categorical or with the Mann-Whitney U test if continuous; for multivariate analysis, the Cox proportional regression model was used. Differences with a *P* value < 0.05 were considered statistically significant. This retrospective study complied with Declaration of Helsinki and was approved by the Ethics Committee of The Jikei University School of Medicine (protocol ID number 27-177) with waiving of informed consent.

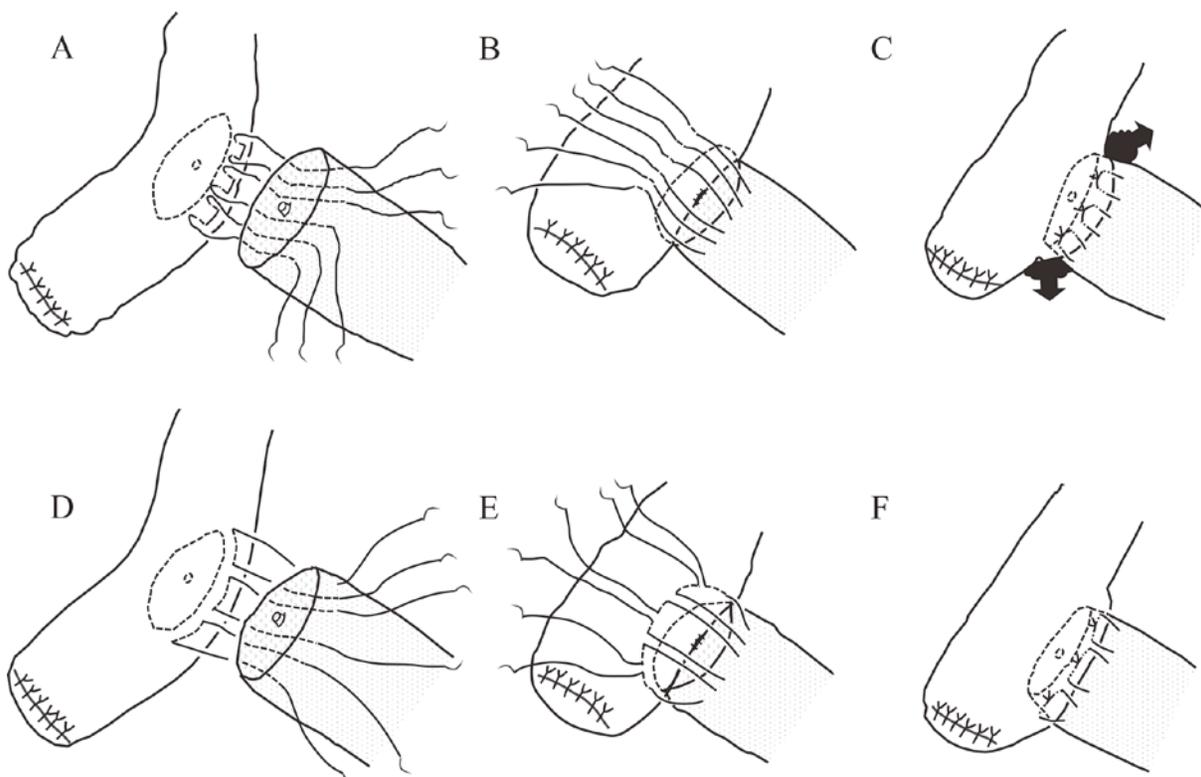


Fig. 1. (A) Posterior wall sutures in horizontal suture mBA. (B) Anterior wall sutures in mBA. (C). Completion of horizontal suture mBA. (D). Posterior wall sutures in circular stitch mBA. (E). Anterior wall sutures in circular stitch mBA. (F). Completion of circular stitch mBA.

RESULTS

Risk factors of postoperative PF

Of the 60 patients, 13 (21.7%) had postoperative PF and 47 (78.3%) did not (Table 1). Patients with postoperative PF, when compared via univariate analysis, with patients without postoperative PF, were more likely to have preoperative diagnosis of pancreatic ductal adenocarcinoma (84.6% vs. 46.8%, $p < 0.05$) and to be treated with horizontal suture mBA anastomosis for PJ (92.3% vs. 55.3%, $P < 0.05$). Preoperative diagnosis of pancreatic ductal adenocarcinoma and horizontal suture mBA anastomosis were also identified, via multivariate analysis, as independent risk factors for postoperative PF. Patients with postoperative PF and those without did not differ significantly regarding such variables as age, sex, body mass index, preoperative biliary drainage, pancreatic texture, main pancreatic duct size, surgeons with or without board certification of Japanese Society of Hepato-Biliary-Pancreatic Surgery, operation time, and intraoperative blood loss.

Comparison of horizontal suture mBA and circular stitch mBA

Of the patients, 38 underwent horizontal suture mBA ($n = 38$) and 22 underwent circular stitch mBA (Table 2). Patients undergoing circular stitch mBA, compared via multivariate analysis of patients, pancreatic and operative factors, and outcomes, with patients undergoing horizontal suture mBA, had a significantly lower postoperative PF rate (4.5% vs. 31.6%, $p < 0.05$) and shorter operative time (480.5 minutes vs. 565.5 minutes, $p < 0.05$). However, other factors, including postoperative complication (other than postoperative PF) rates and the postoperative hospital stay, did not differ significantly between the patient groups.

DISCUSSION

Postoperative PF is a severe complication of PD which may create life-threatening conditions and lead to a patient's death^{11,12}. Although novel anastomotic methods have been developed in an attempt to avoid postoperative PF¹³⁻¹⁸, an optimal technique for PJ has not been established. Modi-

Table 1. Patients with and without postoperative pancreatic fistula

	With postoperative pancreatic fistula (<i>n</i> = 13)	Without postoperative pancreatic fistula (<i>n</i> = 47)	Univariate	Multivariate
			<i>p</i> value	<i>p</i> value
Age, years (range)	70 (63-76)	72 (63.5-76.5)	N/S	
Sex : male/female	11 (84.6%)/2 (15.4%)	29 (61.7%)/18 (38.3%)	N/S	
Body mass index, kg/m ² (range)	22.9 (20.5-24.5)	22.2 (19.8-23.6)	N/S	
Preoperative diagnosis : PDAC+/PDAC-	2 (15.4%)/11 (84.6%)	25 (53.2%)/22 (46.8%)	0.015	0.019
Preoperative biliary drainage : yes/no	2 (15.4%)/11 (84.6%)	8 (17.0%)/39 (38.0%)	N/S	
Pancreatic texture : soft/hard	9 (69.2%)/4 (30.8%)	21 (44.7%)/26 (55.3%)	N/S	
Main pancreatic duct size, mm (range)	4 (2-5)	3 (2-5)	N/S	
Surgeon JSHBPS board certified/uncertified	2 (15.4%)/11 (84.6%)	20 (42.6%)/27 (57.4%)	N/S	
Horizontal mBA/circular mBA	12 (92.3%)/1 (7.7%)	26 (55.3%)/21 (44.7%)	0.014	0.027
Operative time, minutes (range)	555 (527-602)	516 (476.5-610)	N/S	
Intraoperative blood loss, g (range)	740 (390-1,115)	600 (270-875)	N/S	

PDAC, pancreatic ductal adenocarcinoma ; Circular mBA, modified Blumgart anastomosis with circular stitch ; horizontal mBA, modified Blumgart anastomosis with horizontal stitch) ; JSHBPS, Japanese Society of Hepato-Biliary-Pancreatic Surgery

Table 2. Modified Blumgart anastomosis with horizontal sutures or circular stitches

	Horizontal suture mBA (<i>n</i> = 38)	Circular stitch mBA (<i>n</i> = 22)	Univariate	Multivariate
			<i>p</i> value	<i>p</i> value
Age, years (range)	71.5 (63-76)	73.5 (63.3-78)	N/S	
Sex : male/female	26 (68.4%)/12 (31.6%)	14 (63.6%)/8 (36.4%)	N/S	
Body mass index, kg/m ² (range)	22.3 (19.9-24.2)	21.9 (20.0-23.7)	N/S	
Preoperative diagnosis : PDAC+/PDAC-	17 (44.7%)/21 (55.3%)	10 (45.5%)/12 (54.5%)	N/S	
Preoperative biliary drainage : yes/no	7 (18.4%)/31 (81.6%)	3 (13.6%)/19 (86.4%)	N/S	
Pancreatic texture : soft/hard	18 (47.4%)/20 (52.6%)	12 (54.5%)/10 (45.5%)	N/S	
Main pancreatic duct size, mm (range)	3 (2-5)	3 (3-5)	N/S	
Surgeon JSHBPS board certified/uncertified	13 (34.2%)/25 (65.8%)	9 (40.9%)/13 (59.1%)	N/S	
Operative time, min (range)	565.5 (513-624.5)	480.5 (431.8-518.8)	<0.01	0.046
Intraoperative blood loss, g (range)	750 (531.3-1,047.5)	312.5 (185-610)	<0.01	N/S
Postoperative pancreatic fistula : +/-	12 (31.6%)/26 (68.4%)	1 (4.5%)/21 (95.5%)	<0.14	0.045
Pseudoaneurysm : +/-	3 (7.9%)/35 (92.1%)	1 (4.5%)/21 (95.5%)	N/S	
Other complications : +/-	18 (47.4%)/20 (52.6%)	11 (50.0%)/11 (50.0%)	N/S	
Postoperative hospital stay, days (range)	31 (23-57)	28 (24.3-40)	N/S	

Circular stitch mBA, modified Blumgart anastomosis with circular stitch ; Horizontal suture mBA, modified Blumgart anastomosis with horizontal sutures ; PDAC, pancreatic ductal adenocarcinoma ; JSHBPS, Japanese Society of Hepato-Biliary-Pancreatic Surgery

fied Kakita anastomosis (mKA), an interrupted full-thickness pancreatic suture introduced by Kakita et al.¹⁹, is a procedure widely adopted in Japan. Recently, mBA⁷, a horizontal mattress suture penetrating the pancreatic parenchyma introduced by Blumgart et al.⁶, has been widely adopted for its theoretical advantage of tight adaptation between the jejunal wall and pancreatic parenchyma. Although a recent randomized control study in Japan²⁰ finds no significant difference in the postoperative PF rate between mBA and

mKA, several earlier studies have demonstrated the superiority of mBA over mKA^{8,9} ; we introduced horizontal suture mBA in our department in 2013. Our horizontal suture mBA technique has a rate of postoperative PF rate similar to that of mKA ; however, the rate of postoperative PF was not significantly reduced. Because a possible mechanism of postoperative PF is pancreatic juice leakage from the small branches at the cut surface of the pancreatic remnant^{21,22}, we hypothesized that complete blockage of the pancreatic

stump can prevent pancreatic juice leakage from the cut surface and reduce the rate of postoperative PF. Then we focused on covering the pancreatic stump with the jejunal wall from all directions, not only from the dorsal and ventral sides. Oda et al. introduced their anastomotic technique with the concept of using one suture loop placed at an anterior and posterior “semicircle” and had a postoperative PF rate of 20.5%. This technique of anastomosis was simple and facilitated tight attachment between the pancreatic stump and the jejunal wall, but with our technique we focused more on placing circular-shaped seromuscular sutures on the jejunum so that the pancreatic stump would be covered completely from all directions with the jejunal wall. The postoperative PF rate of 4.5% with our circular stitch mBA was similar to previously reported postoperative PF rates of 2.5% to 20.5%^{8,9,20} with mBA. Circular stitch mBA in the present study was also associated with shorter operative time and less intraoperative blood loss, which were possible results of technical refinement and integration of the anastomotic method after introduction of circular stitch mBA.

The present study had several limitations. First, the sample size was small. The number of patients was 60, but might be insufficient to conclude valid results. Second, the study was retrospective and nonrandomized. Although patients undergoing horizontal suture mBA or circular stitch mBA did not differ significantly in such variables as demographic and pancreatic characteristics and surgeon’s certification, most recent patients had undergone circular stitch mBA. This difference in which technique was performed during the study period suggests a possible bias in selecting techniques and that these results cannot exclude an institutional learning curve.

CONCLUSION

The results of the present study suggest that circular stitch mBA can be safely performed to reduce the postoperative PF rate, operative time, and intraoperative blood loss.

Authors have no conflict of interest.

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