

A comparative study of postoperative outcomes after stapled versus handsewn gastrojejunal anastomosis for pylorus-resecting pancreaticoduodenectomy

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Backgrounds/Aims: A stapler is widely used in various surgeries, and there have been recent attempts to use it for performing duodenojejunostomy and gastrojejunostomy during pancreaticoduodenectomy. This study aimed to compare the postoperative results of handsewn gastrojejunostomy (HGJ) and stapled gastrojejunostomy (SGJ) limited to pylorus-resecting pancreaticoduodenectomy (PrPD) performed by a single surgeon. **Methods:** This retrospective study was conducted between January 2014 and March 2020, and included 131 patients who underwent PrPD performed by a single surgeon. Of the total subjects, 90 were in the HGJ group and 41 in the SGJ group. **Results:** The mean time of surgery was significantly shorter in the stapled group than in the handsewn group (450.4±75.4 min vs. 397.1±66.5 min, $p < 0.001$). However, there were no significant differences between the groups in the rates of postoperative pancreatic fistula, bile leak, chyle leak, intra-abdominal fluid collection, postoperative bleeding, ileus, Clavien-Dindo, rate of reoperation, and 30-day mortality, including delayed gastric emptying (DGE) ($n=11$ vs. $n=6$, $p=0.92$). **Conclusions:** Gastrojejunostomy using a stapler in PrPD reduces the reconstruction time without any increase in the rate of complications, including DGE. Therefore, using a stapler for gastrojejunostomy in pancreaticoduodenectomy is feasible and safe. (*Ann Hepatobiliary Pancreat Surg* 2021;25:84-89)

Key Words: PrPD; DGE; Stapler; Pancreaticoduodenectomy; Single surgeon

INTRODUCTION

Pancreaticoduodenectomy is the standard surgical method for benign and malignant tumors of the pancreatic head or periampullary region.¹ However, compared to the other abdominal surgeries, complications such as anastomotic leakage, stricture, bleeding, dumping syndrome, and delayed gastric emptying are more likely to occur in this surgery due to various anastomoses created for reconstruction after resection.^{2,3} Patients with many underlying diseases might develop medical or systemic complications due to the long operation time.^{4,5} With the development of surgical tools and surgical methods, stapling has been used for intestinal anastomosis in several surgeries to ease the complex surgical process and to reduce the time of surgery compared to that in manual anastomosis.⁶⁻⁹ After

pancreaticoduodenectomy, the stapler has also been used for duodenojejunostomy or gastrojejunostomy, and it has been reported that operation time was reduced. Moreover, the incidence of delayed gastric emptying (DGE) after surgery decreased in patients who underwent gastro/duodenojejunostomy using stapling anastomosis after pylorus-preserving pancreaticoduodenectomy (PPPD) and Whipple's operation.¹⁰ However, some reports also mentioned that the decrease in the incidence of DGE was not significant.¹¹ The above studies analyzed several surgical methods such as Whipple's op, PPPD, and pylorus-resecting pancreaticoduodenectomy (PrPD); therefore, factors other than the handsewn and stapled anastomosis might have influenced the outcomes. This study aimed to compare the postoperative results of stapled gastrojejunostomy and handsewn gastrojejunostomy in patients who under-

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sent PrPD performed by a single surgeon.

MATERIALS AND METHODS

Patients population

We reviewed the data of 211 patients in whom pancreaticoduodenectomy was planned as an elective surgery between January 2014 and to March 2020. Nine patients who underwent PPPD, 27 patients who underwent Whipple's operation, and 44 patients with distant lymph node metastasis, liver metastasis, angioinvasion, or those who underwent palliative surgeries were excluded. Finally, 131 patients who underwent PrPD were enrolled; 90 patients underwent handsewn gastrojejunostomy (HGJ), and 41 underwent stapled gastrojejunostomy (SGJ). This study was approved by the Institutional Review Board of Hwasun Chonnam National University Hospital (IRB No. CNUHH-2020-144).

Surgical procedure

All surgeries were performed under laparotomy. The stomach was incised 2 cm proximal to the pylorus, so that the antrum and the entire stomach was preserved. The gallbladder, pancreatic head with the bile duct, pylorus, and proximal jejunal loop were excised. Lymphadenectomy to similar extent was performed in all patients. Pancreaticojejunostomy was performed in an end-to-side, duct-to-mucosa anastomosis. Hepaticojejunostomy was performed 15 cm distal to the pancreaticojejunostomy site. For gastrojejunostomy, antecolic Billroth II reconstruction was performed distal to the hepaticojejunostomy site without Braun anastomosis. In the HGJ group, gastrojejunostomy was performed with an end-to-side anastomosis between the rest of the stomach and the jejunum. The mucosa was sewn with a continuous suture using Vicryl Plus[®] 3/0, and the seromuscular layer was sewn with an interrupted suture. The SGJ group was underwent side-to-side anastomosis between the greater curvature of the stomach and the jejunum using a linear stapler 75 mm (ETHICON Linear Cutter NTLC75, Johnson & Johnson). The opening length of the anastomosis was 60 mm. In both groups, interrupted seromuscular Lambert sutures for the outer layer were performed with Sof silk[®] 3/0. After reconstruction, a drainage tube was inserted into the pancreaticojejunostomy and hepaticojejunostomy site.

Postoperative management

The nasogastric tube (NGT) was inserted before surgery in all patients and was removed on postoperative day (POD) 1 if the drainage volume was below 200 ml/day and not blood stained. Oral intake was initiated by providing sips of water after removing the NGT. A soft diet was started on POD 3. If vomiting or severe distention of the stomach was observed on abdominal radiography after surgery, the NGT was reinserted. The amylase levels in the serum and in the drain fluid were measured on or after POD 1, 3, and 7. Prophylactic octreotide (Sandostatin[®], 100 µg subcutaneously three times per day, Novartis, Rueil Malmaison, France) was administered routinely to all patients for 7 days from the day before surgery. Proton pump inhibitors were injected in all patients after surgery, and were switched to oral medications after the initiation of diet, and administered until 30 days after discharge. Abdominal computed tomography was performed on POD 7, and the abdominal drain was removed on the same day if there were no signs of postoperative pancreatic fistula (POPF), intra-abdominal collection, or other complications related to the surgery.

Definitions of outcome measures

According to the International Study Group of Pancreatic Surgery, DGE was defined as the need for or re-insertion of NGT after POD 3 or failure to start oral diet on POD 7. The DGE was subdivided into grades A, B, and C in the order of increasing severity. Grade A was defined as the need for NGT within POD 4-7, reinsertion of NGT after removal at POD 3, or inability to tolerate a solid diet on POD 7. Grade B was defined as the need for NGT from POD 8 to 14, reinsertion of the NGT after POD 7, or inability to tolerate a solid diet on POD 14. Grade C was defined as the inability to remove the NGT, reinsertion of NGT after POD 14, or inability to tolerate a solid diet on POD 21.¹²

POPF was defined according to the guidelines of the International Study Group on Pancreatic Fistula (ISGPF) as an amylase level in the drain fluid more than three times that of the serum amylase on or beyond POD 3. POPF grades were stratified based on the revised ISGPF definition in 2016. Patients were assigned POPF grades B and C if they had a clinically relevant condition related directly to POPF, and POPF grade A if there was no

change in their clinical condition, or had a “biochemical leak”.¹³

Statistical analysis

Statistical analysis was performed using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA). Student’s *t*-test or Mann-Whitney U test were used to compare the continuous variables, and Fisher’s exact test or chi-square test were used to compare the categorical variables. All *p*-values were two-sided, and *p*<0.05 was considered significant.

RESULTS

A total of 131 patients underwent PrPD; 90 in the HGJ group and 41 in the SGJ group. The relevant patient characteristics and perioperative details are shown in Table 1. There were no significant differences in the age, sex, BMI, American Society of Anesthesiologists (ASA) score ≥ 3 , underlying diseases such as hypertension and diabetes mellitus, previous operation history, preoperative total bilirubin or preoperative bile drainage between the groups. Histologically, bile duct carcinoma was the most common type of tumor in both groups (n=28 vs. n=17, *p*=0.338). Further, no significant difference in pancreatitis

Table 1. Patient and operative characteristics

Variables	Handsewn (n=90)	Stapled (n=41)	<i>p</i>
Age	66.6±11.6	66.7±9.5	0.966
Sex			0.403
Male	44 (48.9%)	25 (58.5%)	
Female	46 (51.1%)	17 (41.5%)	
BMI	23.0±3.2	22.7±3.1	0.675
ASA classification			0.059
<3	76 (84.4%)	28 (68.3%)	
≥3	14 (15.6%)	13 (31.7%)	
Underlying disease			
HTN	50 (55.6%)	23 (56.1%)	1.000
DM	36 (40.0%)	10 (24.4%)	0.124
Heart	11 (12.2%)	6 (14.6%)	0.920
Pulmonary	4 (4.4%)	2 (4.9%)	1.000
Hepatic	3 (3.3%)	2 (4.9%)	1.000
Renal	2 (2.2%)	0 (0.0%)	0.847
Cerebrovascular	5 (5.6%)	4 (4.9%)	0.611
Previous operation history	17 (18.9%)	12 (29.3%)	0.271
Preoperative total bilirubin	1.6±1.9	1.4±1.8	0.477
Preoperative bile drainage (ENBD, ERBD, PTBD)	50 (56.6%)	26 (63.4%)	0.412
Tumor type			
Pancreatic adenocarcinoma	17 (18.9%)	2 (4.9%)	0.065
Bile duct carcinoma	28 (31.1%)	17 (41.5%)	0.338
Ampullary adenocarcinoma	22 (24.4%)	7 (17.1%)	0.474
Duodenal adenocarcinoma	1 (1.1%)	2 (4.9%)	0.480
Intraductal papillary neoplasms	12 (13.3%)	7 (17.1%)	0.767
Pancreatic endocrine tumor	4 (4.4%)	0 (0.0%)	0.410
Other diseases	7 (7.8%)	6 (14.6%)	0.367
Pancreatitis	26 (28.9%)	9 (22.0%)	0.536
Pancreas texture			0.409
Soft	60 (66.7%)	31 (75.6%)	
Hard	30 (33.3%)	10 (24.4%)	
Vein resection (PV, SMV, IVC)	11 (11.2%)	4 (9.8%)	0.908

BMI, body mass index; ASA, American Society of Anesthesiologists; HTN, hypertension; ENBD, endoscopic nasobiliary drainage; ERBD, endoscopic retrograde biliary drainage; PTBD, percutaneous transhepatic biliary drainage; PV, portal vein; SMV, superior mesenteric vein; IVC, inferior vena cava

Table 2. Postoperative outcomes

Variables	Handsewn (n=90)	Stapled (n=41)	<i>p</i>
Delayed gastric emptying	20 (39.2%)	5 (8.8%)	0.92
Grade A	3 (5.9%)	0 (0.0%)	0.611
Grade B	6 (11.8%)	0 (0.0%)	0.48
Grade C	11 (21.6%)	5 (8.8%)	0.295
Start of solid diet (day)	4.1±1.1	3.9±1.2	0.277
Postoperative hospital stay (day)	22.7±24.7	19.7±15.4	0.353
Operative time	451.7±76.1	397.7±67.2	<0.001
Transfusion	8	1 (2.4%)	0.327
Bile leak	1	0 (0.0%)	1
Chyle leak	6	0 (0.0%)	0.214
Intra-abdominal fluid collection	5	6 (14.6%)	0.162
Postoperative bleeding	1	1 (2.4%)	1
Ileus	2	1 (2.4%)	1
POPF			
A	12	5 (12.2%)	0.796
B	4	3 (7.3%)	0.807
C	0	0 (0.0%)	
Clavien-Dindo classification			
Grade I-II	83	37 (90.2%)	0.969
Grade IIIa-IIIb	5	4 (9.8%)	0.611
Grade IV-V	1	0 (0.0%)	1
Reoperation	0	2 (4.9%)	0.179
30-day mortality	0	1 (2.4%)	1

POPF, postoperative pancreatic fistula

(n=26 vs. n=9, $p=0.536$), pancreas texture (soft n=60 vs. n=31, $p=0.409$), and vein resection including the portal vein, superior mesenteric vein, or inferior vena cava (n=11 vs. n=4, $p=0.908$) was noted between the two groups.

Table 2 shows the postoperative outcomes in both groups. The mean operative time was shorter in the SGJ than in the HGJ (450.4±75.4 min vs. 397.1±66.5 min, $p<0.001$). The incidence of DGE in HGJ and SGJ was 12.2% and 14.6%, respectively; however, there was no significant difference (n=11 vs. n=6, $p=0.92$). Additionally, there were no significant differences in postoperative length of hospital stay (22.7±24.7 day vs. 19.7±15.4 day, $p=0.353$), bile leak (n=1 vs. n=0, $p=1$), chyle leak (n=6 vs. n=0, $p=0.214$), intra-abdominal fluid collection (n=5 vs. n=6, $p=0.162$), postoperative bleeding (n=1 vs. n=1, $p=1$), ileus (n=2 vs. n=1, $p=1$), POPF (n=16 vs. n=8, $p=1$), Clavien-Dindo classification (Grade I-II n=83 vs. n=37, $p=0.969$, Grade IIIa-IIIb n=5 vs. n=4, $p=0.611$, Grade IV-V n=1 vs. n=0, $p=1$), reoperation (n=0 vs. n=2, $p=0.179$), or 30-day mortality (n=0 vs. n=2, $p=0.179$) between both groups.

DISCUSSION

In this study, we compared the clinical outcomes between the stapler and handsewn anastomosis for gastrojejunostomy in patients who underwent PrPD. The operative time was significantly shorter in stapler group, while post-operative morbidity and mortality were no significantly different between the stapler and handsewn group.

There have been some attempts to use a stapler in pancreaticoduodenectomy, especially to reduce the incidence of DGE in duodenojejunal anastomosis using circular stapler in PPPD. Murata et al.¹⁴ reported that the incidence of primary DGE was significantly low in the stapled side-to-side gastrojejunostomy group for subtotal stomach-preserving pancreaticoduodenectomy. This was thought to be because the stapling anastomosis, prevented anastomotic edema or stenosis, and disruption in the blood supply, and allowed easier drainage of the food contents. According to a systematic review compared to conventional handsewn anastomosis, stapled anastomosis might be associated with a lower incidence of DGE after pan-

creaticoduodenectomy without increasing the risk of POPF or mortality.^{10,15} However, in some cases, the decrease in the reconstruction time was the same. A few other studies showed no difference in the incidence of DGE.^{11,16-18}

In these studies, most of the results after gastrojejunostomy were in patients who underwent Whipple's operation or PPPD, and there were few reports about the results after gastrojejunostomy using staples in PrPD. Moreover, in most studies, several surgical methods such as Whipple's operation, PPPD, and PrPD were analyzed together. In some reports, duodenojejunostomy and gastrojejunostomy were included and analyzed together in the stapled group; hence, so there might have been some other factors influencing the DGE, such as pylorospasm. However, we analyzed only cases of PrPD for the following reasons. First, many reports have described that the rate of DGE is lower in PrPD than PPPD.^{16,19-21} Second, the possibility of occurrence of DGE due to the spasm of the pyloric ring was excluded by excising the pyloric ring.²² Third, excision of the pyloric ring eases the linear stapled anastomotic procedure and enables a consistent surgical method. Furthermore, single surgical method was performed by a single surgeon in order to reduce the factors that might affect the results due to the differences in the surgical methods and to limit the technical variables. Therefore, it can be presumed that the outcomes of the two groups are highly reliable.

Although this result showed that there was no difference in the rate of DGE between the groups, the use of stapler has the advantage of reducing the operation time without any difference in the incidence of other complications. Moreover, the handsewn technique might differ between each surgeon. A stapler can ensure a more standardized anastomotic method with less variation between the surgeons.

Two patients in the stapled group required re-operation. The first patient was re-operated for pancreaticojejunostomy leakage, and the second patient was re-operated for postoperative bleeding. The bleeding was not at the staple line, and thus, it might not be associated with staple use. In the HGJ group, there were no cases that required re-operation; however, one patient died. The patient had an Eastern Cooperative Oncology Group (ECOG) score of 1 due to an underlying disease and died due to postoperative

pneumonia.

Our study has several limitations. First, this study was a retrospective analysis; therefore, the possibility of selection bias cannot be eliminated. In order to minimize this bias, we analyzed data for one surgical method performed by a single surgeon. Second, the different number of patients between the two groups might have affected the power of statistical evaluation. Third, when randomly checking the time of gastrojejunostomy, handsewn took 23-25 minutes and stapled was 9-10 minutes. However, the procedure time was not recorded for all patients. Fourth, this study reported only the short-term outcomes, further analysis is necessary to determine if there is any difference in the long-term outcome.

In conclusion, this study suggest that stapled GJ shortens reconstruction time during PrPD without affecting the incidence of DGE. Therefore, using a stapler for the GJ is feasible and safe technique.

CONFLICT OF INTEREST

The authors have no potential conflicts of interest to disclose.

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AUTHOR CONTRIBUTIONS

Design: YHH. Data curation: HJK, BGC. Statistical analysis: YHL. Writing - original draft: SHL. Writing review & editing: YHH.

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