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Effectiveness of Zero-Angle Gastrojejunostomy Anastomosis Technique Applied to Pancreaticoduodenectomy on Delayed Gastric Emptying

Pankreatikoduodenektomide Sıfır Açılı ile Yapılan Gastrojejunostomi Anastomoz Tekniğinin Mide Boşalım Üzerine Etkinliği

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ABSTRACT

Objective: This study aims to investigate the effectiveness of the gastrojejunostomy anastomosis method performed at zero angle in pancreaticoduodenectomy in reducing delayed gastric emptying (DGE).

Method: Patients who underwent a pancreaticoduodenectomy between January 2014 and July 2017 (n=57) (Group 1) and those who underwent between August 2017 and January 2020 (n=90) (Group 2) were included in this study in two groups. There were patients who consecutively underwent anastomosis with irregular angles before August 2017. Then, gastrojejunostomy was applied at zero angle. The patients were evaluated in terms of age, gender, duration of surgery, preoperative blood loss, wound site infection, postoperative bleeding, gastric emptying difficulty, American Society of Anesthesiology (ASA) score, body mass index (BMI), pancreatic fistula, and the length of hospital stay.

Results: A total of 147 patients were included in the study. It was shown that 14.3% of the patients had DGE. DGE was observed at a rate of 24.6% with 14 patients in Group 1 and a rate of 7.8% with 7 patients in Group 2 (p=0.019). There was no statistically significant difference in the other features of the patients.

Conclusion: Gastrojejunostomy performed with zero angle and one-third of resection causes significantly less DGE when compared with irregular methods.

Keywords: Blumgart anastomosis, delayed gastric emptying, pancreatic fistula, pancreaticoduodenectomy

Öz

Amaç: Bu çalışmada pankreatikoduodenektomide sıfır açılı tekniği ile yapılan gastrojejunostomi anastomoz tekniğinin mide boşalım güçlüğünü azaltmadaki etkinliğini araştırmayı hedefledik.

Yöntem: Bu çalışmaya Ocak 2014-Temmuz 2017 tarihleri arasında pankreatikoduodenektomi uyguladığımız hastalar n: 57 (Grup 1) ile Ağustos 2017-Ocak 2020 tarihleri arasında pankreatikoduodenektomi uyguladığımız hastalar n: 90 (Grup 2) çalışmaya iki grup olarak dahil edildi. Ağustos 2017 öncesi düzensiz açılı ile anastomoz yapılan hastalar ardışık olarak mevcuttu, sonrasında klinik kararı ile sıfır derece açılıyla gastrojejunostomi uygulanmaya başlandı. Hastalar yaş,cinsiyet,ameliyat

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süresi, preoperatif kan kaybı, yara yeri enfeksiyonu, postoperatif kanama, mide boşalım güçlüğü, ASA skoru, vücut kitle indeksi (VKİ), pankreatik fistül, hastanede yatış süresi açısından değerlendirildi.

Bulgular: Toplam 147 hasta çalışmaya dahil edildi. Tüm hastalar incelendiğinde %16,6 oranında mide boşalım güçlüğü izlendi. İki grup karşılaştırıldığında. Grup 1'de 14 hastada %24,5 grup ikide ise 7 hastada %7,77 oranında mide boşalım güçlüğü izlendi ($p=0,034$). Hastalar yaş, cinsiyet, ameliyat süresi, preoperatif kan kaybı, yara yeri enfeksiyonu, postoperatif kanama açısından değerlendirildiğinde iki grup arasında anlamlı fark olmamakla beraber pankreatik fistül, hastanede yatış süresi açısından iki grup arasında anlamlı fark vardı.

Sonuç: Sıfır derece açılı ve 1/3 oranında rezeksiyon ile yapılan gastrojejunostomi düzensiz teknikler ile karşılaştırıldığında anlamlı olarak daha az mide boşalım güçlüğüne sebep olmaktadır.

Anahtar kelimeler: Blumgart anastomoz, mide boşalım güçlüğü, pankreatik fistül, pankretikoduodenektomi

INTRODUCTION

Although the development of surgical techniques for the pancreas, intensive care facilities, determination of patient selection criteria, and multidisciplinary approaches have reduced mortality rates to 1–3% after pancreaticoduodenectomy (PD) especially in high-volume centers, morbidity rates remain high around 30–60%.^[1–3] Although postoperative pancreatic fistula (POPF) seems to be one of the most important causes of morbidity, delayed gastric emptying (DGE) is a considerable cause of morbidity ranging from 6% to 57%.^[4–8]

There is no clear consensus in the literature regarding the effect of the surgical method on DGE. The present study aims to examine the effectiveness of gastrojejunostomy anastomosis performed at zero angle in PD cases in reducing DGE.

METHOD

In this study, the data of 151 patients who underwent a PD between January 2014 and September 2019 were analyzed retrospectively. A total of four patients whose clinical demographic data were missing were not compatible with the treatment and could not be followed up, and therefore they were excluded from the study. Patients who underwent PD between January 2014 and July 2017 ($n=57$) (Group 1) and patients who underwent PD between August 2017 and January 2020 ($n=90$) (Group 2) were included in this study in two groups.

All patients were preoperatively evaluated at the multidisciplinary hepatobiliary committee and were taken into operation after obtaining informed consent forms. All operations were performed by a surgical team specialized in hepatopancreatobiliary surgery.

Pancreaticojejunostomy anastomoses after resection were performed using the modified Blumgart method.^[9] Hepaticojejunostomies, however, were performed retrocolically with an end-to-side single row of 4/0 PDS sutures. While gastrojejunostomy anastomosis was performed without any specific an-

gle ratio and gastric resection amount measurement in Group 1, it was performed anticolically with zero angle in Group 2.

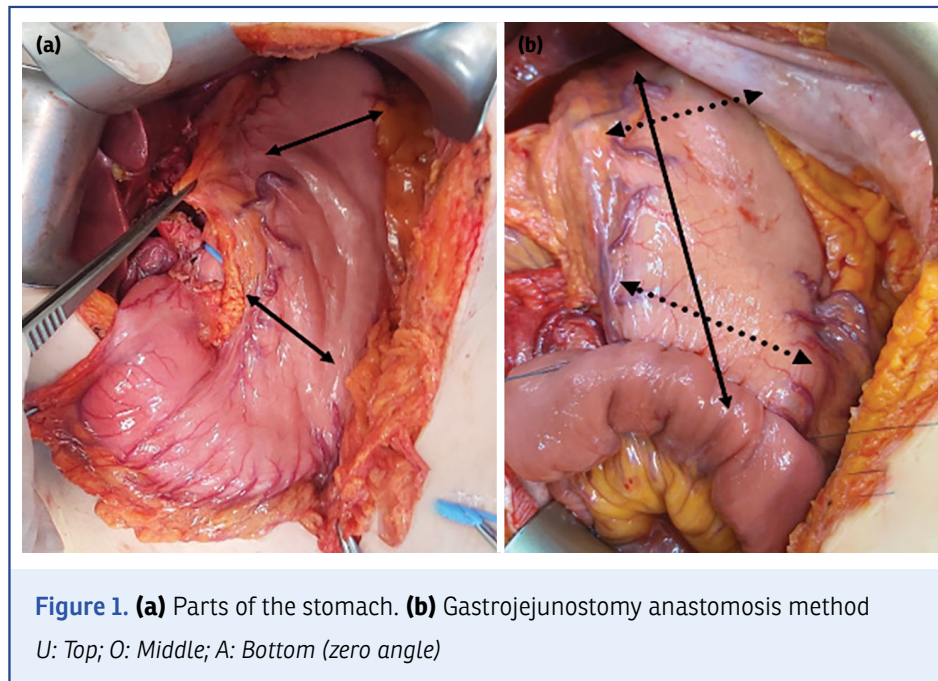
Gastrojejunostomy: The stomach was divided into three equal parts as in the Japanese Gastric Cancer guide, and the distal one-third part was resected (Fig. 1a).^[10] The stapler line was closed. The anastomosis was applied at the 60th cm of the jejunum loop parallel to the 5-cm length stapler line (0°) based on the large curvature of the antecolic area 1 cm proximal to the stapler line. A double anastomosis line was made (Fig. 1b).

Demographic information of the patients such as age, gender, body mass index (BMI), ASA scores, and comorbidities was recorded. Cases that underwent vascular reconstruction during the PD were evaluated. Tumor types, operation times, needs for reoperation, mortality rates, and lengths of hospital stay were recorded. Vascular reconstructions were performed with primary repair in the wedge resection of the portal vein, with end-to-end anastomosis in portal vein resections less than 3 cm and with autologous vein or Gore-Tex grafts in resections larger than 3 cm. Arterial reconstruction was not performed. The single-row suture method was used with 6/0 prolene in anastomoses. A preoperative nasogastric catheter was applied in all patients, and it was removed on the first postoperative day.

Diagnosis and Definitions

The term DGE was first used by Warshaw and Torchiana.^[11] DGE is a clinical condition in which there is functional gastroparesis without mechanical obstruction. DGE was defined and staged by the International Study Group for Pancreatic Surgery (ISGPS) in 2007 to ensure complete consensus in the literature.^[5]

The operation time was evaluated as the time (minutes) elapsed from the skin incision to the skin closure. Postoperative complications (wound site infection, bleeding, intra-abdominal abscess, pancreatic fistula, and DGE) were recorded. Wound site infection was defined as edema, redness in the incision area,



or purulent discharge from the incision within the postoperative 30 days. The diagnosis of the intra-abdominal abscess was made by computed tomography after clinical suspicion. Drain and serum amylase values were observed in all patients in the postoperative third and fifth days. POPF was classified as Biochemical leak, Grade B, and Grade C as defined by the ISGPS.^[12] DGE situations were questioned in patients and grouped as Grades A, B, and C as defined by the ISGPS (Table 1).^[5]

Statistical Analysis

Number Cruncher Statistical System (NCSS) 2007 (Kaysville, Utah, USA) program was used for statistical analysis. Descriptive statistical methods (mean, standard deviation, median, frequency, ratio, minimum, and maximum) were used when evaluating the study data. The suitability of quantitative data for normal distribution was tested by Kolmogorov-Smirnov, Shapiro-Wilk test, and graphical evaluations. Student's t-test was used to compare two groups of normally distributed quantitative data, and Mann-Whitney U test was used

for two-group comparisons of non-normally distributed data. Comparison of qualitative data, Pearson's chi-squared test, Fisher-Freeman-Halton exact test, and Fisher's exact test was performed. Significance was evaluated at the level of $p < 0.05$.

RESULTS

The data from 147 patients were examined within the scope of the study. Of the patients, 41.5% were females ($n=61$) and 58.5% were males ($n=71$), and the mean age was 64.48 ± 10 . The patients were divided into two groups according to the gastrojejunostomy anastomosis method. The age and gender distributions of the cases were not statistically significant according to the groups ($p > 0.05$). There was no significant difference between the groups in terms of ASA scores and BMI values ($p > 0.05$). When comorbidities were examined (DM, HT, COPD, CVA, CRF, CAH), there was no significant difference between the groups ($p > 0.05$). The demographic data of the patients are shown in Table 2.

Table 1. International study group for pancreatic surgery DGE classification^[5]

Grade	Nasogastric tube requirement	Solid diet intolerance duration	Vomiting/gastric dilatation	Prokinetic use
A	Reattachment after 4–7 days or PO 3 rd day	7	+/-	+/-
B	Reattachment after 8–14 days or PO 7 th day	14	+	+
C	Reattachment after >14 days or >PO 14 th day	21	+	+

DGE: Delayed gastric emptying; PO: Postoperative

Table 2. Evaluation of demographic features by groups

	Total (n=147) n (%)	Group 1 (irregular angle) (n=57, 38.8%) n (%)	Group 2 (zero angle) (n=90, 61.2%) n (%)	p
Age (years)				
Min-max (median)	34–79 (67)	34–79 (67)	38–78 (67)	0.413 ^a
Mean±SD	64.48±10.00	63.63±11.06	65.02±9.30	
<55 years	21 (14.3)	11 (19.3)	10 (11.1)	
55–64 years	39 (26.5)	11 (19.3)	28 (31.1)	
≥65 years	87 (59.2)	35 (61.4)	52 (57.8)	
Gender				
Female	61 (41.5)	24 (42.1)	37 (41.1)	0.905 ^b
Male	86 (58.5)	33 (57.9)	53 (58.9)	
BMI (kg/m ²)				
Min-max (median)	18–39 (27)	19–38 (27)	18–39 (26)	0.116 ^a
Mean±SD	26.92±4.15	27.60±4.33	26.49±4.01	
Normal weight	44 (29.9)	13 (22.8)	31 (34.4)	
Over weight	68 (46.3)	27 (47.4)	41 (45.6)	
Obese	35 (23.8)	17 (29.8)	18 (20.0)	
Comorbidities				
–	62 (42.2)	26 (45.6)	36 (40.0)	0.502 ^b
+	85 (57.8)	31 (54.4)	54 (60.0)	
Comorbidities ^c				
DM	25 (17.0)	7 (12.3)	18 (20.0)	0.225 ^b
HT	23 (15.6)	7 (12.3)	16 (17.8)	0.371 ^b
CAD	30 (20.4)	11 (19.3)	19 (21.1)	0.790 ^b
COPD	9 (6.1)	3 (5.3)	6 (6.7)	1.000 ^d
CVD	9 (6.1)	4 (7.0)	5 (5.6)	0.735 ^d
CKF	6 (4.1)	3 (5.3)	3 (3.3)	0.677 ^d
ASA				
ASA1	8 (5.4)	3 (5.3)	5 (5.6)	0.993 ^e
ASA2	77 (52.4)	29 (50.9)	48 (53.3)	
ASA3	34 (23.1)	14 (24.6)	20 (22.2)	
ASA3 ICU	28 (19.0)	11 (19.3)	17 (18.9)	

^a: Student's t-test; ^b: Pearson's chi-squared test; ^c: Multiple diseases are seen; ^d: Fisher's exact test; ^e: Fisher-Freeman-Halton exact test. DM: Diabetes mellitus; HT: Hypertension; CAD: Coronary artery disease; COPD: Chronic obstructive pulmonary disease; CVD: Cerebrovascular disease; CKF: Chronic kidney failure; ASA: American Society of Anesthesiology; ICU: Intensive care unit

When the duration of the surgery was examined, there was no significant difference between the groups ($p>0.05$). The length of the hospital stay was found to be statistically significantly lower in Group 2 (zero angle) ($p=0.001$, $p<0.05$) (Table 3).

Vascular reconstruction was applied to 5 (8.8%) patients in Group 1 (irregular angle) and 10 (11.1%) patients in Group 2 (zero angle), while blood transfusion was required in 8 (14%) patients in Group 1 and 15 (16.7%) patients in Group 2 in the postoperative period. There was no significant difference be-

tween the groups in terms of vascular reconstruction, blood transfusion, bleeding, intra-abdominal abscess, wound site infection, and reoperation ($p>0.05$).

When postoperative mortality rates were evaluated, there was no significant difference between the groups ($p>0.05$) (Table 4).

In Group 1, 37 (64.9%) patients had not developed POPF, while 8 (14%) patients had a biochemical leak, 8 (14%) patients had Grade B, and 4 (7%) patients had Grade C POPF. In Group 2, 73 (81.1%) patients had not developed POPF,

Table 3. Duration of surgery and length of hospital stay of the groups

	Total (n=147)	Group 1 (irregular angle) (n=57)	Group 2 (zero angle) (n=90)	p
Duration of surgery (min)				
Min-max (median)	140–355 (220)	140–335 (205)	155–355 (220)	0.082 ^a
Mean±SD	220.04±39.22	212.46±46.09	224.84±33.57	
Length of hospital stay (day)				
Min-max (median)	5–37 (9)	8–37 (14)	5–23 (8)	0.001 ^{b,**}
Mean±SD	11.50±6.09	16.00±6.83	8.64±3.18	

^a: Student's t-test; ^b: Mann-Whitney U test; **: p<0.01.

Table 4. Evaluations by groups

	Total (n=147) n (%)	Group 1 (irregular angle) (n=57) n (%)	Group 2 (zero angle) (n=90) n (%)	p
Blood transfusion				
None	124 (84.4)	49 (86)	75 (83.3)	0.669 ^a
Yes	23 (15.6)	8 (14)	15 (16.7)	
Vascular reconstruction				
None	132 (89.8)	52 (91.2)	80 (88.9)	0.648 ^a
Yes	15 (10.2)	5 (8.8)	10 (11.1)	
Bleeding				
None	134 (91.2)	51 (89.5)	83 (92.2)	0.567 ^a
Yes	13 (8.8)	6 (10.5)	7 (7.8)	
Wound site infection				
None	135 (91.8)	51 (89.5)	84 (93.3)	0.538 ^b
Yes	12 (8.2)	6 (10.5)	6 (6.7)	
Intra-abdominal abscess				
None	133 (90.5)	50 (87.7)	83 (92.2)	0.365 ^a
Yes	14 (9.5)	7 (12.3)	7 (7.8)	
Reoperation				
None	141 (95.9)	54 (94.7)	87 (96.7)	0.677 ^b
Yes	6 (4.1)	3 (5.3)	3 (3.3)	
Mortality				
None	138 (93.9)	52 (91.2)	86 (95.6)	0.310 ^b
Yes	9 (6.1)	5 (8.8)	4 (4.4)	

^a: Pearson's chi-squared test; ^b: Fisher's exact test.

while 10 (11.1%) patients had Grade A, 6 (6.7%) patients had Grade B, and 1 (1.1%) patient had Grade C POPF. When the groups were compared, there was no significant difference between the two groups in terms of POPF (p=0.071). The DGE was not observed in 43 (75.4%) patients in Group 1 and 83 (92.2%) patients in Group 2. However, in Group 1, 9 (15.8%) patients had Grade A, 4 (7%) patients had Grade

B, and 1 (1.8%) patient had Grade C DGE, while in Group 2, Grade A DGE was observed in 5 (5.6%) patients and Grade B in 2 (2.2%) patients. None of the patients in Group 2 had Grade C gastric emptying difficulties. When the groups were compared, it was seen that there was a statistically significantly lower number of DGE in Group 2 (p=0.019, p<0.05) (Table 5).

Table 5. Evaluation of POPF and DGE levels according to groups

	Total (n=147) n (%)	Group 1 (irregular angle) (n=57) n (%)	Group 2 (zero angle) (n=90) n (%)	p
POPF				
None	110 (74.8)	37 (64.9)	73 (81.1)	0.071 ^a
Biochemical leak	18 (12.2)	8 (14.0)	10 (11.1)	
Grade B	14 (9.5)	8 (14)	6 (6.7)	
Grade C	5 (3.4)	4 (7)	1 (1.1)	
Delayed gastric emptying				
None	126 (85.7)	43 (75.4)	83 (92.2)	0.019 ^{a,*}
Grade A	14 (9.5)	9 (15.8)	5 (5.6)	
Grade B	6 (4.1)	4 (7.0)	2 (2.2)	
Grade C	1 (0.7)	1 (1.8)	0 (0)	

^a: Fisher-Freeman-Halton exact test; ^{*}: p<0.05. POPF: Postoperative pancreatic fistula; DGE: Delayed gastric emptying

DISCUSSION

DGE usually occurs because of other complications of PD, such as POPF and intra-abdominal abscesses.^[13,14] DGE can also be seen without any intra-abdominal complications. DGE may increase morbidity and even mortality and negatively affect the quality of life of the patients. It increases the duration of hospital stay and cost. It may cause recurrent hospitalization and delayed adjuvant therapy.^[3,15-17]

Although its mechanism is still not completely clear, the width of gastric resection, loss of pylorus, loss of gastrointestinal neural network, diabetes, local ischemia, and loss of gastrointestinal hormone (motilin) can be listed among the causes of DGE.^[15,18,19] Male gender, smoking, and increased preoperative blood loss may be associated with the incidence of DGE as the patient-induced factor.^[13]

The present study revealed the effectiveness of the zero-angle method in terms of DGE in gastrojejunostomy anastomosis performed after PD.

When the method used was examined, it was observed that one-third of the stomach was resected and the pylorus was not preserved. As described by Traverso and Longmire^[20] first, pylorus preservative pancreaticoduodenectomy (PPPD) aimed to reduce the high incidence of DGE by maintaining the nerve innervation of the pylorus. Although many surgeons prefer this method because of its positive results,^[21] meta-analyses and prospective studies were not able to prove the superiority of this method in DGE.^[21-24] The subtotal gastric preserving pancreaticoduodenectomy (SSPPD), a method in which 90% of the stomach is preserved and only

the pyloric ring is resected, was described in the late 1990s. With this method, a larger gastric outlet was achieved compared to PPPD, and it was aimed to prevent DGE by protecting the neural network and vascular structure of the prepyloric area.^[23,25,26] Although publications comparing SSPPD with PPPD indicate that there is less incidence of DGE in SSPPD, there is no consensus on the subject yet.^[23,26-28]

When the method used in the present study was examined, it was found that gastrojejunostomy anastomosis was applied antecolically. In previous studies, gastrojejunostomy methods on gastric emptying were examined, and antecolic (AC) and retrocolic (RC) anastomoses were compared. According to the meta-analyses on retrospective cohort analysis and randomized clinical trials, the risk of DGE incidence is lower in AC anastomosis.^[29,30]

Another important issue related to this method used in the present study is the application of gastrojejunostomy anastomosis at zero angle. Masui et al.,^[31] found that the angle between gastric and efferent jejunum loop may be effective on postoperative DGE in the gastrojejunostomy anastomosis after distal gastrectomy, and DGE is significantly lower in anastomosis performed at zero angle parallel to the vertebra line. Studying the effect of gastrojejunostomy anastomosis angle on DGE after robotic PD, Jung et al.,^[32] showed that the incidence of DGE was significantly lower in anastomoses where the angle between the stomach and the efferent loop was less than 30°.

The retrospective design of the present study is its most important limitation. In the second group, besides gastrojeju-

nostomy, the surgical method to be a standard in pancreaticojejunostomy and hepaticojejunostomy decreased gastric emptying rates and contributed to the success of the method used. There is no statistical difference in pancreatic fistula rates, and the statistical difference between DGE incidences reveals the success of the method used.

CONCLUSION

In pancreatic surgery, there is a consensus associated with the success brought by the standardization of the anastomosis method. Accordingly, it is seen that antrectomy and zero-angle gastrojejunostomy anastomosis can be successfully applied in a way to reduce the risk of gastric emptying within certain principles.

Disclosures

Ethics Committee Approval: The study was approved by the Bakirköy Dr. Sadi Konuk Training and Research Hospital Clinical Research Ethics Committee (No: 2020-03-18, Date: 03/02/2020).

Informed Consent: Written informed consent was obtained from all patients.

Peer-review: Externally peer reviewed.

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REFERENCES

1. Winter JM, Brennan MF, Tang LH, D'Angelica MI, Dematteo RP, Fong Y, et al. Survival after resection of pancreatic adenocarcinoma: Results from a single institution over three decades. *Ann Surg Oncol* 2012;19:169–75.
2. Kneuert PJ, Pitt HA, Bilimoria KY, Smiley JP, Cohen ME, Ko CY, et al. Risk of morbidity and mortality following hepato-pancreato-biliary surgery. *J Gastrointest Surg* 2012;16:1727–35. [\[CrossRef\]](#)
3. Ahmad SA, Edwards MJ, Sutton JM, Grewal SS, Hanseman DJ, Maitel SK, et al. Factors influencing readmission after pancreaticoduodenectomy: A multi-institutional study of 1302 patients. *Ann Surg* 2012;256:529–37. [\[CrossRef\]](#)
4. Büchler MW, Wagner M, Schmied BM, Uhl W, Friess H, Z'graggen K. Changes in morbidity after pancreatic resection: Toward the end of completion pancreatectomy. *Arch Surg* 2003;138:1310–4; discussion 1315. [\[CrossRef\]](#)
5. Wente MN, Bassi C, Dervenis C, Fingerhut A, Gouma DJ, Izbicki JR, et al. Delayed gastric emptying (DGE) after pancreatic surgery: A suggested definition by the international study group of pancreatic surgery (ISGPS). *Surgery* 2007;142:761–8. [\[CrossRef\]](#)
6. Cameron JL, He J. Two thousand consecutive pancreaticoduodenectomies. *J Am Coll Surg* 2015;220:530–6. [\[CrossRef\]](#)
7. Yamaguchi K, Tanaka M, Chijiwa K, Nagakawa T, Imamura M, Takada T. Early and late complications of pylorus-preserving pancreaticoduodenectomy in Japan 1998. *J Hepatobiliary Pancreat Surg* 1999;6:303–11.
8. Richter A, Niedergethmann M, Sturm JW, Lorenz D, Post S, Trede M. Long-term results of partial pancreaticoduodenectomy for ductal adenocarcinoma of the pancreatic head: 25-year experience. *World J Surg* 2003;27:324–9. [\[CrossRef\]](#)
9. Fujii T, Sugimoto H, Yamada S, Kanda M, Suenaga M, Takami H, et al. Modified Blumgart anastomosis for pancreaticojejunostomy: Technical improvement in matched historical control study. *J Gastrointest Surg* 2014;18:1108–15. [\[CrossRef\]](#)
10. Japanese Gastric Cancer Association. Japanese classification of gastric carcinoma: 3rd English edition. *Gastric Cancer* 2011;14:101–12. [\[CrossRef\]](#)
11. Warshaw AL, Torchiana DL. Delayed gastric emptying after pylorus-preserving pancreaticoduodenectomy. *Surg Gynecol Obstet* 1985;160:1–4.
12. Bassi C, Marchegiani G, Dervenis C, Sarr M, Abu Hilal M, Adham M, et al. The 2016 update of the international study group (ISGPS) definition and grading of postoperative pancreatic fistula: 11 Years After. *Surgery* 2017;161:584–91. [\[CrossRef\]](#)
13. Eisenberg JD, Rosato EL, Lavu H, Yeo CJ, Winter JM. Delayed Gastric Emptying After Pancreaticoduodenectomy: An Analysis of Risk Factors and Cost. *J Gastrointest Surg* 2015;19:1572–80. [\[CrossRef\]](#)
14. Park JS, Hwang HK, Kim JK, Cho SI, Yoon DS, Lee WJ, et al. Clinical validation and risk factors for delayed gastric emptying based on the international study group of pancreatic surgery (ISGPS) classification. *Surgery* 2009;146:882–7. [\[CrossRef\]](#)
15. Tanaka M, Sarr MG. Role of the duodenum in the control of canine gastrointestinal motility. *Gastroenterology* 1988;94:622–9. [\[CrossRef\]](#)
16. Dong K, Yu XJ, Li B, Wen EG, Xiong W, Guan QL. Advances in mechanisms of postsurgical gastroparesis syndrome and its diagnosis and treatment. *Chin J Dig Dis* 2006;7:76–82. [\[CrossRef\]](#)
17. Bhatia S, Miller RC, Haddock MG, Donohue JH, Krishnan S. Adjuvant therapy for ampullary carcinomas: The Mayo clinic experience. *Int J Radiat Oncol Biol Phys* 2006;66:514–9. [\[CrossRef\]](#)
18. Qu H, Sun GR, Zhou SQ, He QS. Clinical risk factors of delayed gastric emptying in patients after pancreaticoduodenectomy: A systematic review and meta-analysis. *Eur J Surg Oncol* 2013;39:213–23. [\[CrossRef\]](#)
19. Park YC, Kim SW, Jang JY, Ahn YJ, Park YH. Factors influencing delayed gastric emptying after pylorus-preserving pancreaticoduodenectomy. *J Am Coll Surg* 2003;196:859–65. [\[CrossRef\]](#)
20. Traverso LW, Longmire WP Jr. Preservation of the pylorus in pancreaticoduodenectomy. *Surg Gynecol Obstet* 1978;146:959–62.
21. Seiler CA, Wagner M, Bachmann T, Redaelli CA, Schmied B, Uhl W, et al. Randomized clinical trial of pylorus preserving duodenopancreatectomy versus classical whipple resection-long term results. *Br J Surg* 2005;92:547–56. [\[CrossRef\]](#)
22. Tran KT, Smeenk HG, van Eijck CH, Kazemier G, Hop WC, Greve JW, et al. Pylorus preserving pancreaticoduodenectomy versus standard Whipple procedure: A prospective, randomized, multicenter analysis of 170 patients with pancreatic and periampullary tumors. *Ann Surg* 2004;240:738–45. [\[CrossRef\]](#)
23. Akizuki E, Kimura Y, Nobuoka T, Imamura M, Nishidate T, Mizuguchi T, et al. Prospective nonrandomized comparison between pylorus-preserving and subtotal stomach-preserving pancreaticoduodenectomy from the perspectives of DGE occurrence and postoperative digestive functions. *J Gastrointest Surg* 2008;12:1185–92. [\[CrossRef\]](#)

24. Wu W, Hong X, Fu L, Liu S, You L, Zhou L, et al. The effect of pylorus removal on delayed gastric emptying after pancreaticoduodenectomy: A meta-analysis of 2,599 patients. *PLoS One* 2014;9:e108380. [\[CrossRef\]](#)
25. Hanna MM, Gadde R, Tamariz L, Allen CJ, Meizoso JP, Sleeman D, et al. Delayed gastric emptying after pancreaticoduodenectomy: Is subtotal stomach preserving better or pylorus preserving? *J Gastrointest Surg* 2015;19:1542–52. [\[CrossRef\]](#)
26. Hayashibe A, Kameyama M, Shinbo M, Makimoto S. The surgical procedure and clinical results of subtotal stomach preserving pancreaticoduodenectomy (SSPPD) in comparison with pylorus preserving pancreaticoduodenectomy (PPPD). *J Surg Oncol* 2007;95:106–9. [\[CrossRef\]](#)
27. Nanashima A, Abo T, Sumida Y, Tobinaga S, Nonaka T, Takeshita H, et al. Comparison of results between pylorus-preserving pancreaticoduodenectomy and subtotal stomach-preserving pancreaticoduodenectomy: Report at a single cancer institute. *Hepatogastroenterology* 2013;60:1182–8.
28. Matsumoto I, Shinzeki M, Asari S, Goto T, Shirakawa S, Ajiki T, et al. A prospective randomized comparison between pylorus- and subtotal stomach-preserving pancreaticoduodenectomy on postoperative delayed gastric emptying occurrence and long-term nutritional status. *J Surg Oncol* 2014;109:690–6. [\[CrossRef\]](#)
29. Tamandl D, Sahara K, Prucker J, Schmid R, Holst JJ, Miholic J, et al. Impact of the reconstruction method on delayed gastric emptying after pylorus-preserving pancreaticoduodenectomy: A prospective randomized study. *World J Surg* 2014;38:465–75. [\[CrossRef\]](#)
30. Imamura N, Chijiwa K, Ohuchida J, Hiyoshi M, Nagano M, Otani K, et al. Prospective randomized clinical trial of a change in gastric emptying and nutritional status after a pylorus-preserving pancreaticoduodenectomy: Comparison between an antecolic and a vertical retrocolic duodenojejunostomy. *HPB (Oxford)* 2014;16:384–94. [\[CrossRef\]](#)
31. Masui T, Kubota T, Nakanishi Y, Aoki K, Sugimoto S, Takamura M, et al. The flow angle beneath the gastrojejunostomy predicts delayed gastric emptying in Roux-en-Y reconstruction after distal gastrectomy. *Gastric Cancer* 2012;15:281–6. [\[CrossRef\]](#)
32. Jung JP, Zenati MS, Dhir M, Zureikat AH, Zeh HJ, Simmons RL, et al. Use of video review to investigate technical factors that may be associated with delayed gastric emptying after pancreaticoduodenectomy. *JAMA Surg* 2018;153:918–27. [\[CrossRef\]](#)