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Effect of the Gastrojejunostomy Position on the Postoperative Amount of Oral Intake in Pancreaticoduodenectomy

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Keywords
Pancreaticoduodenectomy · Delayed gastric emptying · Gastrojejunostomy

Abstract
Introduction: We investigated the effect of the gastrojejunostomy position on the postoperative oral intake in patients who have undergone pancreaticoduodenectomy (PD). ***Methods:*** We investigated 119 patients who underwent PD between June 2013 and December 2019 and examined the effect of the horizontal and vertical distance rates of the gastrojejunostomy position on the postoperative oral intake. The patients were categorized as having poor or good oral intake based on whether their intake was up to half the required calorie intake. ***Results:*** There were significant differences in the number of cases with grade B or C postoperative pancreatic fistula (good, 20.3% vs. poor, 60.0%; p < 0.001), horizontal distance rate (good, 0.57 vs. poor, 0.48; p = 0.02), and postoperative hospitalization period (good, 15 vs. poor, 35 days; p < 0.001). However, there was no significant difference in the vertical distance rate (good, 0.67 vs. poor, 0.71; p = 0.22). The horizontal distance rate was the independent risk factor for postoperative poor oral intake at 2–3 weeks (risk ratio, 3.69; 95% CI: 1.48–9.20). ***Discussion:*** The oral intake was greater in patients whose gastrojejunostomy position in PD was farther from the median, suggesting the necessity of intraoperative placement of the gastrojejunostomy position as far from the median as possible.

Introduction

Pancreaticoduodenectomy (PD) is performed on benign and malignant lesions of the head of the pancreas, distal bile duct, and duodenum. Generally, among digestive surgical procedures, it is one of the most demanding procedures that require the highest level of surgical skills.

Although recent improvements in surgical procedures and the development of perioperative management have contributed to reducing the mortality rate to below 5% in PD, the incidence rate of postoperative complications (30–60%) remains relatively higher than that in other digestive surgery cases [1–8]. Some of the postoperative complications of PD include postoperative pancreatic fistula (POPF), intra-abdominal hemorrhage, intra-ab-

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dominal abscess, delayed gastric emptying (DGE), cholangitis, anastomotic ulcer, and gastrointestinal hemorrhage.

The most severe complication from the viewpoint of postoperative management is POPF-induced intra-abdominal hemorrhage or abscess, which may lead to mortality. DGE should also be a clinically important complication; although it does not directly lead to mortality, it causes a decline in the patient's postoperative quality of life or the elongation of the hospitalization period [9].

Some of the causes of DGE include the lack of a gastrointestinal hormone called motilin [10], ischemia near the gastric pylorus [11], and the secondary gastric motility disorder accompanying postoperative complications such as POPF or intra-abdominal abscess [12]. The definition of DGE has been slightly ambiguous in the past. The definition proposed in 2005 by the International Study Group of Pancreatic Surgery (ISGPS) has become acceptable worldwide [13]. The ISGPS definition of DGE is determined based on the period of gastric-tube insertion, the presence/absence of gastric tube reinsertion, period of inability to digest solid food, the presence/absence of vomiting; in short, it defines DGE as whether the patient condition requires postoperative fasting or not.

However, few studies have investigated decline in oral intake, which could be the preliminary stage of DGE. Akizuki et al. [14] reported in 2009 that the postoperative oral intake correlated with the DGE grade, indicating that patients with a small dietary intake had a longer hospitalization period than those with a larger dietary intake. The decline in postoperative oral intake would lead to a decline in the patient's quality of life, causing undernutrition and prolonged hospitalization. Therefore, it is mandatory to develop a new countermeasure to prevent a decrease in postoperative oral intake. This study focused on the correlation between the amount of oral intake and gastrojejunostomy position in patients who have undergone PD.

Materials and Methods

A total of 119 PD patients out of 132 treated from June 2013 to December 2019, excluding those who received tube feeding or required a long postoperative fasting period, were retrospectively investigated. The excluded patients included seven who underwent tube feeding by enterostomy, 1 case in which sigmoidectomy was performed simultaneously, 1 patient developed nonocclusive mesenteric ischemia at the early postoperative stage, 1 patient required postoperative reintubation due to aspiration pneumonia, 1 case of mortality at the early postoperative period due to *Aeromonas hydrophila* infection, 1 case in which reconstruction was performed by Billroth-I type reconstruction, and 1 case in which pancreaticogastrostomy was performed. There were no obvious cases of anastomotic stenosis during the period of this study.

Based on the average oral intake from the second to third weeks after surgery, these 119 patients were categorized into two groups: those with less than half of the required total energy expenditure (TEE) (poor oral intake group, $n = 40$) and those with more than half the TEE (good oral intake group, $n = 79$). The basal energy expenditure of the participants was measured using the Harris-Benedict equation [15]. The TEE is usually defined as basal energy expenditur × stress factor × activity factor [16]. At our hospital, the stress factor after PD is set to 1.2. This is based on the previous study measuring energy expenditure after PD [17]. In addition, since the amount of activity decreases after surgery, the activity factor is set to 1.2. According to the guidelines of the *Journal of Parenteral and Enteral Nutrition* and the European Society for Clinical Nutrition and Metabolism, it is recommended to add parenteral nutrition to satisfy the amount of energy if 50–60% of the required amount of energy cannot be taken orally within 7–10 days after starting oral intake [18, 19]. In this study, the abovementioned point is the reason why the poor oral intake group was defined as less than half of TEE.

The patient's background factors, blood test results, surgical factors, postoperative complications, and gastrojejunostomy positions of these groups were investigated and compared. The ISGPS definition was used to define DGE [13]. POPF was defined as proposed by the International Study Group of Pancreatic Fistula (ISGPF) [20]. The Center for Disease Control and Prevention guidelines were used to diagnose surgical site infection (SSI) [21]. Likewise, the Clavien-Dindo classification was used for other complications [22].

Operative Methods

All patients underwent antrectomy 4 cm proximal to the pylorus ring. Child reconstruction with Billroth-II or Roux-en-Y methods was performed. Gastrojejunostomy was performed via the antecolic route using stapled anastomosis in all cases. The opening of the anastomosis was at the posterior wall of the stomach, and side-to-side anastomosis was performed using a 60-mm Signia Stapling System (Medtronic Inc., Minneapolis, MN, USA). Pancreaticojejunostomy was performed using duct-to-mucosal anastomosis. An inner mucosal anastomosis was performed between the pancreatic duct and jejunal mucosa using 8 interrupted 5-0 Maxon sutures (Medtronic Inc.) regardless of duct size in all patients. Then, the outer layer of the end-to-side pancreaticojejunostomy between the pancreatic tissue and the jejunal serosa was constructed using interrupted sutures with 4-0 PDS-II sutures (Ethicon Inc., Somerville, NJ, USA) or the Blumgart anastomosis method [23] using 3-0 Monoflen (Alfresa Pharma, Osaka, Japan) to form a seromuscular envelope. A lost stent tube of 5-Fr size was placed in the anastomotic site of the pancreaticojejunostomy for patients with a main pancreatic duct diameter of 2 mm or less.

Postoperative Management

After the operation, second-generation cephem antibiotics were administered prophylactically for 3 days, and an intravenous proton pump inhibitor was administered for 2 weeks. None of the patients were given either somatostatin analogs or prokinetic agents, such as erythromycin. Two 19-Fr-sized J-VAC drains (Eth-

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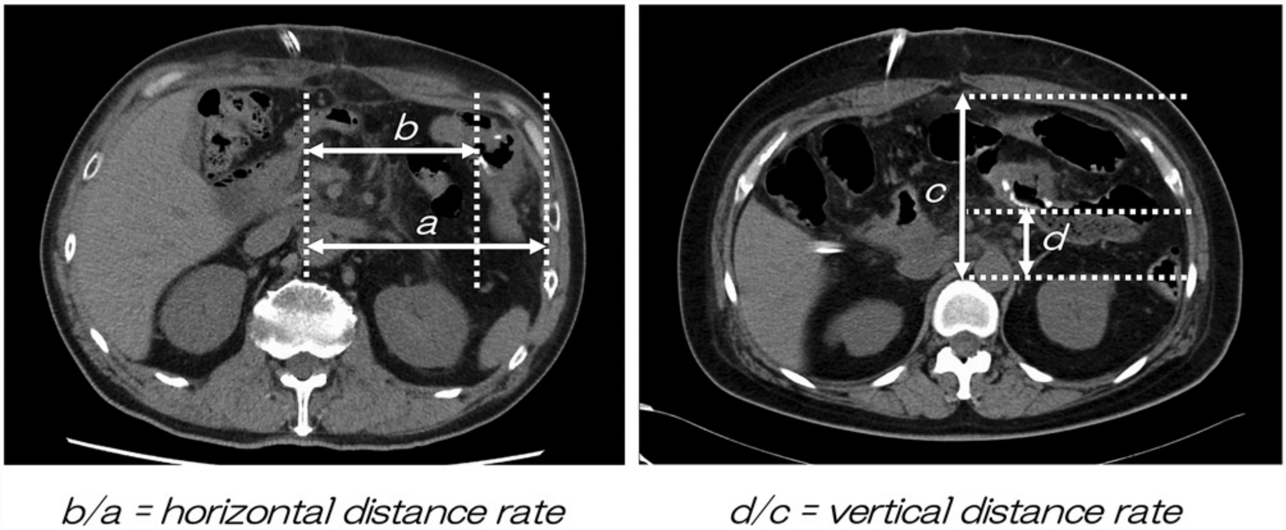

Fig. 1. Measurement of the gastrojejunostomy position. The gastrojejunostomy positions were measured using axial CT images taken on POD 5. The distance rate in the horizontal direction was calculated by dividing the distance from the median to the anastomosis by that from the median to the left side of the peritoneum (horizontal distance rate). In the vertical direction, the distance rate was obtained by dividing the distance from the spine to the anastomosis by that from the spine to the median of the peritoneum (vertical distance rate).

icon Inc.) were routinely placed around the pancreaticojejunostomy site and Morison space and connected to a closed drainage system. The drains were removed on postoperative day (POD) 5 in all patients if high drain amylase levels and bacterial contamination were absent. The nasogastric tube was removed on POD 1 when the drainage volume was less than 500 mL/day. If the drainage was more than 500 mL/day, the nasogastric tube was left in place until it decreased to less than 500 mL/day.

Measurement of Oral Intake

Oral intake commenced on POD 3, starting with a liquid diet, and changed to a normal solid diet on POD 7. The average amount of oral intake from the second to third weeks after surgery was measured by the nutrition support team. The nutrition support team measured each patient's daily oral intake since the initiation of oral intake and changed the menu accordingly to meet the patient's preferences.

Definition of the Gastrojejunostomy Position

The gastrojejunostomy positions were measured using axial computed tomography (CT) images obtained on POD 5. The distance rate in the horizontal direction was calculated by dividing the distance from the median to the anastomosis by that from the median to the left side peritoneum (horizontal distance rate). For the vertical direction, the distance rate was obtained by dividing the distance from the spine to the anastomosis by that from the spine to the median of the peritoneum (vertical distance rate) (Fig. 1).

Statistical Analysis

The age and body mass index of the patients were presented as mean ± standard deviation. Other continuous variables were expressed as median values and interquartile range. For the comparison between the two groups, either the χ^2 test or Fisher's exact test was used for nominal variables; continuous variables were analyzed using either Student's *t* test or Mann-Whitney U test. The cutoff values for continuous variables were selected using receiver operating characteristics curve analysis. Statistically significant variables in the univariate analysis were included in the multivariate logistic regression analysis. In all statistical analyses, p values <0.05 were considered statistically significant. All statistical analyses were performed using R statistical software version 4.0.2. (The R Foundation for Statistical Computing, Vienna, Austria; https://cran.r-project.org/bin/macosx/).

Results

Table 1 shows the results of the comparison between the good oral intake and poor oral intake groups. Patients' background factors, age, sex, body mass index, the presence/absence of diabetes, history of cerebral infarction, the presence/absence of preoperative chemotherapy, the presence/absence of preoperative biliary drainage, and performance status of the American Society of Anesthe-

Table 1. Comparison results of the good oral intake group and the poor oral intake group

	Good oral intake group (*n* = 79)	Poor oral intake group (*n* = 40)	*p* value
Age, years	66.9±11.0	69.5±9.5	0.219
Sex, *n* (%)			
Men	48 (60.8)	23 (57.5)	0.844
Women	31 (39.2)	17 (42.5)	
BMI	22.2±3.9	22.3±3.4	0.874
DM, *n* (%)	25 (31.6)	12 (30.0)	>0.999
History of cerebral infarction, *n* (%)	6 (7.6)	3 (7.5)	>0.999
Preoperative chemotherapy, *n* (%)	14 (17.7)	3 (7.5)	0.171
Preoperative biliary drainage, *n* (%)	32 (40.5)	18 (45.0)	0.696
ASA performance status, *n* (%)			
I	11 (13.9)	8 (20.0)	0.396
II	56 (70.9)	29 (72.5)	
III	12 (15.2)	3 (7.5)	
IV	0 (0.0)	0 (0.0)	
Hb, g/dL	12.4 [11.1, 13.6]	12.3 [11.2, 13.6]	0.989
WBC, /μL	5,300 [4,300, 6,450]	6,000 [4,700, 6,900]	0.174
PLT, $\times 10^4$/μL	21.2 [17.5, 27.6]	22.7 [19.2, 28.1]	0.723
CRP, mg/dL	0.14 [0.06, 0.41]	0.17 [0.10, 0.55]	0.299
ALB, g/dL	3.7 [3.4, 3.9]	3.6 [3.4, 3.9]	0.411
AST, IU/L	23 [19, 34]	27 [19, 36]	0.284
ALT, IU/L	24 [17, 39]	23 [18, 47]	0.575
T-BIL, mg/dL	0.8 [0.6, 1.1]	0.8 [0.6, 1.2]	0.609
AMY, IU/L	73 [48, 115]	69 [51, 102]	0.822
eGFR, mL/min	72 [62, 86]	70 [59, 79]	0.362
Primary disease, *n* (%)			
Cancer	61 (77.2)	30 (75.0)	0.821
Benign	18 (22.8)	10 (25.0)	
Portal-vein resection, *n* (%)	20 (25.3)	9 (22.5)	0.823
Gastrojejunostomy, *n* (%)			
B-II	57 (72.2)	23 (57.5)	0.147
R-Y	22 (27.8)	17 (42.5)	
Pancreato-jejunostomy, *n* (%)			
Blumgart	71 (89.9)	32 (80.0)	0.16
Layered suture	8 (10.1)	8 (20.0)	
Operative time	457 [391, 517]	462 [402, 541]	0.478
Intraoperative bleeding	670 [361, 941]	691 [437, 1,281]	0.234
Soft pancreatic tissue, *n* (%)	35 (44.3)	25 (62.5)	0.081
DGE, *n* (%)	1 (1.2)	8 (20.0)	<0.001
CD grade ≥3, *n* (%)	21 (26.6)	28 (70.0)	<0.001
POPF grade ≥ B, *n* (%)	16 (20.3)	24 (60.0)	<0.001
Superficial incisional SSI, *n* (%)	5 (6.3)	5 (12.5)	0.301
Deep incisional SSI, *n* (%)	2 (2.5)	5 (12.5)	0.042
Organ/space SSI, *n* (%)	9 (11.4)	20 (50.0)	<0.001
Hospitalization, days	15 [12, 20]	35 [27, 47]	<0.001
Horizontal distance rate	0.57 [0.46, 0.67]	0.48 [0.38, 0.64]	0.022
Vertical distance rate	0.67 [0.54, 0.77]	0.71 [0.57, 0.80]	0.229

Age and BMI are expressed as mean±SD. Other data are expressed as median with 25th and 75th percentiles. BMI, body mass index; DM, diabetes mellitus; ASA, American Society of Anesthesiologists; Hb, hemoglobin; WBC, white blood count; PLT, platelet count; CRP, C-reactive protein; ALB, albumin; ALT, alanine aminotransferase; AST, aspartate aminotransferase; T-BIL, total bilirubin; AMY, amylase; eGFR, estimated glomerular filtration rate; B-II, Billroth-II reconstruction; R-Y, Roux-en-Y reconstruction; DGE, delayed gastric emptying; CD, Clavien-Dindo classification; POPF, postoperative pancreatic fistula; SSI, surgical site infection.

Table 2. Univariate and multivariate analysis for identifying independent factors contributing to poor oral intake

	Univariate analysis		Multivariate analysis	
	risk ratio (95% CI)	*p* value	risk ratio (95% CI)	*p* value
Age ≥69 years	2.10 (0.96–4.57)	0.063		
Sex (men)	0.87 (0.40–1.89)	0.73		
BMI ≥21.7 kg/m^2	0.93 (0.43–1.98)	0.84		
DM	0.93 (0.41–2.11)	0.86		
History of cerebral infarction	0.99 (0.23–4.17)	0.98		
Preoperative chemotherapy	0.38 (0.10–1.40)	0.14		
Preoperative biliary drainage	1.20 (0.56–2.59)	0.64		
ASA performance status ≥ III	0.45 (0.12–1.71)	0.24		
Hb ≤12.3 g/dL	1.13 (0.53–2.43)	0.75		
WBC ≥5,400/μL	1.79 (0.83–3.88)	0.14		
PLT <21.8 × 10^4/μL	0.84 (0.39–1.80)	0.65		
CRP ≥0.15 mg/dL	1.32 (0.62–2.83)	0.48		
ALB <3.6 g/dL	1.89 (0.87–4.12)	0.11		
AST ≥25 IU/L	1.46 (0.68–3.13)	0.33		
ALT ≥23 IU/L	0.93 (0.43–1.98)	0.84		
T-BIL ≥0.83 mg/dL	1.08 (0.50–2.31)	0.84		
AMY ≥70 IU/L	0.84 (0.39–1.80)	0.65		
eGFR <71 mL/min	1.19 (0.56–2.55)	0.65		
Primary disease (cancer)	0.89 (0.36–2.15)	0.79		
Portal-vein resection	0.86 (0.35–2.10)	0.74		
Gastrojejunostomy (R-Y)	1.92 (0.86–4.25)	0.11		
Pancreato-jejunostomy (Blumgart)	0.45 (0.16–1.31)	0.14		
Operation time ≥453 min	0.98 (0.46–2.09)	0.95		
Intraoperative bleeding ≥672 mL	1.19 (0.56–2.55)	0.65		
Soft pancreatic tissue	2.10 (0.96–4.57)	0.063		
CD grade ≥3	6.44 (2.78–14.90)	0.000014	2.95 (0.76–11.50)	0.12
POPF grade ≥ B	5.91 (2.56–13.60)	0.000032	1.13 (0.24–5.35)	0.88
Superficial incisional SSI	2.11 (0.57–7.78)	0.26		
Deep incisional SSI	5.50 (1.02–29.70)	0.048	1.92 (0.28–13.00)	0.5
Organ/space SSI	7.78 (3.07–19.70)	0.000016	3.54 (0.92–13.60)	0.067
Horizontal distance rate <0.5	3.44 (1.55–7.60)	0.0023	3.69 (1.48–9.20)	0.005
Vertical distance rate <0.5	0.56 (0.20–1.53)	0.26		

BMI, body mass index; DM, diabetes mellitus; ASA, American Society of Anesthesiologists; Hb, hemoglobin; WBC, white blood count; PLT, platelet count; CRP, C-reactive protein; ALB, albumin; ALT, alanine aminotransferase; AST, aspartate aminotransferase; T-BIL, total bilirubin; AMY, amylase; eGFR, estimated glomerular filtration rate; R-Y, Roux-en-Y reconstruction; CD, Clavien-Dindo classification; POPF, postoperative pancreatic fistula; SSI, surgical site infection.

siologists (ASA) were compared: there were no significant differences in all these factors. For the preoperative blood tests, hemoglobin, white blood count, platelet count, C-reactive protein, albumin, aspartate aminotransferase, alanine aminotransferase, total bilirubin, amylase, and estimated glomerular filtration rate, comparisons showed similar results in both groups.

Regarding surgical factors, the rate of malignant tumor operation with lymphadenectomy was similar between the good (77.2%) and poor oral intake (75.0%) groups. Likewise, the rate of cases requiring portal-vein reconstruction was similar in both groups. As for gastrojejunostomy factors, the rate of the Billroth-II method usage was higher in the good oral intake group, but the difference was insignificant (good, 72.2% vs. poor, 57.5%; $p = 0.147$). In the pancreaticojejunostomy factors, the rate of usage of the Blumgart anastomosis method was similar between the groups (good, 89.9% and poor, 80.0%). The soft pancreas rate was higher in the poor than in the good oral intake group, but the difference was not significant (poor, 62.5% vs. good, 44.3%; $p = 0.081$).

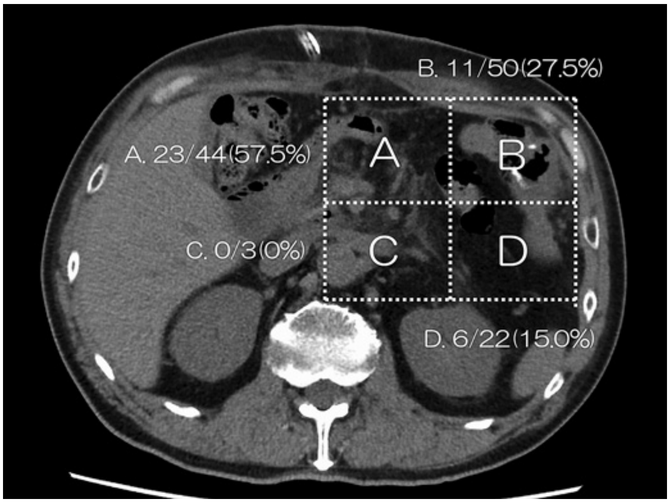

Fig. 2. Rate of poor oral intake according to the gastrojejunostomy position. The horizontal and vertical distance rates were divided by 0.5. In area A (horizontal <0.5, vertical ≥0.5), 23 out of 44 (57.5%) patients had poor oral intake. Likewise, 11 out of 50 cases (27.5%) in area B (horizontal ≥0.5, vertical ≥0.5) and six cases out of 22 (15.0%) in area D (horizontal ≥0.5, and vertical <0.5) were those with poor oral intake. Only three cases were categorized into area C (horizontal <0.5, vertical <0.5).

Regarding postoperative complications, the incidence rate of DGE showed a significant difference between the groups (good, 1.2% vs. poor, 20.0%; $p < 0.001$). The details of the DGE grade were grade A in 2 cases, grade B in 1 case, and grade C in 6 cases. In addition, the incidence rate of POPF of grade B and above was significantly higher in the poor oral intake group (good, 20.3% vs. poor, 60.0%; $p < 0.001$). Likewise, the rates of patients with Clavien-Dindo grade III and above, those with deep incisional SSI, and those with organ/space SSI were significantly higher in the poor oral intake group.

The average hospitalization period was 15 and 35 days in the good and poor oral intake groups, respectively, showing a significantly longer period in the latter group ($p < 0.001$). As for the comparison of the gastrojejunostomy positions, the horizontal distance rate was significantly lower in the poor oral intake group (good, 0.57 vs. poor, 0.48; $p = 0.022$), while the vertical distance rate was similar in both groups (Table 1).

A series of multivariate analyses were conducted to identify the independent risk factors contributing to poor oral intake. Factors confirmed to be significant in the univariate analyses were postoperative complications of Clavien-Dindo grade III and above, POPF grade B and above, incidence of deep incisional SSI, incidence of organ/space SSI, and horizontal distance rate <0.5. The results of the multivariate analysis using these factors identified a horizontal distance rate of <0.5 as the independent risk factor (risk ratio 3.69, 95% CI: 1.48–9.20) (Table 2).

Figure 2 shows a quadrisection image of the gastrojejunostomy position. Results of those with a horizontal distance rate <0.5 and a vertical distance rate ≥0.5 are shown in area A, those with a horizontal distance rate ≥0.5 and a vertical distance rate ≥0.5 in area B, those with a horizontal distance rate <0.5 and a vertical distance rate <0.5 in area C, and those with a horizontal distance rate ≥0.5 and a vertical distance rate <0.5 in area D, respectively. The proportion of patients with poor oral intake was 57.5%, 27.5%, and 15.0% in areas A, B, and D, respectively. The number of cases in area C was small, with three cases.

Discussion

The current study focused on the position of the gastrojejunostomy site, which was measured by examining axial CT images. The oral intake was confirmed to be greater in patients whose gastrojejunostomy site positions were farthest from the median. The number of cases with DGE of grade A and above according to the ISGPS definition was nine of the 119 cases in this study. Due to the small number of samples that met the definition of DGE, we used the postoperative oral intake amount for our investigation. DGE is defined according to the period of fasting or the presence/absence of vomiting; thus, DGE is confirmed only when the patient is completely incapable of oral intake. On the contrary, oral intake measurement includes the preliminary stage to DGE confirmation, possibly providing a more detailed evaluation. A study reported that the presence/absence of DGE based on the ISGPS definition correlated with a decrease in the postoperative oral intake amount [14]. The results of our study also showed a significant difference in the postoperative hospitalization period: 35 versus 15 days in the poor and good oral intake groups, respectively, demonstrating that investigating the decrease in oral intake should be as critical as investigating DGE. Herein, the difference in the gastrojejunostomy position was investigated to propose a new surgical intervention to prevent postoperative oral intake decrease.

Various types of surgical interventions for DGE have been reported thus far [24–28]. A study reported a series of randomized controlled trials performed to compare the DGE incidence rate in gastrojejunostomy between antecolic and retrocolic routes, and the results showed 5% in the former and 50% in the latter [24]. Currently, gastrojejunostomy is usually performed using the antecolic route. The presence of the transverse colon between the pancreaticojejunostomy and stomach in the antecolic route can prevent inflammation from spreading from the pancreaticojejunostomy site, probably leading to the low incidence rate of DGE. The method of preventing DGE with surgical techniques is to meet the two concepts of keeping a distance between the pancreaticojejunostomy site and gastrojejunostomy site and straightening the anastomosis. In the abovementioned study, it is considered that there was a significant difference in RCT because the reconstruction by the antecolic route naturally satisfies the first concept unconsciously.

Another study reported that the DGE incidence rate was successfully reduced from 23.0% to 9.0% by introducing a new anastomosis technique called Flange gastroenterostomy [27], in which the distance of the gastroenterostomy site was set as further as possible, to prevent inflammation from spreading to the vital anastomotic site of gastrojejunostomy. The low incidence rate of DGE may be due to this protective feature of the procedure.

Preventing inflammation from spreading to the gastrojejunostomy site is vital in preventing DGE; however, some patients experience a decline in the amount of oral intake, which could be the preliminary stage of DGE. The postoperative low nutritional status is considered to lead to a decline in the patient's quality of life, causing undernutrition and prolonged hospitalization; therefore, in this study, we focused on the correlation between the site of gastrojejunostomy and postoperative oral intake, not the occurrence of DGE. The longer distance between pancreaticojejunostomy and gastrojejunostomy sites probably contributed to preventing POPF-induced inflammation from spreading to the latter, which could be one reason for the good oral intake of the patients.

There are limitations to the current study. First, the distance between the pancreaticojejunostomy and gastrojejunostomy sites was not measured directly. To do so, it would require complicated modification of CT images, along with the preparation of MIP images. Measurement of the anastomosis positions in the current study was conducted using axial CT images. It should be mandatory in the future to continue the study as joint research with the Department of Radiology to measure the distance between pancreaticojejunostomy and gastrojejunostomy sites more precisely by recalibrating CT images. Second, bending at the gastrojejunostomy site was not investigated in the current study. A study reported that the amount of oral intake or the rate of postoperative body weight loss differed among patients according to the degree of bending at the gastrojejunostomy sites [29]. The gastrojejunostomy sites which located far from the median probably contributed to preventing bending at the gastrojejunostomy sites, possibly leading to an increase in oral intake. Further investigation is necessary to evaluate the correlation between position and the presence/absence of bending at the gastrojejunostomy sites. Third, gastric fluoroscopy with oral contrast medium is often used to assist in the diagnosis of DGE. However, because the DGE criteria defined by ISGPS do not include findings of gastric fluoroscopy, we routinely do not perform gastric fluoroscopy in postoperative patients with PD. In the future, it is necessary to examine the interaction between the findings of gastric fluoroscopy and the horizontal or vertical distance rate. Fourth, if the coronary vein is cut during surgery, the blood flow in the stomach may become congested and the peristalsis of the stomach wall may decrease. In the future, we should prospectively investigate the relationship between coronary vein preservation and DGE. Last, this was a retrospective study conducted at a single institute. Therefore, this is only the result obtained from the postoperative CT examination. As mentioned above, the method of preventing DGE with surgical techniques is to meet the two concepts of keeping a distance between the pancreaticojejunostomy site and gastrojejunostomy site and straightening the anastomosis. By surgically placing the gastrojejunostomy to the left side peritoneum, it is considered that the two concepts are satisfied at the same time. It should be verified whether placing gastrojejunostomy sites away from the midline is optimal.

Conclusion

In conclusion, the amount of oral intake was significantly higher in patients whose gastrojejunostomy sites were positioned farther from the midline. The current study results suggest that intraoperative intervention of fixing the gastrojejunostomy position farther from the midline might increase the postoperative oral intake amount.

Statement of Ethics

This retrospective observational study conformed to the Clinical Research Guidelines and was approved by Shiga University of Medical Science Research Ethics Committee (Institutional approval number: 29-170). Written informed consent was obtained from all patients.

Conflict of Interest Statement

The authors have no related conflicts of interest to declare.

Funding Sources

No funding was received for this study.

Author Contributions

Hiroya Iida designed the research and analyzed the patient data. Hiroya Iida, Hiromitsu Maehira, Takeru Maekawa, Haruki Mori, Nobuhito Nitta, Katsushi Takebayashi, Masatsugu Kojima, Mika Kurihara, Shigeki Bamba, Masaya Sasaki, and Masaji Tani performed data collection. Hiroya Iida drafted the manuscript. All the authors read and approved the final version of the manuscript.

Data Availability Statement

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

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