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Robotic Distal Gastrectomy Reduces Drain Amylase Values in Patients With a Small Pancreas-left Gastric Artery Angle

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Purpose: Pancreatic fistula is a severe complication after laparoscopic distal gastrectomy (LDG). We previously evaluated the pancreas-left gastric artery angle (PLA) as a risk indicator for developing a pancreatic fistula after LDG. This study evaluated the incidence of pancreatic fistula with robotic distal gastrectomy (RDG) in comparison to LDG from the view of the PLA.

Materials and Methods: An association between the PLA and the incidence of pancreatic fistula in 165 patients who underwent either RDG (n = 45) or LDG (n = 120) was investigated retrospectively.

Results: RDG patients had significantly lower drain amylase values (postoperative day 2) than LDG patients. As opposed to LDG patients, drain amylase values were similar for patients with small (PLA <62 degrees) and large (PLA ≥62 degrees) PLA in RDG patients.

Conclusion: Robotic surgery may reduce the risk of postoperative pancreatic fistula in patients with a small PLA.

Key Words: pancreas-left gastric artery angle, laparoscopic distal gastrectomy, robotic distal gastrectomy, suprapancreatic lymph node dissection, pancreatic fistula, gastric cancer

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Postoperative pancreatic fistula is one of the most serious complications after gastrectomy for gastric cancer (GC).[1] Postoperative pancreatic fistula can result in various serious adverse events, including sepsis and the rupture of pseudoaneurysms, which can lead to surgery-related death.[2–5] Thus, it is important to establish protocols that reduce the risk of postoperative pancreatic fistula after gastrectomy.

Laparoscopic gastrectomy (LG) has been reported to be superior to an open gastrectomy (OG) as it is less invasive and is associated with fewer surgical complications.[6] However, the incidence of a pancreatic fistula occurring is much higher after an LG than after an OG,[7,8] and has been reported to occur in 1.7% to 7.2% of LG cases.[9–12] In an LG, the angle of operation and viewing angle are limited, and the procedure usually requires the downward retraction of the pancreas by the assistant surgeon to obtain a sufficient surgical field for dissection at the suprapancreatic lymph node. Ida et al[13] suggested that the compression of the pancreas by the assistant surgeon's forceps may contribute to pancreatic fistula.

Robotic gastrectomy (RG) was introduced in the mid-2000s as a new, minimally invasive approach that allows surgeons to perform a more precise dissection. Robotic surgical systems, such as the da Vinci Xi Surgical System (Intuitive, Sunnyvale, CA), provide a magnified, 3-dimensional view of the operating field and greatly enhance surgical precision and dexterity.[14–17] Uyama et al[18] reported that the postoperative complication rate [Clavien-Dindo (C-D) grade ≥IIIa] with RG was 2.45%, which was significantly lower than the postoperative complication rate experienced with the historical LG control (6.4%). Suda et al[19] also reported a significant reduction in the rate of local complication when using the surgical robot compared with LG, particularly the frequency of pancreatic fistula. Several other studies have reported that RG was beneficial for reducing the occurrence of pancreatic fistula in cases of GC.[20–22]

Few reports have evaluated the incidence of pancreatic fistula in relation to factors that can be assessed preoperatively, such as anatomic variation in the patient's organs.[23,24] In a previous study, we evaluated the anatomic variation in the angle between the suprapancreatic region and the root of the left gastric artery (LGA) in patients with GC. We defined the angle as the pancreas-left gastric artery angle (PLA) and investigated the incidence of pancreatic fistula after laparoscopic distal gastrectomy (LDG) in relation to the PLA. In the small PLA group, the drain amylase (D-AMY) values on postoperative days (PODs) 1 and 2 and the maximum D-AMY value were significantly higher than in the large PLA group. Furthermore, multivariate analyses demonstrated that a small PLA was an independent risk factor for high D-AMY levels. We proposed that PLA could be used as an anatomic indicator for postoperative complications in LDG.[25] However, the potential for RG to reduce the incidence of pancreatic fistula in patients with a small PLA remains to be established. In this study, we explore the effect of the anatomic position of the pancreas on the rate of postoperative complications in robotic distal gastrectomy (RDG). The aim of this study is to establish whether RDG could reduce the incidence of pancreatic fistula. Furthermore, we aimed to clarify if the PLA affected D-AMY in robotic surgery.

MATERIALS AND METHODS

PLA

We defined the PLA and the cutoff for large versus small PLA in a previous study.[25] Briefly, the root of the LGA was detected on the sagittal section of the preoperative abdominal contrast-enhanced computed tomography (CT) images in the arterial phase. A line was then drawn between the center root of the LGA and the cranial side of the pancreas on the same CT image. The PLA was defined as the angle between this straight line and the patient horizontal line (Figs. 1A, B). The cutoff value for large and small PLA was defined as 62 degrees which was previously defined in our report.[25]

Evaluation of the Association Between the PLA and Surgical Approach

We retrospectively collected the sequential data of 347 patients who underwent gastrectomy for GC from 2017 to 2020 at Osaka University Hospital. These patients with total gastrectomy (n = 49), proximal gastrectomy (n = 45), and other gastrectomy (n = 36) were excluded. Patients who underwent DG were 217 cases. We excluded 27 cases with open surgery. The patients with R1 and R2 resection were excluded; finally, 165 patients were analyzed. All patients were classified into either a small PLA group (PLA < 62 degrees) or a large PLA group (PLA ≥ 62 degrees). All RDG procedures were performed by some surgeons (Y.K., T.T.) using the da Vinci Surgical System Xi (Intuitive). LDG was performed by the same surgeons (Y.K., T.T.) who were all board-certified by the Japanese Society for Endoscopic Surgery. Patients were classified into an LDG group (n = 120) or an RDG group (n = 45). Data on patient characteristics, clinicopathologic features, surgical outcomes, and postoperative findings were reviewed from medical reports. The stage of the cancer was described according to the 14th edition of the Japanese Classification of Gastric Carcinoma.[26] The extent of lymph node dissection was decided according to the Japanese Gastric Cancer Treatment Guideline version 5.[27] The maximum tumor size was measured using resected specimens. Histopathologic features were obtained by examination of hematoxylin and eosin-stained specimens. Surgical outcomes were evaluated by operation time and amount of operative blood loss. Postoperative complications, particularly the grade of pancreatic fistula, were classified according to the C-D classification.[28] Generally, the International Study Group of Postoperative Pancreatic Fistula (ISGPF) grading classification is adopted in pancreatic surgery.[29,30] It also provided a clear, objective, and uniform definition of "biochemical leak" (former grade A fistula) and clinically-relevant fistula (grades B and C), but gastrectomy which does not directly touch the pancreas, we would like to evaluate the less damage more in detail and selected the C-D classification which involved all the patients whose D-AMY level elevated. The pancreatic fistula in C-D grade ≥ I was defined as having drainage fluid amylase levels on or after POD3 of ≥ 3 times the upper limit of the institutional

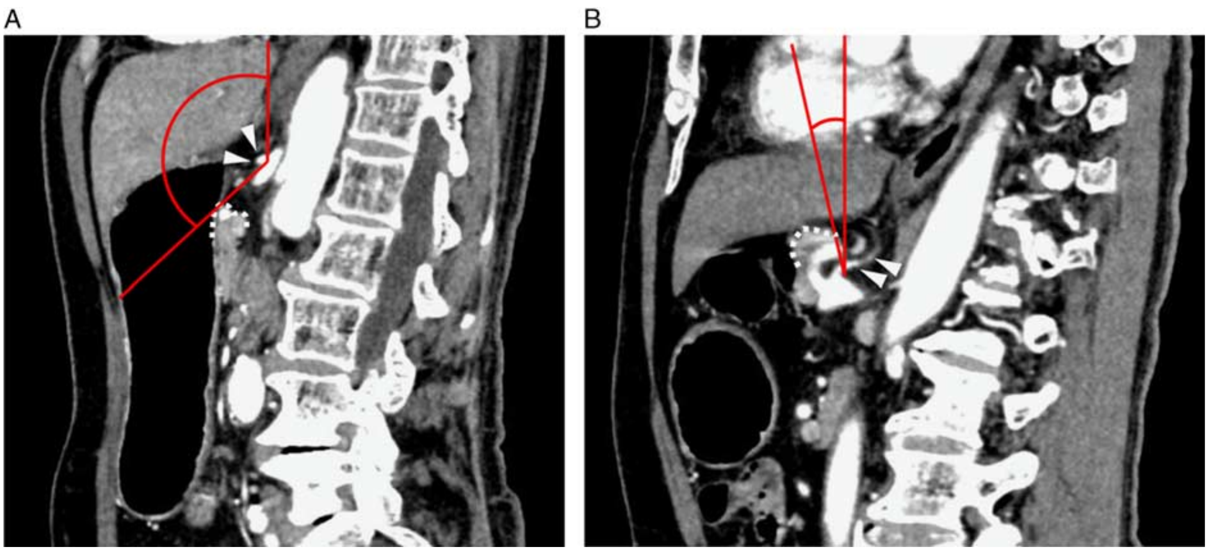

FIGURE 1. The pancreas-left gastric artery angle (indicated by the red lines) was defined as the angle between horizontal and a straight line connecting the upper edge of the pancreas (white dotted lines) and the root of the laparoscopic distal gastrectomy (white arrowheads) in a preoperative abdominal contrast-enhanced computed tomography image with sagittal section. A, An example from a patient with a large pancreas-left gastric artery angle = 135.6 degrees. B, An example from a patient with a small pancreas-left gastric artery angle = 4.1 degrees.

normal range of the plasma amylase level, but without the need for intervention. The pancreatic fistula in C-D grade ≥ I was defined as having drainage fluid amylase levels on or after POD3 of ≥ 3 times the upper limit of the institutional normal range of the plasma amylase level, but without the need for intervention. These factors of surgical outcome and postoperative complications were compared between the LDG and RDG groups. We routinely placed a closed drain in the nearby suprapancreatic region after distal gastrectomy and removed on POD4 in LDG and RDG. We measured the D-AMY value on PODs 1, 2, and 3 to detect pancreatic fistula. The Human Ethics Review Committee of Osaka University Graduate School of Medicine approved this study (No. 08226-11). All patients provided written informed consent for surgery and the use of clinical data as required by the institutional review board of the Osaka University of Medicine. This study has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Statistical Analysis

Results are expressed as median (range) for continuous variables and percentage for categorical variables. We retrospectively analyzed associations between patient data and operative procedures using χ^2 tests and the Mann-Whitney *U* test. All statistical tests were 2 tailed, and the threshold for statistical significance was $P=0.05$. Statistical analyses were performed with JMP Pro 13.2 (SAS Institute Inc., Cary, NC).

RESULTS

PLA

The median PLA of patients in this study was 58 degrees (range, 0.4 to 150 degrees), with 91 patients falling in the small PLA group and 74 patients falling in the large PLA group. Figure 2 shows the surgical view of the lymph node dissection of the pancreatic upper region in a patient with GC, with the LGA pulled to the ventral side. The pancreas in the small PLA group (Fig. 2A) overhung further against the root of the LGA than in the large PLA group (Fig. 2B).

Comparison of Patients Who Underwent RDG and LDG

Patient characteristics are summarized in Table 1. The median PLA of patients in the LDG and RDG groups was 56.1 degrees (range: 0.4 to 150.1 degrees) and 60.3 degrees (range: 9.1 to 149.5 degrees), respectively. No significant differences in patient characteristics or clinicopathologic features were found between the 2 groups. Operative time was significantly longer ($P<0.001$) in the RDG group, but the incidence of complications (C-D classification grade ≥ II) was significantly lower in the RDG group than in the LDG group ($P<0.001$). The incidence of the pancreatic fistula was particularly attenuated when using the surgical robot (RDG: 0%, LDG: 5.0%, $P=0.12$). D-AMY (POD2) was significantly lower in the RDG group (RDG: 267 IU/L, range: 56 to 265 IU/L; LDG: 383 IU/L; range: 34 to 43,986 IU/L; $P=0.01$; Table 2).

A

B

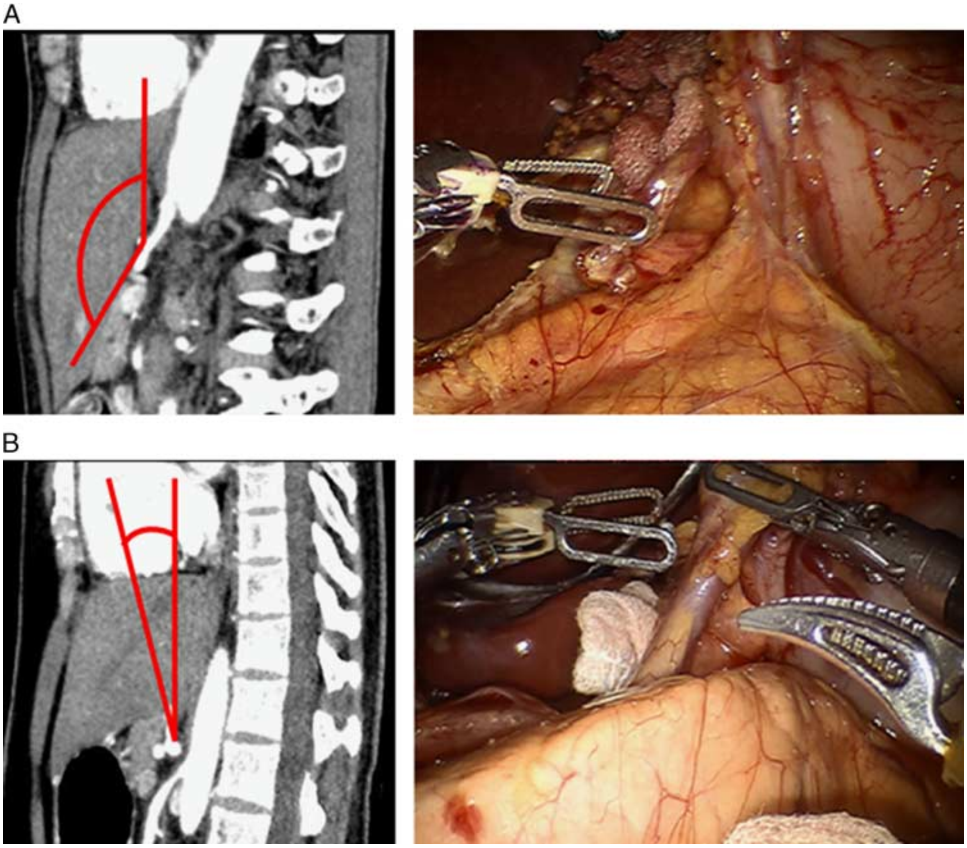

FIGURE 2. Illustration of the preoperative computed tomography image (left) and surgical view during lymph node dissection of the pancreatic upper region using an endoscope with a 30-degree viewing angle (right). A, An example from a patient with a large pancreas-left gastric artery angle = 149.5 degrees. B, An example from a patient with a small pancreas-left gastric artery angle = 9.1 degrees. The pancreas-left gastric artery angle is indicated by the red lines.

TABLE 1. Comparison of Patient Characteristics and Clinicopathologic Features in RDG and LDG Groups

	n (%)		
	RDG (N = 45)	**LDG (N = 120)**	***P***
Age [median (range)] (y)	69 (35-87)	72 (38-90)	0.22
Sex			0.95
Male	31 (68.9)	82 (68.3)	
Female	14 (31.1)	38 (31.7)	
Height [median (range)	164 (142-175)	161 (138-180)	0.46
BMI [median (range)] (kg/m^2)	22.5 (15.6-28.2)	22.4 (12.9-31.9)	0.97
PLA [median (range)] (deg.)	60.3 (9.14-149.5)	56.1 (0.36-150.1)	0.56
Differentiation			0.65
Differentiated	22 (48.9)	61 (50.8)	
Not differentiated	23 (51.1)	57 (47.5)	
Others	0 (0)	2 (1.7)	
cT			0.74
1	29 (64.4)	74 (61.7)	
2-4	16 (35.6)	46 (38.3)	
cN			0.09
0	41 (91.1)	96 (80.0)	
1-3	4 (8.9)	24 (20.0)	
cStage			0.43
I	35 (77.8)	86 (71.7)	
II-IV	10 (22.2)	34 (28.3)	
Surgical lymph node dissection			0.77
1+	24 (53.3)	67 (55.8)	
2	21 (46.7)	53 (44.2)	

BMI indicates body mass index; LDG, laparoscopic distal gastrectomy; PLA, pancreas-left gastric artery angle; RDG, robotic distal gastrectomy.

Comparison of PLA in Patients Who Underwent RDG

Of the 45 patients who underwent RDG, 24 belonged to the small PLA group, and 21 belonged to the large PLA group. Patient characteristics and clinicopathologic features were similar between the large and the small PLA groups in the RDG patients (Table 3). Operation time (large PLA: 380 min, range: 243 to 632 min; small PLA: 394 min, range: 292 to 498 min; $P = 0.35$) and blood loss (large PLA: 10 mL, range: 5 to100 mL; small PLA: 15 mL, range: 5 to 100 mL; $P = 0.91$) were similar between the 2 groups. Postoperative complications (C-D grade ≥ II) were anastomotic stenosis (n = 1) and pneumonia (n = 1). D-AMY values (PODs 1 to 3) were similar between the 2 groups (POD1 large PLA: 419 IU/L, range: 118 to 4074 IU/L; small PLA: 549 IU/L, range: 92 to 2903 IU/L; $P = 0.33$, POD2 large PLA: 179 IU/L, range: 56 to 3265 IU/L; small PLA: 279 IU/L, range: 85 to 1578 IU/L; $P = 0.46$, POD3 large PLA 117 IU/L, range: 52 to 944 IU/L; small PLA: 240 IU/L, range: 46 to 1200 IU/L, $P = 0.14$) (Table 4).

TABLE 2. Surgical Outcomes in RDG and LDG Groups

	RDG (N = 45)	**LDG (N = 120)**	***P***
Operative time [median (range)] (min)	387 (243-632)	261 (175-467)	< 0.001
Blood loss [median (range)] (mL)	10 (5-100)	10 (5-500)	0.83
Postoperative complication* [n (%)]	2 (4.4)	27 (22.5)	< 0.001
Pancreatic fistula	0 (0)	6 (5.0)	0.12
Bleeding	0 (0)	3 (2.5)	0.28
Pneumonia	1 (2.2)	3 (2.5)	0.91
Anastomotic stenosis	1 (2.2)	3 (2.5)	0.92
Anastomotic leakage	0 (0)	2 (2.5)	0.38
Others	0 (0)	10 (8.3)	—
Drain amylase value [median (range)] (IU/L)			
POD1	472 (92-4074)	569 (57-32,109)	0.28
POD2	267 (56-3265)	383 (34-43,986)	0.01
POD3	202 (46-1200)	257 (51-43,968)	0.07

*Clavien-Dindo classification ≥ II.

LDG indicates laparoscopic distal gastrectomy; POD; postoperative day; RDG; robotic distal gastrectomy.

TABLE 3. Comparison of Patient Characteristics and Clinicopathologic Features in RDG

	n (%)		
	Large PLA (N = 21)	**Small PLA (N = 24)**	***P***
Age [median (range)] (y)	71 (44-87)	69 (35-84)	0.33
Sex			0.34
Male	13 (61.9)	18 (75.0)	
Female	8 (38.1)	6 (25.0)	
Height [median (range)]	164 (147.5-174.5)	163 (142-175)	0.74
BMI [median (range)] (kg/m^2)	21.4 (15.6-28.2)	22.8 (18.6-28.0)	0.21
Differentiation			0.66
Differentiated	11 (52.4)	11 (48.4)	
Not differentiated	10 (47.6)	13 (48.4)	
cT			0.36
1	15 (71.4)	14 (58.3)	
2-4	6 (28.6)	10 (41.7)	
cN			0.89
0	19 (90.5)	22 (91.7)	
1-3	2 (9.5)	2 (8.3)	
cStage			0.23
I	17 (81.0)	18 (75.0)	
II-IV	4 (19.1)	6 (25.0)	
Surgical lymph node dissection			0.28
1+	13 (61.9)	11 (45.8)	
2	8 (38.1)	13 (54.2)	

BMI indicates body mass index; PLA, pancreas-left gastric artery angle; RDG, robottic distal gastrectomy.

Comparison of PLA in Patients Who Underwent LDG

Of the 120 patients who underwent LDG, 58 belonged to the large PLA group, and 62 belonged to the small PLA group. Patient characteristics, clinicopathologic features, surgical outcomes, and postoperative complication were similar between 2 groups (Supplemental Figs. 1, 2, Supplemental Digital Content 1, http://links.lww.com/SLE/A308). D-AMY values in the small PLA group were significantly higher than in the large PLA group (Supplemental Fig. 2, Supplemental Digital Content 2, http://links.lww.com/SLE/A309).

DISCUSSION

For the patients included in this study, the incidence of postoperative complications was significantly lower in the RDG group than in the LDG group. In particular, none of

TABLE 4. Surgical Outcomes in Large PLA and Small PLA in RDG

	Large PLA (N = 21)	Small PLA (N = 24)	*P*
Operation time [median (range)] (min)	380 (243-632)	394 (292-498)	0.35
Blood loss [median (range)] (mL)	10 (5-100)	15 (5-100)	0.91
Postoperative complication* [n (%)]	0 (0)	2 (8.3)	0.11
Pancreatic fistula	0 (0)	0 (0)	—
Bleeding	0 (0)	0 (0)	—
Anastomotic stenosis	0 (0)	1 (4.2)	0.34
Pneumonia	0 (0)	1 (4.2)	0.34
Anastomotic leakage	0 (0)	0 (0)	—
Others	0 (0)	0 (0)	—
Drain amylase value [median (range)] (IU/L)			
POD1	419 (118-4074)	549 (92-2903)	0.33
POD2	179 (56-3265)	279 (85-1578)	0.46
POD3	117 (52-944)	240 (46-1200)	0.14

*Clavien-Dindo classification ≥II.

PLA indicates pancreas-left gastric artery angle; POD; postoperative day; RDG; robotic distal gastrectomy.

the patients in the RDG group developed a pancreatic fistula (Table 2). In a previous study, we investigated D-AMY in patients who underwent LDG and found that D-AMY values were significantly higher in patients with a small PLA than in patients with a large PLA on PODs 1 and 2.[25] In this study, we investigated whether RDG reduces D-AMY values in patients with a small PLA. However, there was no difference in D-AMY values between the small and large PLA groups in patients who underwent RDG (Table 4). We also compared the incidence of pancreatic fistula of patients who underwent LDG versus RDG in relation to the PLA, using the C-D classification as a clinical indicator (Table 5). In the LDG group, the incidence of pancreatic fistula in patients with a small PLA (C-D grade ≥I) was significantly higher than in patients with a large PLA. In contrast, in the RDG group, there was no difference in the incidence of a pancreatic fistula between patients with a small PLA and patients with a large PLA (Table 5). These data suggest that RDG reduces D-AMY values in patients with a small PLA, compared with LDG. High D-AMY value without the need for therapeutic intervention in pancreatic-enteric anastomosis with pancreatectomy is lacking in clinical implications. In contrast, pancreatic fistula in gastrectomy is caused by indirect damage to the pancreas, and D-AMY may be an indicator of pancreatic damage. Therefore, we speculated that RDG could reduce the pancreatic damage in patients with a small PLA compared with LDG.

TABLE 5. Comparison of Pancreatic Fistulas in Large and Small PLA by RDG and LDG

	n (%)		
	Large PLA	Small PLA	*P*
RDG	4 (19.1)	5 (20.8)	0.88
LDG	10 (18.9)	23 (34.3)	0.06

LDG indicates laparoscopic distal gastrectomy; PLA, pancreas-left gastric artery angle; RDG, robottic distal gastrectomy.

Various invasive surgical procedures, bursectomy, splenectomy, pancreatectomy, and extended lymphadenectomy in the OG, are known to carry a high risk of postoperative pancreatic fistula.[31–33] These risk factors for pancreatic fistula in the OG are thought to be occurred by direct damage to the pancreas. In contrast, with LDG, risk factors for pancreatic fistula are related to the limited operating angle and field of view, which are specific to laparoscopic surgery. During suprapancreatic lymph node dissection with LDG, the forceps concentrate the force on one specific point, which then acts as a fulcrum resulting in the forceps applying a stronger force than is intended by the surgeon.[33] In our institution, we retract the pancreas with a grasping gauze to avoid the force on one specific point. Nevertheless, increased pressure on the pancreas by the assistant surgeon's forceps can contribute to the development of the pancreatic fistula. Furthermore, the incidence of pancreatic fistula in LDG may be affected by the position of the pancreas in relation to the surrounding arteries.[23–25] The risk of the pancreatic fistula may be reduced when using RDG, however, as many of the risk factors associated with LDG outlined above may be lower with RDG.

Several factors contribute to the superiority of RDG over LDG in upper pancreatic lymph node dissection. First, the articulated forceps of RDG may reduce pancreatic compression. Figure 3 shows the surgical view of a lymph node dissection of the pancreatic upper region using LDG (Fig. 3A) and RDG (Fig. 3B), both representing patients with a small PLA (8 and 9.1 degrees, respectively). With LDG, the surgical assistant needs to compress the pancreas with forceps, whereas with RDG, the articulated forceps allow for a reduced compression of the pancreas. Second, the 4 robot ports and one assistant port used in RDG are placed across and above the midline of the abdomen in both quadrants. In addition, these ports are lifted the abdominal wall by robot arms. The positioning of these ports is more cranial compared with LDG. Therefore, with RDG, the surgeon can get a better field of view from more cranial direction to reduce the compression of the pancreas during an upper pancreatic lymph node dissection. Finally, with RDG, the operative field is magnified tenfold, and the primary surgeon has better optical control due to the high-definition 3-dimensional views provided by a mounted, stabilized, surgeon-controlled camera which reduces the reliance on an assistant surgeon.

In this study, a lower pancreatic fistula rate was associated with RDG, regardless of PLA. However, since the number of institutions that can perform RDG is limited, it is also necessary to consider methods of reducing the incidence of pancreatic fistula when LDG is performed for patients with a small PLA. Tsujiura et al[34] proposed the pancreas-compressionless gastrectomy which relies on caudal and dorsal traction of the surrounding tissues of the pancreas by an assistant. The D-AMY in the compressionless group was significantly lower on PODs 1 and 3 ($P<0.001$ and $P=0.013$, respectively) compared with the compression group. Pancreas-compressionless gastrectomy may reduce the occurrence of pancreatic fistula. The use of recently developed ultrasonic scalpels may also allow for reduced risk of pancreatic fistula. However, the use of ultrasonic scalpels have a risk of lateral thermal damage. Pogorelić et al[35] conducted an animal experiment and demonstrated that the use of ultrasonic scalpels and dissection equipment at high power for extended periods of time causes lateral heat damage of pancreatic tissue during suprapancreatic lymph node dissection. Irino et al[36]

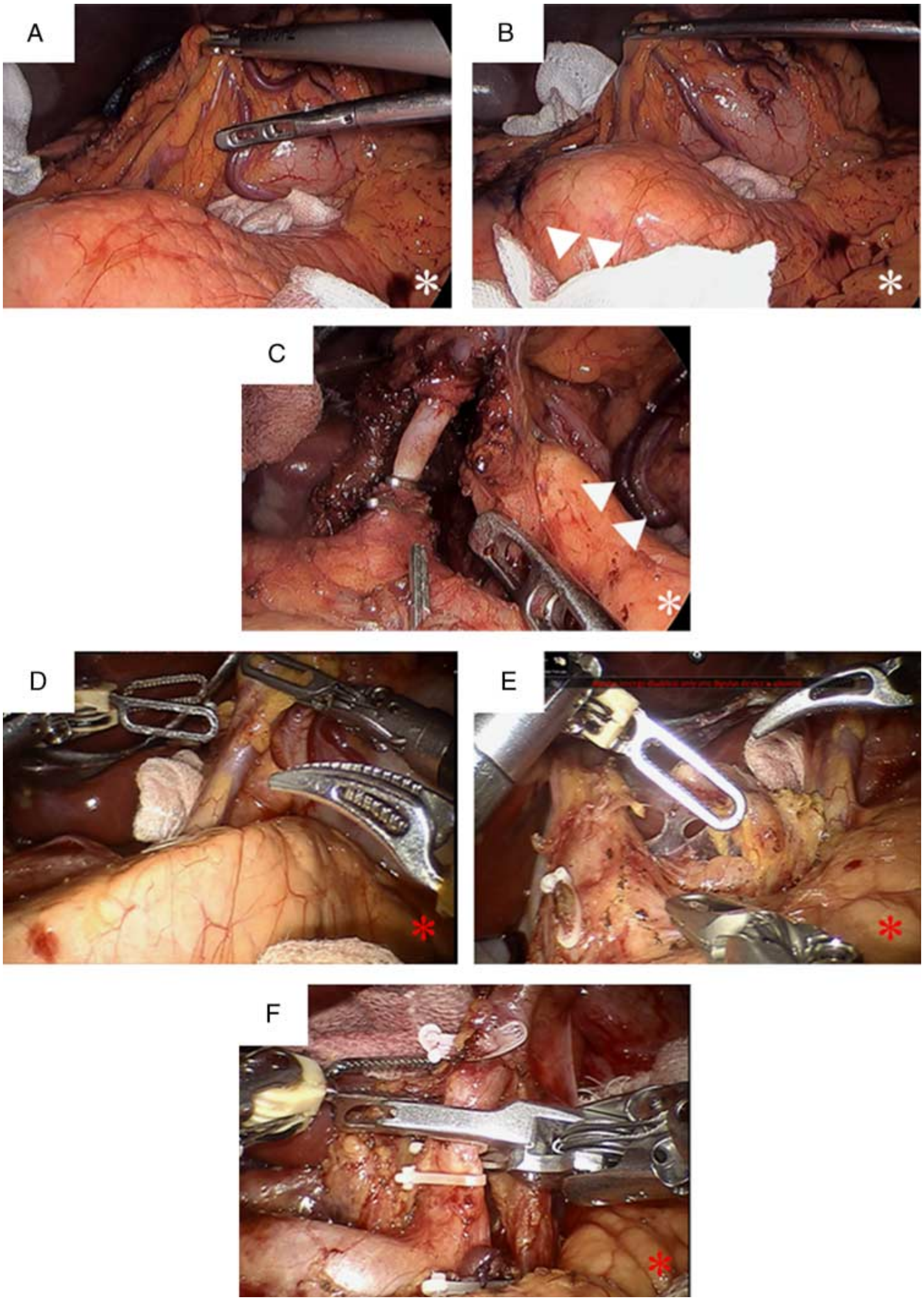

FIGURE 3. Examples of surgical views with LDG (A–C; white asterisk) and RDG (D–F; red asterisk) during lymph node dissection of the pancreatic upper region using an endoscope with a 30 degrees viewing angle. In both cases, the patient had a small PLA, and the pancreas was overhung. A, Initial surgical view with LDG (PLA = 8.0 degrees). B, Downward retraction of the pancreas by the assistant surgeon (white arrowheads) during LDG. C, It was necessary to avoid the pancreas with the forceps when sacrificing the left gastric artery (white arrowheads) during LDG. D, Initial surgical view with RDG (PLA = 9.1 degrees). E, A mounted, stabilized surgeon-controlled camera and articulated forceps could provide the operative field of view without compressing the pancreas during RDG. F, The articulated forceps of RDG reduce the compression of the pancreas when sacrificing the left gastric artery. Note how LDG needed the compression of the pancreas (white arrowheads in B), while RDG could avoid compressing the pancreas by using articulated forceps. LDG indicates laparoscopic distal gastrectomy; PLA, pancreas-left gastric artery angle; RDG, robottic distal gastrectomy.

proposed the "Hit and Away" technique which advocates clamping tissues and blood vessels with ultrasonically activated surgical device, performing "3 activations," and then releasing them immediately. This technique is effective and could reduce lateral thermal damage, resulting in decreased risk of pancreatic fistula. A flexible laparoscope would also be effective, as it provides a stable and clear surgical field. However, the image provided is of poor quality, but we use a 45-degree endoscope to solve this problem.

Patient characteristics and clinicopathologic features of patients in the large and small PLA groups are shown in Supplemental Figures 3 and 4 (Supplemental Digital Contents 3, http://links.lww.com/SLE/A310 and 4, http://links.lww.com/SLE/A311). Height and body mass index were not significantly different between the 2 groups, but the small PLA group contained a higher proportion of males than females. This suggests that PLA is difficult to predict from physical factors.

This study had some limitations. First, the evidence level of this study is low because it is retrospective, single-center, small number of eligible patients. However, the PLA cutoff value was established in a previous study, and the applicability this value was confirmed in the current study, which was focused on a different population from that of the previous study.[25] Second, since the occurrence of pancreatic fistula in LDG with that in OG, we might have had better to compare RDG with OG. However, the spread of minimally invasive surgery such as LDG and RDG is limited to the indication of OG, and we could not compare RDG with OG by the large difference of patients' background. In the previous study, Washio et al[33] compared the incidence of postoperative pancreatic fistula after gastrectomy in previous reports and reported that the incidence of the pancreatic fistula was lower in RG compared with OG. In our study, we also showed the very low incidence of pancreatic fistula in RDG and speculated that RDG might not be inferior to OG in the incidence of pancreatic fistula. Third, preoperative measurement of PLA from CT is a burden for surgeons. However, it is important for the surgeon to know the anatomic location of the pancreas and should be confirmed preoperatively. Kumagai et al[23] also reported the relationship between the anatomic location of the pancreas and postoperative complications and D-AMY values using by some anatomic parameters. And these preoperative predictions might lead to avoid serious complications.

In conclusion, PLA, which considers the position of the pancreas relative to the LGA, had a significant association with postoperative D-AMY values, and we show that patients with a small PLA had a higher risk of postoperative pancreatic fistula. Robotic surgery may reduce the risk of postoperative pancreatic fistula in patients regardless of PLA.

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