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Division of surgeon workload in pancreaticoduodenectomy: striving to decrease post-operative pancreatic fistula

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Abstract

Background: Many studies have reported factors affecting pancreatic leakage after pancreaticoduodenectomy (PD), but there have been few reports on surgeon workload and post-operative pancreatic fistula (POPF). This study was conducted to explore whether a surgeon's workload during PD impacts the occurrence of POPF.

Methods: We retrospectively analysed 270 consecutive patients who underwent PD between January 2008 and June 2013 by a single experienced surgeon. These patients were divided into those who underwent PD entirely by a single operator (group 1) and those who received reconstructions by other operators (group 2). Duct-to-mucosa pancreaticojejunostomy was performed on all patients. The International Study Group on Pancreatic Fistula criteria were used to define POPF.

Results: There were 157 patients (58.1%) in group 1 and 113 patients (41.9%) in group 2. The post-operative morbidity rate was comparable between the two groups (55.4% versus 52.2%; $P = 0.603$), but the clinical pancreatic fistula (grade B/C) rate was significantly different (10.8% versus 2.7%; $P = 0.011$). The overall post-operative mortality was one patient (0.4%). Significant associations were found between clinical pancreatic fistulas and soft pancreas texture ($P = 0.021$), preoperative serum albumin level ≤3.5 g/dL ($P = 0.012$), other pathology besides pancreatic cancer ($P = 0.027$) and a single-operator procedure ($P = 0.019$). A multivariate logistic regression analysis revealed that a single operator (odds ratio: 4.2, $P = 0.029$) was a significant predictive risk factor for clinically relevant POPF.

Conclusion: Dividing the surgeon's workload in PD is associated with lower rates of POPF.

Introduction

The development of pancreatic fistula is a potentially life-threatening complication after pancreaticoduodenectomy (PD). It is generally reported that the incidence of clinically relevant post-operative pancreatic fistulas after PD is 7.6–36.4%,[1–5] in accordance to the definition of the International Study Group of Pancreatic Fistula (ISGPF).[6] Researchers have suggested factors that affect pancreatic leakage after PD, including male gender, advanced age, post-operative albumin level, intraoperative bleeding, soft pancreatic parenchyma, small pancreatic duct, drain amylase level on post-operative day one, pancreatic parenchymal thickness and surgeon volume, among others.[1,7–14]

Although several surgeon-related factors affecting post-operative morbidity in pancreatic surgery have been reported,[9,14,15] there have been no articles reporting links between surgical outcome and the surgeon's level of alertness or burnout. A higher surgeon workload may result in increasing fatigue and reduce the surgeon's ability to concentrate on the procedure. Thus, it is thought that work-sharing would increase work efficiency and improve concentration on one's specific duties. As currently seen in practice, in liver transplantation, which has a relatively long operative time, the operation is performed by dividing duties between the recipient liver resection and the vascular and biliary anastomoses.[16,17] If this concept is adopted in pancreatic surgery, observing changes in the surgical outcomes

will be interesting and telling. Therefore, this study was conducted to determine if surgeon workload during PD could impact the occurrence of post-operative pancreatic fistula (POPF).

Methods

Study population

Data from a prospectively maintained PD database were retrieved and reviewed. This study was reviewed and approved by the Samsung Medical Center Institutional Review Board (No. 2013-12-141). From January 2008 to June 2013 at a single institute, conventional PD or pylorus-preserving pancreaticoduodenectomies (PPPD) were performed for 274 consecutive patients with benign or malignant disease by a single experienced surgeon. We excluded three patients who were diagnosed with synchronous double primary cancers (two patients with lung cancers and one renal cell cancer) because of prolonged co-operative time, which may have influenced post-operative outcomes. Also excluded was one patient who underwent completion pancreatectomy on post-operative day one because the pancreaticojejunostomy was disrupted and massive extraluminal bleeding occurred. Finally, we identified 270 patients with data suitable for analysis.

Operative procedure and grouping

Patients were grouped according to whether one or two operators were involved in procedures during PD. Group 1 included patients who underwent PD entirely by a single operator from January 2008 to May 2011. The surgeon performed all of the procedures of a PD himself. The operator was a 50-year-old high-volume surgeon with more than 15 years of specialized experience in hepatobiliary pancreatic surgery and who has performed over 600 PDs since 1996 (484 PPPD, 117 conventional PD). Group 2 included patients who underwent PD with a two-operator approach from June 2011 to June 2013. A primary operator performed selected procedures in the PD and a second operator performed the remaining procedures. The primary operator was the more experienced surgeon and was the same surgeon mentioned earlier and this surgeon only performed the pancreas resection in the PD. The second operator performed the reconstructions (pancreaticojejunostomy, hepaticojejunostomy and the gastro or duodenojejunostomy) after the pancreas was resected by the primary operator. There were three secondary operators who were clinical fellows in their mid-30s. Each of them was involved at different times. The secondary operators had more than 6 months of training in hepatobiliary pancreatic surgery when this study took place. These secondary operators, surgeons 1, 2 and 3, participated in this study from January 2013 to June 2013, June 2012 to December 2012 and June 2011 to May 2012, respectively. Because of two or more surgeons performed several procedures in the operation, we defined this to be a division of workload.

All patients underwent the same pancreaticojejunal anastomosis, which was performed using a double-layer duct-to-mucosa technique, where the jejunal mucosa was stitched to the pancreatic duct with 5-0 absorbable polydioxanone interrupted sutures and the edge of the parenchymal resection surface was stitched to the serosa of the jejunum using 5-0 Prolene continuous sutures. The second operators performed the pancreaticojejunostomies using the same method as the primary operator. A pancreas drainage stent (internal or external) was inserted when the diameter of main pancreatic duct was less than 6 mm. As the primary operator preferred internal stent insertion to external, the secondary operators would follow his preference. Notably, some patients who had been enrolled in multicentre prospective randomized studies exploring comparisons between internal and external pancreas drainage in Korea from 2010 to 2012 were included in our study. And so, patients with external pancreas drainage were included in our study, regardless of the preference of the primary operator.

Statistical analysis

We retrospectively reviewed medical records, including operation notes, radiologic images and pathology reports. Preoperative parameters included patient age, gender and laboratory findings, and intraoperative parameters included operative time, pancreas texture and the use of stents. Post-operative parameters and complications were recorded and they included the use of antibiotics, nutritional support, laboratory and imaging studies, radiologic interventions, post-operative hospital stay, hospital readmissions, reoperations and mortality. The pathological findings were based on the histology obtained from the post-operative biopsy of the resected specimen. Mortality and morbidity were defined as death or complications occurring within 30 days of surgery. POPF were classified by the ISGPF criteria.[6]

Chi-squared tests were used to cross-tabulate nominal data. Parametric continuous variables were tested using Student's *t*-tests and the Mann–Whitney test was used for non-parametric continuous variables. Predictive risk factors for pancreatic fistulas were studied using logistic analysis. Data were analysed using PASW Statistics version 20.0 (SPSS, IBM, Armonk, NY, USA). Statistical significance was set at $P < 0.05$.

Results

The median age of the study population was 62 years (range: 17–81 years) and male patients ($n = 154$, 57.0%) outnumbered females. Among the 270 patients in the study, 157 (58.1%) were in group 1 and 113 (41.9%) were in group 2. Demographics, preoperative laboratory variables, pathological findings and neoadjuvant treatment were the same in groups 1 and 2 (Table 1). However, preoperative serum albumin ($P = 0.020$) differed significantly between the two groups. Biliary drainage procedures, such as percutaneous transhepatic biliary drainage (PTBD, 49 patients), endoscopic retrograde biliary drainage (ERBD, 54 patients), endoscopic nasobiliary drainage (ENBD, 44 patients) and combined PTBD and ERBD/ENBD (two patients), for jaundice or upcoming biliary obstruction on the endoscopic retrograde cholangiopancreatography, were performed preoperatively in 149 patients. PD was performed more frequently in patients with malignancy ($n = 238$, 88.1%). The most common indication for PD was pancreatic adenocarcinoma ($n = 86$, 36.1%). In the 152 patients with other malignancies (63.9%) aside from pancreatic adenocarcinoma, no significant differences were observed between group 1 ($n = 93$, 61.2%) and group 2 ($n = 59$, 38.8%) ($P = 0.686$). Nine patients with pancreatic cancer (3.3%)

Table 1 Demographics, clinical features and pathology in patients who underwent pancreaticoduodenectomy with or without division of workload

	Group 1 (n = 157)	Group 2 (n = 113)	P
Age (years ± SD)	60.8 ± 10.5	61.8 ± 11.3	0.420
Gender			0.541
Male/Female	92/65	62/51	
American Society of Anesthesiologists			
I/II/III/IV	33/118/6/NA	27/78/8/NA	0.381
Body mass index (±SD)	22.2 ± 2.9	22.4 ± 3.4	0.729
Preoperative total bilirubin (>2 mg/mL)	67 (42.7%)	36 (31.9%)	0.071
Preoperative biliary drainage	91 (58%)	58 (51.3%)	0.280
Serum albumin (g/dL ± SD)	3.9 ± 0.5	4.1 ± 0.5	0.020
Serum haemoglobin (g/dL ± SD)	12.3 ± 1.5	12.6 ± 1.7	0.122
Serum creatinine (mg/dL ± SD)	0.8 ± 0.2	0.8 ± 0.2	0.438
Benign disease/malignant disease	15/142	17/96	0.169
Pancreatic adenocarcinoma	49	37	—
Distal cholangiocarcinoma	36	27	—
Ampullary carcinoma	39	20	—
Duodenal carcinoma	5	5	—
Intraductal papillary mucinous neoplasm	6	12	—
Intraductal papillary mucinous carcinoma	4	1	—
Neuroendocrine tumour	11	4	—
Serous cystic neoplasm	0	2	—
Solid pseudopapillary tumour	2	3	—
Metastatic carcinoma	1	0	—
Pancreatitis	1	0	—
Other†	3	2	—
Neoadjuvant therapy	3	6	0.171

†Pancreas pseudocyst, tubulovillous adenoma of the duodenum, ampullary adenomyoma, benign stricture of the distal bile duct and malignant fibrous histiocytoma.
NA, not applicable; SD, standard deviation.

Table 2 Surgical procedures in patients who underwent pancreaticoduodenectomy with or without division of workload

	Group 1 (n = 157)	Group 2 (n = 113)	P
Type of resection			0.973
Conventional pancreaticoduodenectomy	22 (14)	16 (14.2)	
Pylorus-preserving pancreaticoduodenectomy	135 (86)	97 (85.8)	
Additional procedures			
Vascular resection	—	—	—
Hepatic artery	1 (0.6)	0	0.999
Portal vein	9 (5.7)	5 (4.4)	0.633
Other organ resection	4 (2.5)	3 (2.7)	0.956
Operative time (min, mean ± SD)	350 ± 58	314 ± 79	<0.001
Intraoperative blood loss (mL, mean ± SD)	502 ± 432	499 ± 383	0.948
Intraoperative red blood cell transfusions	8 (5.1)	9 (8)	0.338
Soft pancreas texture	74 (47.1)	58 (51.3)	0.496
Main pancreatic duct diameter (≤3 mm)	75 (48.1)	68 (60.2)	0.050
Type of stent			<0.001
Internal	48 (30.6)	95 (84.1)	
External	100 (63.7)	14 (12.4)	
None	9 (5.7)	4 (3.5)	

Values in parentheses are percentages unless otherwise indicated. SD, standard deviation.

received neoadjuvant concurrent chemoradiation therapy (5-fluroruracil-based chemoradiation, 54 Gy).

The type and extent of the surgical procedures in the two groups are presented in Table 2. In advanced periampullary malignant disease, portal vein (12 patients) or hepatic artery (one patient) segmental resection and primary anastomoses were performed. The anastomoses were interposed with cadaveric vein grafts in two patients with portal vein resections. Other organ resections included distal gastrectomies for three patients with early gastric cancers and for patients with advanced gastric cancer, right adrenalectomies were performed in two patients with a non-functioning adrenal adenoma and a pheochromocytoma, and a small bowel resection was performed in one patient with a gastrointestinal stromal tumour. Distal gastrectomy was included in en-bloc resection with conventional PD. Notably, the two patients with early gastric cancer and the patient with the gastrointestinal stromal tumour were in group 2. Of the seven patients who underwent other organ resection, POPF developed in three patients and wound dehiscence was observed in one patient. The complication rate was not significantly different between patients with other organ resection (n = 4, 57.1%) and without (n = 142, 54.0%) (P = 0.869). Seventeen patients (6.2%) required operative blood

Table 3 Post-operative complications and outcomes in patients who underwent pancreaticoduodenectomy with or without division of workload

	Group 1 (n = 157)	Group 2 (n = 113)	P
Overall morbidity	87 (55.4)	59 (52.2)	0.603
Abdominal complications			
Pancreatic fistula†			
A	41 (26.1)	28 (24.8)	0.804
B/C	12/5 (10.8)	2/1 (2.7)	0.011
Delayed gastric emptying	16 (10.2)	9 (8)	0.534
Post-pancreatectomy haemorrhage	7 (4.5)	1 (0.9)	0.145
Intra-abdominal fluid collection	12 (7.6)	6 (5.3)	0.448
Ascites	9 (5.7)	13 (11.5)	0.087
Marginal ulcer in the duodenojejunostomy or gastrojejunostomy	1 (0.6)	4 (3.5)	0.165
Wound infection	9 (5.7)	7 (6.2)	0.874
Other abdominal complications‡	5 (3.2)	3 (2.7)	0.800
Extra-abdominal complications			
Cardiac complications	2 (1.3)	2 (1.8)	0.739
Uncontrolled diabetes mellitus	3 (1.9)	0	0.267
Other complications§	5 (3.2)	3 (2.7)	0.800
Timing of drain removal (POD)	9 ± 5	8 ± 2	0.124
Persistent drain (n, more than 3 weeks)	4 (2.5)	1 (0.9)	0.404
Reoperation	7 (4.5)	0	0.044
Radiologic intervention	18 (11.5)	2 (1.8)	0.003
Post-operative hospital stay (days ± SD)	14 ± 6	12 ± 5	0.003
Hospital readmission	5 (3.2)	5 (4.4)	0.746
In-hospital mortality	1 (0.6)	0	0.999

†Post-operative pancreatic fistula was defined by the International Study Group on Pancreatic Fistula criteria. ‡Includes paralytic ileus, liver abscess, enterocutaneous fistula, superior mesenteric vein thrombosis, infectious colitis, cholangitis, leakage of the gastrojejunostomy site and post-operative pancreatitis. §Includes depression (three patients), pneumonia, bacteremia, common iliac artery occlusion, deep vein thrombosis and peroneal neuropathy. Values in parentheses are percentages unless otherwise indicated; POD, post-operative day; SD, standard deviation.

transfusions (mean = 2.5 U (range: 1–13 U) of packed red blood cells) because of bleeding. With the division of workload in group 2, the operative time was significantly shorter ($P < 0.001$). Notably, a significantly larger proportion of patients in group 1 had external pancreas stent drainage ($P < 0.001$).

Of the 89 patients with POPF, the number of patients with grade B or C pancreatic fistula was significantly lower in group 2 (2.7%) than in group 1 (10.8%). In regard to abdominal complications besides POPF, and extra-abdominal complications, there were no significant differences between the two groups (Table 3). In group 1, grade C POPF was observed in four patients after discharge who had initially been classified as grade A (three patients) and B when they were discharged. On the other hand, in groups 1 and 2, grade C POPF initially developed in one patient, respectively, before discharge. Reoperations were only required in seven patients in group 1. Wound repair for wound dehiscence was performed in three patients, bleeding control for small bowel bleeding in two patients, complete pancreatectomy for disruption of pancreaticojejunostomy in one patient and gastrojejunostomy repair for leakage in one patient. Of the 270 study subjects, 20 (7.4%) underwent radiologic intervention. Five of the 20 patients underwent angiographic coil embolization or stent insertion for pseudoaneurysm rupture in the common hepatic artery (two patients), proper hepatic artery (one patient), gastroduodenal artery (one patient) and the superior mesenteric artery (one patient). Only one of these patients was in group 2. Two patients developed common iliac artery occlusion and coronary artery disease post-operatively and they underwent angiographic stent insertion and percutaneous coronary intervention, respectively. Twelve patients who developed intra-abdominal fluid collection post-operatively underwent percutaneous drainage and one of them was in group 2. One patient with post-operative gastric bleeding was treated with endoscopic cauterization. One 70-year-old patient with pseudoaneurysm rupture of the common hepatic artery and the first branch of the superior mesenteric artery after PD underwent angiographic coil embolization and stent insertion two times, and although reoperation with bleeding control was performed, he died of multi-organ failure.

Of the three secondary operators, who each aided in the division of workload, no significant differences were observed between them with regard to post-operative complications and outcomes (Table 4). Patients with grade C POPF, who underwent pancreaticojejunostomy by surgeon 1, had pseudoaneurysm rupture and underwent angiographic stent insertion. Two patients with grade B POPF, who underwent pancreaticojejunostomy by surgeon 3, underwent percutaneous drainage and had persistent drain, respectively.

According to univariate analysis, preoperative serum albumin level (≤3.5 g/dL), other pathology except pancreatic adenocarcinoma, PD performed entirely by a single operator and soft pancreatic parenchyma were significantly associated with grade B and C pancreatic fistulas (Table 5). According to multivariate analysis using logistic regression, PD performed entirely by a single operator (odds ratio: 4.2, $P = 0.029$) was the only significant independent predictor of grade B and C pancreatic fistula (Table 6).

Discussion

Despite recent advancements in surgical procedures and post-operative management techniques, pancreatic fistula remains the most common post-operative complication after PD, even at

Table 4 Post-operative complications and outcomes for the secondary operators in the division of workload approach

	Surgeon 1 (n = 34)	Surgeon 2 (n = 36)	Surgeon 3 (n = 43)	P
Overall morbidity	17	19	23	0.952
Pancreatic fistula†				
A	7 (20.6)	11 (30.6)	10 (23.3)	0.601
B/C	0/1	0/0	2/0	0.636
Delayed gastric emptying	3 (8.8)	2 (5.6)	4 (9.3)	0.829
Post-pancreatectomy haemorrhage	0	0	1 (2.3)	0.999
Abdominal complications	8 (23.5)	10 (27.8)	13 (30.2)	0.806
Extra-abdominal complications	1 (2.9)	2 (5.6)	2 (4.7)	0.999
Radiologic intervention	1 (2.9)	0	1 (2.3)	0.755
Post-operative hospital stay (days ± SD)	13 ± 7	11 ± 2	12 ± 4	0.565
Hospital readmission	2 (5.9)	0	3 (7)	0.321

†Post-operative pancreatic fistula was defined by the International Study Group on Pancreatic Fistula criteria. Values in parentheses are percentages unless otherwise indicated. SD, standard deviation.

Table 5 Univariate analysis of risk factors for grade B and C pancreatic fistula

Risk factor	Pancreatic fistula		
	None or grade A (n = 250)	Grade B/C (n = 20)	P
Age (<70/ ≥70 years)	185/65	14/6	0.696
Gender (male/female)	142/108	12/8	0.781
Body mass index (≤25/ >25 kg/m^2)	210/40	17/2	0.530
ASA (I and II/III)	238/12	18/2	0.324
Preoperative total bilirubin (≤4/ >4 mg/mL)	198/52	13/7	0.146
Preoperative biliary drainage (yes/no)	135/115	14/6	0.173
Preoperative albumin (≤3.5/ >3.5 g/dL)	33/217	7/13	0.012 (OR = 3.5)
Histology			0.027 (OR = 9.8)
Pancreatic cancer	85	1	
Other pathologies	165	19	
Division of workload			0.019 (OR = 4.5)
Single operator	140	17	
Two operators	110	3	
Operation time (≤300/ >300 min)	79/171	2/18	0.060
Intraoperative blood loss (≤600/ >600 mL)	204/46	14/6	0.212
Intraoperative red blood cells transfusion (yes/no)	16/234	1/19	0.805
Pancreatic texture (soft/hard)	117/133	15/5	0.021 (OR = 3.4)
Main pancreatic duct (≤3/ >3 mm)	130/119	13/7	0.275
Stent insertion (internal/external)	135/102	8/12	0.149

ASA, American Society of Anesthesiologists; OR, odds ratio.

Table 6 Multivariate analysis of risk factors for clinically relevant pancreatic fistula

Risk factor	OR	95% CI	P
Preoperative albumin ≤3.5 g/dL	2.29	0.81–6.48	0.120
Other pathology besides pancreatic cancer	6.1	0.76–49.70	0.090
Single operator	4.2	1.15–15.09	0.029
Soft pancreatic texture	2.3	0.77–6.96	0.133

CI, confidence interval; OR, odds ratio.

high-volume centres.[18,19] Therefore, most surgeons strive to decrease the occurrence of POPF and research has been conducted on the various risk factors that significantly influence POPF. Outcomes in pancreatic surgery may be a reflection of the interplay between the surgeon, hospital and patient factors. There are many surgeon-specific factors that affect post-operative morbidity, such as age, gender, extent and type of training and operative volume or workload. Higher surgeon volumes in pancreatic surgery have been linked to an overall improvement in patient outcomes, including reduced intraoperative blood loss, shorter hospital stay, lower pancreas fistula rate and improved mortality.[1,9] However, Waljee *et al*.[14] reported that surgeon age is a relatively weak predictor of operative mortality. The experienced surgeon in this study is a high-volume surgeon who has performed more than 40 PDs annually. Because the number of pancreatic fistulas did not gradually decreased with his increased experience over the years, he adopted a division of the operative workload in an attempt to reduce the number of fistulas. We postulated that the more work for which a surgeon was responsible during an operation would result in a loss of concentration, inducing technical errors and lower emergency preparedness, and these results would be directly linked to post-operative outcomes.

Few reports exploring surgeon workload and pancreatic fistula exist in the current literature. However, one study did report that already experienced surgeons gained no additional measurable

benefit with an increased annual volume.[1] Thomas *et al*.[20] concluded that outcomes after pulmonary lobectomies may be adversely affected by primary surgeons having longer operating days and surgeon fatigue may be responsible for their findings. Halldorson *et al*.[21] reported that patient survival at 1 and 3 years after liver transplantation was dependent on the time interval between the surgeon's consecutive transplants and the number of operations per week. They suggested that these factors were a result of surgeon fatigue and assumed that fatigue had a cumulative effect in the surgeon. Even in liver transplantation, this high-risk procedure should be performed by an expert surgical team.[17] Because hepatic artery reconstruction is one of the most difficult and important procedures, highly trained surgeons in microvascular techniques should be utilized.[16]

Although our study does not address the potential mechanisms of the relationship between division of workload and operative outcomes, several factors may affect the outcomes. Complex procedures are long and require considerable physical and mental stamina. Previous studies have demonstrated that manual dexterity, strength and visuospatial ability decrease with age, as do the cognitive skill and ability to sustain attention.[22–25] Three young second operators took part in the division of workload group. Although they were not high-volume surgeons, they did have some superior abilities, as mentioned earlier, over the older, more experienced primary surgeon, and by the division of workload approach, they were able to focus on the reconstructions only. Although the physical fatigue that accompanies pancreas resection might affect a surgeon's ability to perform an entire pancreaticojejunostomy from start to finish, we could not demonstrate whether operator burden and exhaustion during the pancreaticojejunostomy is associated with division of workload because surgeon fatigue is not a testable objective measurement.

In the PD, it is important to resect the pancreas for the sake of overall survival, especially in cancer patients, and it is also important to perform pancreaticojejunostomy to improve post-operative morbidity. With this division of workload, each operator was able to concentrate solely on his duties. With the division of workload approach, we found clinically relevant pancreatic fistulas (grade B or C) in 2.7% of the patients, even though there were no significant differences between the two groups by the division of workload in overall morbidity and mortality. It has been suggested that grade A fistulas may lack clinical consequences, whereas grade B and C are not clinically silent and are valuable in delineating the impact of fistula severity.[3,10] In the present study, group 2 had fewer clinically relevant pancreatic fistulas and also had lower rates of reoperation and post-operative interventions. This indicates that group 2, with the division of workload, had fewer potentially life-threatening outcomes.

There are several limitations to our study because of its retrospective design. These data are limited and insufficient to more closely examine additional preoperative laboratory tests, the operative time required for individual procedures, physical or psychological status of the operators and post-operative management, which could influence outcomes after PD. In addition, surgical outcomes may have been influenced by different nutritional statuses of patients and the type of stents used in the two study groups. Therefore, we could not rule out confounding factors by unmeasured variables in our analysis. Because of the lack of risk adjustment, especially for the surgeon's age between the primary operator and secondary operators and individual operative volume of the secondary operators, we could not conclude whether the workload volume would affect surgical outcomes. Also, because the primary operator should alternate roles with the secondary operator, analyses comparing pancreatic fistula rates would be needed because secondary operators could potentially only be experienced in performing pancreaticojejunostomies. However, the experienced surgeon's overall incidence of clinically relevant pancreatic fistulas was 10.8% in this study, which is a similar rate to what other studies have reported.[2,3,5] The pancreatic anastomosis technique has been considered to be the most important factor in fistula development.[26,27] Even though secondary operators use the pancreatic anastomosis technique of the experienced surgeon, fine differences in their technique could affect the development of POPF. Going forward, prospective randomized controlled trials might clarify the impact of division of workload on the development of pancreatic fistula and such trials require large study groups for statistical power.

Conclusion

In conclusion, our study shows that dividing the surgeon's workload in PD is associated with lower rates of POPF. However, our study also suggests that division of workload in PD should not be the primary factor in preventing pancreatic fistula. Nonetheless, division of workload may be one solution by which POPFs are reduced when high-volume centres cultivate specialty surgeons for standardized pancreatic anastomosis procedures.

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