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Laparoscopic spleen-preserving distal versus central pancreatectomy for tumors in the pancreatic neck and proximal body

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Abstract

For benign and borderline tumors in the pancreatic neck and proximal body, laparoscopic spleen-preserving distal pancreatectomy (LSPDP) and laparoscopic central pancreatectomy (LCP) are alternative surgical procedures. Choosing between LSPDP and LCP is difficult. This retrospective cohort study was looking forward to provide evidence for clinical decision.

A total of 59 patients undergoing LSPDP (Kimura procedure) and LCP between June 2013 and March 2017 were selected. The clinical outcomes of patients were compared by χ^2 test or Fisher exact test and Student *t* test.

This study included 36 patients in LSPDP group, and 23 patients in LCP group. The overall complications incidence in LCP group was significantly higher than LSPDP group (35 *vs* 6%, $P = .004$), and the postoperative pancreatic fistula (POPF) (grade B and C) rate and abdominal infection rate in LCP group were still significantly higher than LSPDP group (POPF 22 vs 3%, $P = .019$; abdominal infection 35 vs 3%, $P = .001$, respectively). The length of resected pancreas was significantly longer in LSPDP group (9.8 ± 2.0 vs 5.3 ± 1.1 cm, $P = .007$). The median follow-up was 39 months (range 12–57 months). No patient was confronted by tumor recurrence. The proportion of postoperative pancreatin and insulin treatment in LCP group were similar to LSPDP group (9 vs 17%, $P = .383$; 0 vs 3%, $P = 1.000$, respectively).

For patients with poor general condition, the safety of LCP needs to be taken seriously; in some ways, LSPDP may be more secure, physiological, and easier operation for tumor located in pancreatic neck and proximal body.

Abbreviations: CP = central pancreatectomy, DP = distal pancreatectomy, hr = hour, ISGPF = International Study Group of Pancreatic Fistula, LCP = laparoscopic central pancreatectomy, LDP = laparoscopic distal pancreatectomy, LSPDP = laparoscopic spleen-preserving distal pancreatectomy, POPF = postoperative pancreatic fistula, SD = standard deviation.

Keywords: central pancreatectom, complications, follow up, minimally invasive surgery, pancreatic tumor, spleen-preserving distal pancreatectomy

1. Introduction

For benign or borderline tumors (eg, cystadenoma or neuroendocrine tumor, and so on) located in pancreatic neck and proximal body, the treatments usually adopt distal pancreatectomy (DP) or central pancreatectomy (CP).[1–3] With the surgical organ function protection has been focused on in recent years, it is generally believed that CP could preserve more normal pancreatic parenchyma, sustain endocrine and exocrine pancreatic functions, and CP seems to be more suitable for pancreatic tumors in pancreatic neck and proximal body.[2,4–7] At present, with the development of minimally invasive surgery,[8] to achieve the optimization of the damage control and accelerate the postoperative recovery, laparoscopic spleen-preserving distal pancreatectomy (LSPDP) and laparoscopic central pancreatectomy (LCP) are considered gradually that take place of traditional open operations.[9–12]

Focused on organ preservation and damage control, LSPDP and LCP are alternative surgical procedures for these tumors.[13] Because of special characteristics of laparoscopic operation, the real clinical value of LSPDP and LCP is controversial, choosing between LSPDP and LCP is difficult, and the decision needs to weigh the benefit of perioperative safety and long-term effects.

This retrospective cohort study evaluated patients who had underwent LSPDP and LCP in our hospital and compared complications and long-term postoperative pancreatic functions, and was looking forward to provide evidence for clinical decision.

2. Methods and materials

2.1. Data source

From June 2013 to March 2017, the clinical data of 82 patients who underwent LSPDP or LCP in West China Hospital, Sichuan

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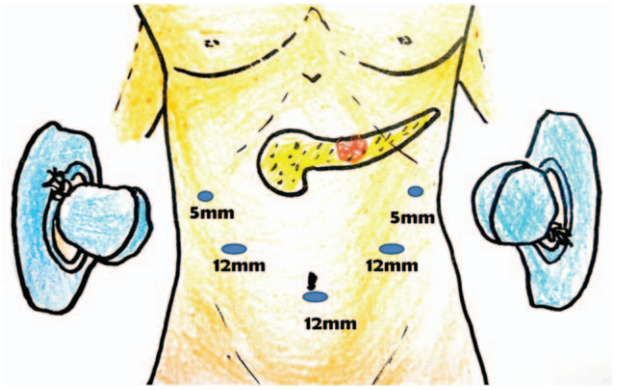

Figure 1. Operation position and trocar placement for LSPDP and LCP. LCP = laparoscopic central pancreatectomy; LSPDP = laparoscopic spleen-preserving distal pancreatectomy.

University were collected in this study. The patients chose the procedure for LSPDP or LCP by themselves after explanation of pros and cons. The surgical team was proficient for these procedures and had crossed the learning curve. The study was approved by the Ethics Committee of West China Hospital, Sichuan University.

The exclusion criteria are: patients who underwent LSPDP were not conservation of the splenic artery and vein (not Kimura procedure[14]); the anastomosis of patients who underwent LCP was not pancreaticojejunostomy; the procedure changed during the operation, such as planned LCP changed into LSPDP and planned laparoscopic surgery changed into open surgery; patients with preoperative insufficient pancreatic function, such as diabetes or high blood glucose and dyspepsia.

Finally, this retrospective study retained the clinical data of 59 patients, including 36 patients who underwent LSPDP (Kimura procedure), and 23 patients who underwent LCP.

2.2. Data collection and screening

Data including medical history, laboratory test results, details of the surgical operation (procedure, pancreatic texture, pancreatic duct diameter, operation time, intraoperative blood loss, intraoperative blood transfusion, and etc), pathologic analysis of the resected specimen , postoperative complications (postoperative pancreatic fistula (POPF) was defined according to 2016 update of the International Study Group of Pancreatic Fistula (ISGPF[15,16]) definition, excluded the biochemical leak) and follow up information (the median follow-up was 39 months) were collected retrospectively on all patients.

2.3. Surgical procedures

The operation position and trocar distribution were depicted in Figure 1. The patients underwent LSPDP in this study retained splenic artery and vein according to the techniques described by Kimura et al[14] (Kimura procedure, Fig. 2). A tunnel was created under the pancreas after removed splenic vein and artery from the body, through which the pancreas were cut off by surgical cut stapler (Echelon 60).[17,18] The distal pancreas with the tumor was resected toward the spleen; the short gastric vessels were preserved. The resection margin was about 1.0 cm from the tumor.[19] For patients who underwent LCP (Fig. 3), the tunnel under the pancreas was created anterior to the portal vein, and surgical cut stapler (Echelon 60) was used to cut off the proximal edge near the pancreatic head. Ultrasonic energy device was used to cut off the distal edge near the pancreatic tail; the main pancreatic duct of distal pancreatic resection surface was exposed and implanted a pancreatic duct stent as internal drainage for anastomosis. The distal pancreas was anastomosed to the jejunum because of mucosa anastomosis with Roux-en-Y reconstruction.[20]

2.4. Statistical analysis

All analyses were performed by SPSS software, version 21.0. Continuous variables were shown as mean ± standard deviation

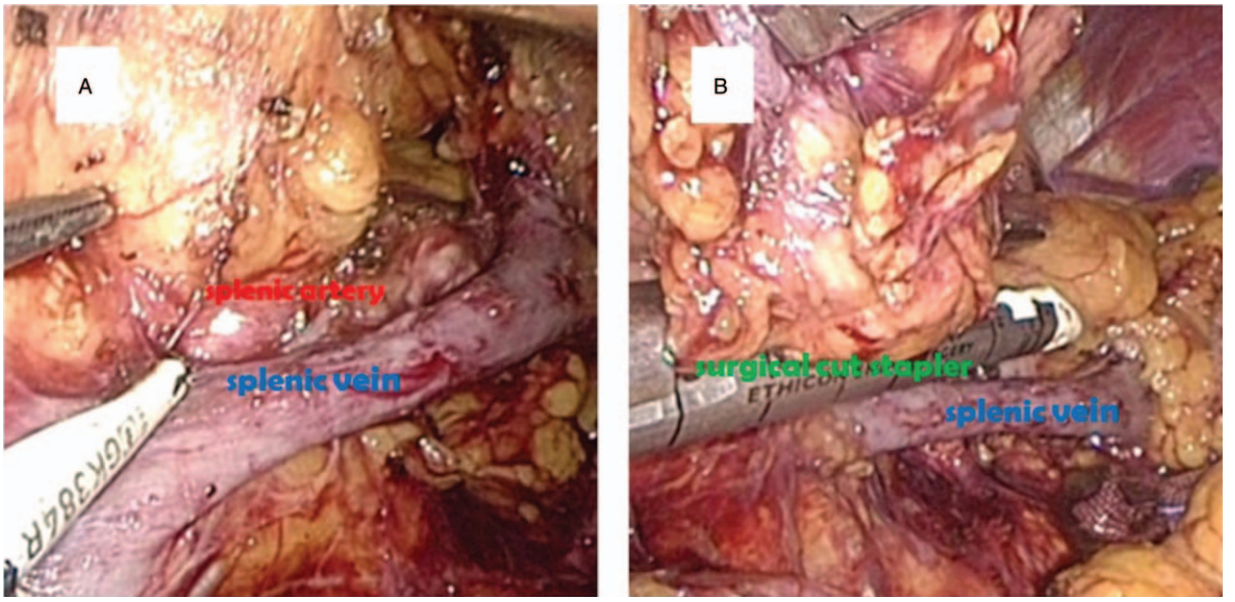

Figure 2. Surgical procedure of LSPDP (Kimura procedure). (A) Dissected splenic vein and artery from the pancreatic body. (B) Surgical cut stapler was used to cut off the pancreas, the resection margin was about 1.0 cm from the tumor. LSPDP = laparoscopic spleen-preserving distal pancreatectomy.

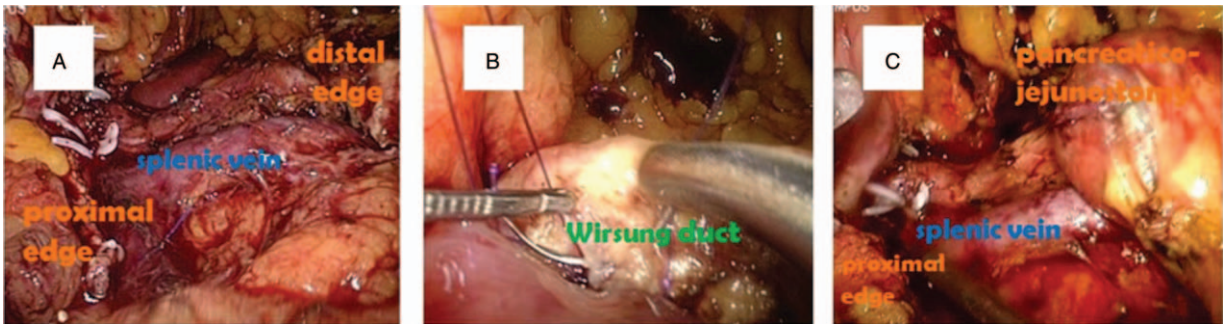

Figure 3. Surgical procedure of LCP. (A) The proximal and distal edges were shown after dissecting splenic vessels from the central pancreatic body. (B) The main pancreatic duct (Wirsung duct) of distal pancreatic resection surface was exposed. (C) The distal pancreas was anastomosed to the jejunum as duct to mucosa anastomosis. LCP = laparoscopic central pancreatectomy.

(SD) and compared by Student *t* test. Categorical data were shown as count (percentage) and compared by χ^2 test or Fisher exact test.

3. Results

3.1. General characteristics

The same surgical team performed all the procedures. LSPDP was planned for 45 patients with pancreas neck and proximal body tumor, 4.4% (2/45 cases) converted from LSPDP to laparoscopic distal pancreatectomy (LDP) with splenectomy. This study included 59 patients who underwent LSPDP (Kimura procedure) or LCP: 36 patients in LSPDP group and 23 patients in LCP group. There were 19 male and 40 female patients, with age from 18 to 72 years. The LSPDP group and LCP group were similar ($P > .05$) as per age, sex, preoperative factors (such as hypertension, diabetes mellitus, anemia, and so on), and history of smoking, alcohol intake, and abdominal surgery (Table 1).

Table 1

Baseline characteristics and intraoperative parameters of patients.

	LSPDP group (n = 36)	LCP group* (n = 23)	*P*
Age, y, mean ± SD	38.4 ± 13.2	46.1 ± 10.9	.393
Gender (female)	25 (69%)	15 (65%)	.735
Preoperative factors			
Hypertension	4 (11%)	1 (4%)	.363
Diabetes mellitus	0	0	—
Increased level of serum amylase	4 (11%)	3 (13%)	.823
Anemia	5 (14%)	1 (4%)	.237
Hypoproteinemia	2 (6%)	1 (4%)	.837
Weight loss (>5 kg)	2 (6%)	2 (9%)	.640
History of smoking	7 (19%)	5 (22%)	.831
History of alcohol intake	3 (8%)	3 (13%)	.559
History of abdominal surgery	7 (19%)	4 (17%)	.843
Intraoperative parameters			
Transfusion	2 (6%)	0 (0%)	.516
Pancreas texture			.650
Soft	24 (67%)	14 (61%)	
Hard	12 (33%)	9 (39%)	
Pancreatic duct diameter, mm			.548
≤3	29 (81%)	17 (74%)	
>3	7 (19%)	6 (26%)	
Operation time, h			.735
<4	25 (69%)	15 (65%)	
≥4	11(31%)	8 (35%)	

LSPDP = laparoscopic spleen-preserving distal pancreatectomy, LCP = laparoscopic central pancreatectomy.

3.2. Intraoperative parameters

Between the LSPDP group and LCP group, there were no statistical differences in intraoperative parameters with respect to transfusion, residual pancreas texture, pancreatic duct diameter, and operation time (Table 1). Most cases of these groups had soft pancreatic texture (about 64%) and thin pancreatic duct (diameter ≤3 mm, about 78%).

3.3. Postoperative pathologic findings

The length of resected pancreas was significantly longer in LSPDP group (9.8 ± 2.0 vs 5.3 ± 1.1 cm, $P = .007$). No significant differences were observed between the 2 groups in tumor size and tumor type (Table 2).

3.4. Postoperative outcomes

For all the patients, the total postoperative complications incidence was 16.9%, postoperative hospitalization mean time was 9.1 ± 3.7 days, reoperation rate was 5.1%, and postoperative mortality was 0. According to 2016 ISGPF definition (excluded the biochemical leak), the incidence of POPF was 10.2%. Postoperative hospital stay was significantly longer in the LCP group (≥10 days' ratio, as 48% vs 22%, $P = .040$), the overall complications incidence in LCP group was significantly higher than in LSPDP group (35% vs 6%, $P = .004$). Furthermore, the POPF (grade B and C) rate and abdominal infection rate in LCP group were still significantly higher than LSPDP group (POPF 22% vs 3%, $P = 0.019$; abdominal infection 35% vs 3%, $P = .001$, respectively). The postoperative exhaust time in patients undergoing LCP was significantly longer than LSPDP (4.4 ± 1.6 vs 2.5 ± 0.9 days, $P = .001$). In LCP group, 2 patients were confronted by postoperative hemorrhage, which is secondary to POPF and infection (9% v. 0%, $P = .148$). Two patients had reoperation (9% vs 3% in LCP and LSPDP groups respectively, $P = .313$) because of POPF and abdominal infection. In LSPDP group, 1 patient underwent reoperation for splenic infarction (Table 2).

Table 2

Postoperative pathologic findings and outcomes of patients.

	LSPDP group (n = 36)	LCP group (n = 23)	*P*
Pathologic findings			
Tumor size, cm	3.2 ± 0.9	2.7 ± 0.7	.331
Resected pancreas length, cm	9.8 ± 2.0	5.3 ± 1.1	.007
Pathologic diagnosis			
Serous cystadenoma	3 (8%)	5 (22%)	.142
Mucinous cystadenoma	13 (36%)	6 (26%)	.422
Neuroendocrine tumor	4 (11%)	5 (22%)	.268
SPN	14 (39%)	5 (22%)	.169
IPMN	0	1 (4%)	.390
Other*	2 (6%)	1 (4%)	.837
Postoperative outcomes			
Postoperative hospital stay			.040
<10 days	28 (78%)	12 (52%)	
≥10 days	8 (22%)	11 (48%)	
Exhaust time (days), mean ± SD	2.5 ± 0.9	4.4 ± 1.6	.001
Overall complications incidence	2 (6%)	8 (35%)	.004
POPF (Grade B + C)	1 (3%)	5 (22%)	.019
Hemorrhage	0	2 (9%)	.148
Abdominal infection	1 (3%)	8 (35%)	.001
Splenic infarction	1 (3%)	0	1.000
MODS	0	0	—
Death	0	0	—
Reoperation	1 (3%)	2 (9%)	.313
Follow-up			
Postoperative pancreatitis	0	2 (9%)	.148
Pancreatin treatment	6 (17%)	2 (9%)	.383
Insulin treatment	1 (3%)	0	1.000

IPMN = intraductal papillary-mucinous neoplasm of the pancreas, LCP = laparoscopic central pancreatectomy, LSPDP = laparoscopic spleen-preserving distal pancreatectomy, MODS = multiple organ dysfunction syndrome, POPF = postoperative pancreatic fistula, SPN = solid pseudopapillary neoplasm.

* Include mass forming chronic pancreatitis and pancreatic rupture because of abdominal trauma.

3.5. Follow-up of pancreatic function

The patients were followed up by telephone interviews and outpatient review. The median follow-up was 39 months (range 12 –57months). None patient confronted by tumor recurrence. 2 patients in LCP group developed postoperative pancreatitis 4 and 6 months after surgery due to pancreaticojejunostomy stenosis, respectively. There were no significant differences between the 2 groups in pancreatic endocrine and exocrine function. The proportion of postoperative pancreatin and insulin treatment in LCP group was similar to LSPDP group (pancreatin: 9% vs17%, $P = .383$; insulin: 0 vs 3%, $P = 1.000$, respectively) (Table 2).

4. Discussion

For benign or borderline tumor located in pancreatic neck and proximal body, traditional open DP and CP are major surgical treatments.[1,2] Since 1994, Gagner and Pomp[21] reported the first laparoscopic pancreatoduodenectomy surgery; laparoscopic surgery was widely used in pancreatectomy for less tissue injury and earlier recovery in recent years.[8,10] With the development of organ preservation and damage control surgery,[22] the laparoscopic pancreatectomy is more suitable for these tumors.[10,13,23,24]

Many reports suggested that CP could preserve more normal pancreatic parenchyma, reduce postoperative endocrine and exocrine pancreatic insufficiency, and CP seemed to be more suitable for these tumors.[2,4–7] However, these reports emphasized long-term effects, but paid insufficient attention to perioperative safety; furthermore, the operations reported in the literature were mainly open surgery, and these viewpoints were not in line with the surgical technique status quo with the time passing.

Both LSPDP and LCP can preserve the spleen and resect tumor with partial pancreas. LSPDP and LCP are alternative and optimal surgical procedures for these tumors focused on organ preservation and damage control.[12] Choosing between LSPDP and LCP is difficult; there have been quite few studies directly comparing the perioperative safety and long-term effects between patients undergoing LSPDP and LCP.

From June 2013 to March 2017, 59 patients undergoing LSPDP (Kimura procedure) or LCP were enrolled in this study. It included 36 patients in LSPDP group, and 23 patients in LCP group. Two of 45 cases (4.4%) converted from LSPDP to LDP (with splenectomy). It was shown that the general characteristics and major pathologic findings of patients between LSPDP group and LCP group were similar ($P > .05$), such as age, sex, preoperative factors, and tumor size and types, among others.

In the aspect of surgical technique, the operative difficulty of LCP is pancreaticojejunostomy,[13,25] whereas that of LSPDP is dissecting splenic vessels from the pancreas.[14] It is seemed that the risk of bleeding during the operation is higher in LSPDP. But this study suggested there was no statistical difference in intraoperative transfusion between LCP and LSPDP groups (0 vs 6%, $P = .516$), but 1 patient underwent reoperation for splenic infarction in LSPDP group.[26] Speicher et al[25] reported pancreatic anastamosis was most difficult technique in laparoscopic pancreatectomy by the learning curve. Majority of cases in this study were soft pancreatic texture (about 64%) and thin pancreatic duct (diameter ≤3 mm, about 78%); pancreaticojejunostomy in LCP was even more difficult. The surgical technique of LCP is more difficult than LSPDP. With repeated training, the operation time between LCP and LSPDP groups was similar (≥4 hours, 35% vs 31%, $P = .735$).

This study investigated that the overall complications incidence was significantly higher in LCP group than LSPDP group (35 vs 6%, $P = .004$). Lv et al[27] reported that overall complications rate of traditional CP was higher as compared with outcomes following DP (68.7 vs 23%, $P = .003$). It was also indicated that the overall complications rate of LCP and LSPDP groups in this study was lower than traditional CP and DP reported in literature,[20,27,28] that might attribute to the fact that laparoscopic surgery was more accurate and with less tissue injured.[10] POPF is considered as most spiny and risky complication after pancreatectomy.[15] It can lead to other severe complications, such as bleeding, intra-abdominal abscesses and sepsis, and even death.[15] According to updated 2016 ISGPF standard, excluding the biochemical leak, the POPF incidence of overall patients was 10.2%. The POPF (grade B and C) rate in LCP group was still significantly higher than LSPDP group (POPF 22% vs 3%, $P = .019$). Other reports also suggested POPF rate after open CP was higher than that of open DP.[5]

As for the reasons that LCP associates with higher POPF rate, on the one hand, the pancreatic stump in LCP (with 2 stumps) is more than LSPDP (with 1 stump),[27] whereas on the other one hand, the main pancreatic duct of distal pancreatic stump surface is exposed and anastomosed to the jejunum in LCP (the pancreatic duct is much smaller closer to the tail side of pancreas, duct to mucosa pancreaticojejunostomy is difficult); however, the main pancreatic duct of pancreatic stump surface is closed by

surgical stapler in LSPDP, theoretically. In addition, because of the pancreaticojejunostomy in LCP, the intestinal juice is mixed with pancreatic juice, pancreatic enzyme is vulnerable to activated by intestinal juice, and the POPF may become more severe.[29] In LCP group, 2 patients confronted by postoperative hemorrhage which is secondary to POPF and infection (LCP vs LSPDP: 9% vs 0%, $P=.148$). Two patients with reoperation were because of POPF and abdominal infection (LCP vs LSPDP: 9% vs 3%, $P=.313$).[30] Postoperative hospital stay was significantly longer in the LCP group (≥10 days' ratio, as 48% vs 22%, $P=.040$). Therefore, surgeons need to pay attention to the postoperative safety of LCP.

Many reports suggested that preserving more normal pancreas tissue could effectively decrease endocrine and exocrine insufficiency after pancreatectomy. Compared with DP, CP could preserve more normal pancreatic parenchyma, and sustain pancreatic functions.[2,4–7] Crippa et al[7] reported incidence of new endocrine and exocrine insufficiency was significantly lower in the CP group (4% vs 38%, $P=.0001$ and 5% vs 15.6%, $P=.039$, respectively) after a median follow-up of 54 months. DiNorcia et al[6] reported CP patients had a lower rate of diabetes than DP patients (14% vs 46%; $P=.003$); only 1 CP patient required insulin compared with 14 DP patients ($P=.002$). Most of these reports compared traditional CP with extended left pancreatectomy. The extended left pancreatectomy leaded to more normal pancreas' tissue loss. In this study, the resection margin was determined by the location of the tumor, about 1.0 cm from the tumor, which could preserve as much normal pancreas tissue as possible. The length of resected pancreas was significantly longer in LSPDP group than LCP group (9.8 ± 2.0 vs 5.3 ± 1.1 cm, $P=.007$). The definition of endocrine and exocrine insufficiency was lack of unified standard in literatures.[2,7,27] In this study, we focused on the quality of life after operation, used whether needing postoperative pancreatin and insulin treatment to evaluate endocrine and exocrine pancreatic functions. The results suggested that the proportion of postoperative pancreatin and insulin treatment in LCP group were similar to LSPDP group (pancreatin: 9% vs 17%, $P=.383$; insulin: 0 vs 3%, $P=1.000$, respectively). Although LCP could preserve more normal pancreatic parenchyma, the efficiency of decreases endocrine and exocrine insufficiency was statistically insignificant. Lv et al[27] observed that patients undergoing DP rarely occurred in pancreatic endocrine and exocrine insufficiency. Seaquist and Robertson[31] suggested that healthy humans might compensate for hemipancreatectomy by increasing glucose disposal to maintain normoglycemia. Whether humans can compensate for pancreatectomy to maintain normal blood glucose level or not is uncertain,[32] and the mechanism for that is unclear. The mechanism may be associated with insulin sensitivity increased, but need more researches to reveal.

There are several issues easily neglected in most studies of CP which need to be emphasized. In conventional CP procedure, the distal pancreas stump is anastomosed to the jejunum with Roux-en-Y enteroenterostomy reconstruction.[20] Compared with LSPDP, the additional reconstruction of LCP is more inconformity with physiological structure of human. It was shown that the postoperative exhaust time in patients undergoing LCP was significantly longer than LSPDP (4.4 ± 1.6 vs 2.5 ± 0.9 days, $P=.001$). The Roux-en-Y enteroenterostomy needs close the mesentery hiatus, it is hard to operate well in laparoscopic surgery, and there are potential risks of intestinal hernia and obstruction for LCP. Some reports mentioned that the Roux-en-Y enteroenterostomy might be associated with metabolic disorder.[33,34] Furthermore, our study suggested that 2 patients in LCP group with postoperative pancreatitis owing to pancreaticojejunostomy stenosis occurred at postoperative month 4 and 6, respectively. The postoperative pancreatitis and pancreaticojejunostomy stenosis need be taken care after LCP.

In conclusion, with development of organ preservation and damage control surgery, the laparoscopic pancreatectomy is more suitable for benign or borderline tumor located in pancreatic neck and proximal body by reason of the laparoscopic surgery was more accurate and with less tissue injured. Both LSPDP and LCP are alternative surgical procedures. The overall complications rate of LSPDP and LCP groups was lower than traditional DP and CP.

The surgical technique of LCP is more difficult than LSPDP. The safety of LCP needs to be taken seriously; this study indicated more severe outcomes in LCP group than LSPDP group, such as overall complications, the POPF (grade B and C) and abdominal infection, postoperative exhaust time, hemorrhage, and hospital stay among others. Although LCP could preserve more normal pancreas tissue in this study, the efficiency of decrease in endocrine and exocrine was statistically insignificant. Therefore, with alternative treatments becoming more mature for postoperative insufficiency of pancreatic functions, for patients with poor general condition, LSPDP may be more secure, physiological, and easier operation for benign or borderline tumor located in pancreatic neck and proximal body.

Author contributions

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Writing – review & editing: Chunlu Tan, Xing Wang, Bing Peng, Xubao Liu, Kezhou Li.

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