

## Laparoscopic vs open distal pancreatectomy for solid pseudopapillary tumor of the pancreas

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Supported by The Key Project Grant from the Science and Technology Department of Zhejiang Province, No. 2011C13036-2

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Received: June 8, 2013

Revised: August 3, 2013

Accepted: August 28, 2013

Published online: October 7, 2013

### Abstract

**AIM:** To compare short- and long-term outcomes of laparoscopic vs open distal pancreatectomy for solid pseudopapillary tumor (SPT) of the pancreas.

**METHODS:** This retrospective study included 28 patients who underwent distal pancreatectomy for SPT of the pancreas between 1998 and 2012. The patients were divided into two groups based on the surgical approach: the laparoscopic surgery group and the open surgery group. The patients' demographic data, operative results, pathological reports, hospital courses, morbidity and mortality, and follow-up data were compared between the two groups.

**RESULTS:** Fifteen patients with SPT of the pancreas underwent laparoscopic distal pancreatectomy (LDP), and 13 underwent open distal pancreatectomy (ODP). Baseline characteristics were similar between the two groups except for a female predominance in the LDP

group (100.0% vs 69.2%,  $P = 0.035$ ). Mortality, morbidity (33.3% vs 38.5%,  $P = 1.000$ ), pancreatic fistula rates (26.7% vs 30.8%,  $P = 0.728$ ), and reoperation rates (0.0% vs 7.7%,  $P = 0.464$ ) were similar in the two groups. There were no significant differences in the operating time (171 min vs 178 min,  $P = 0.755$ ) between the two groups. The intraoperative blood loss (149 mL vs 580 mL,  $P = 0.002$ ), transfusion requirement (6.7% vs 46.2%,  $P = 0.029$ ), first flatus time (1.9 d vs 3.5 d,  $P = 0.000$ ), diet start time (2.3 d vs 4.9 d,  $P = 0.000$ ), and postoperative hospital stay (8.1 d vs 12.8 d,  $P = 0.029$ ) were significantly less in the LDP group than in the ODP group. All patients had negative surgical margins at final pathology. There were no significant differences in number of lymph nodes harvested (4.6 vs 6.4,  $P = 0.549$ ) between the two groups. The median follow-up was 33 (3-100) mo for the LDP group and 45 (17-127) mo for the ODP group. All patients were alive with one recurrence.

**CONCLUSION:** LDP for SPT has short-term benefits compared with ODP. Long-term outcomes of LDP are similar to those of ODP.

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**Key words:** Solid pseudopapillary tumor; Pancreatic tumor; Laparoscopic surgery; Distal pancreatectomy

**Core tip:** Solid pseudopapillary tumor (SPT) of the pancreas is a rare neoplasm. Laparoscopic distal pancreatectomy (LDP) and open distal pancreatectomy (ODP) for SPT have not previously been compared. We compared the short-term and long-term outcomes among patients undergoing either LDP or ODP for SPT. Our results showed that LDP for SPT had the advantages of minimally invasive surgery, less intraoperative blood loss, and rapid recovery. The mortality, morbidity, oncological outcome, and long-term outcome of LDP were similar to those of open surgery.

Zhang RC, Yan JF, Xu XW, Chen K, Ajoodhe H, Mou YP. Laparoscopic vs open distal pancreatectomy for solid pseudopapillary tumor of the pancreas. *World J Gastroenterol* 2013; 19(37): 6272-6277 Available from: URL: <http://www.wjgnet.com/1007-9327/full/v19/i37/6272.htm> DOI: <http://dx.doi.org/10.3748/wjg.v19.i37.6272>

## INTRODUCTION

Solid pseudopapillary tumor (SPT) of the pancreas is a rare neoplasm, accounting for 0.17%-2.7% of all pancreatic tumors, and affecting predominantly young women<sup>[1]</sup>. Frantz<sup>[2]</sup> first described the tumor in 1959 as a papillary tumor of the pancreas. The tumor has been named as a papillary epithelial neoplasm, solid and cystic tumor, solid and papillary tumor, papillary cystic tumor, and solid and papillary epithelial neoplasm depending on its histological features including cystic, solid, and pseudopapillary structures<sup>[1,3]</sup>. In 1996, the World Health Organization renamed this tumor as SPT<sup>[4]</sup>. SPT is of unclear histopathogenesis, and low-grade malignancy, malignant degeneration and lymph node metastasis rarely occur<sup>[1,5]</sup>. Surgical resection of this tumor could result in long-term survival<sup>[1]</sup>.

Laparoscopic resection of the pancreas, including enucleation, pancreaticoduodenectomy, and distal and central pancreatectomy, has been recently described; some of the patients could have benefited from these procedures<sup>[6-10]</sup>. Until April 2013, about 86 cases of laparoscopic/robot-assisted resection for SPT have been reported in the English-language literature. Most of these are case reports and small series. However, there are few reports comparing short-term and long-term outcomes among patients who underwent laparoscopic distal pancreatectomy (LDP) vs open distal pancreatectomy (ODP) for SPT of the pancreas.

The goal of the present study was to compare short-term and long-term outcomes in patients undergoing either LDP or ODP for SPT of the pancreas.

## MATERIALS AND METHODS

### Patient sample and data collection

Between May 1998 and December 2012, 55 patients underwent pancreatectomy for SPT of the pancreas at Sir Run Run Shaw Hospital, Hangzhou, China. We retrieved 29 patients who underwent distal pancreatectomy. One patient with liver metastasis and colon cancer was excluded from the study, and 28 patients were included in this study. The medical records of all patients were retrospectively reviewed, including demographics, clinical presentation, operative results, hospital course, morbidity and mortality, pathological findings, and long-term follow-up data. The Institutional Review Board of Sir Run Run Shaw Hospital of Zhejiang University approved this study protocol.

### Surgical procedure

All operations were performed by four experienced surgeons using our institution's standardized technique. Laparoscopic pancreatic surgery was adopted in 2003 at our institution, therefore, all of the patients who underwent surgery from 1998 to 2003 were included in the open surgery group. After 2003, the surgeons could decide whether to perform laparoscopic or open surgery with the informed consent of the patients.

### Operative technique used for distal pancreatectomy

The operative procedure for LDP has been described previously<sup>[11,12]</sup>. Briefly, the patient was placed in supine position with the head slightly elevated. The surgeon and the second assistant who held the laparoscope stood on the right side of the patient and the first assistant stood on the left. One initial 10-mm trocar was placed for laparoscopy below the umbilicus. A 30-degree telescope was inserted to examine the peritoneal cavity to rule out metastatic disease. After general examination, the other four trocars (one 12 mm, three 5 mm) were inserted into the left upper flank, left flank, right upper flank, and right flank quadrants; and the five trocars were arranged in a V shape. Under pneumoperitoneum, the gastrocolic ligament was divided for entrance to the lesser sac using a harmonic scalpel (Harmonic Ace; Ethicon Endo-Surgery, Cincinnati, OH, United States). The mobilization of the pancreas began at the superior border until the proximal splenic artery was visualized. The pancreas was mobilized at the inferior border to visualize the superior mesenteric and splenic veins. After creating a tunnel behind the neck of the pancreas, the pancreas was transected with an endoscopic linear stapler (Endocutter 60 stapler, white or blue cartridge; Ethicon Endo-Surgery, Cincinnati, OH, United States). For spleen-preserving procedures, the distal pancreas was freely dissected from the splenic vessels by ligation of the small branches connected to the pancreas using small titanium vascular clips or a harmonic scalpel. In the case of DP with splenectomy, the splenic artery and splenic vein were divided. The spleen was resected with the pancreas.

ODP was performed in the same manner as LDP through an upper midline incision. However, a variety of techniques, including suturing and/or stapling, were used to control the pancreas stump, according to the preference of the individual surgeon.

### Postoperative management

Diet was started after the first flatus had been passed. Patients were discharged if they considered themselves sufficiently recovered; tolerated food without any significant discomfort; and had no major complications. Postoperative pancreatic fistula was defined as any measurable volume of drainage fluid (amylase > 3 times the upper limit of normal serum value) on or after postoperative day 3<sup>[13]</sup>. Three different grades of postoperative pancreatic fistula (A-C) were defined according to the clinical impact on the patient's hospital course<sup>[13]</sup>. Postoperative mortality

**Table 1** Baseline characteristics of patients undergoing laparoscopic distal pancreatectomy or open distal pancreatectomy for pancreatic solid pseudopapillary tumor *n* (%)

Characteristics	LDP ( <i>n</i> = 15)	ODP ( <i>n</i> = 13)	<i>P</i> value
Age (yr)	35.4 ± 13.0	35.2 ± 16.6	0.965
Sex			0.035
Male	0 (0.0)	4 (30.8)	
Female	15 (100.0)	9 (69.2)	
BMI (kg/m <sup>2</sup> )	20.8 ± 2.3	22.4 ± 6.1	0.392
Symptoms			0.255
No	10 (66.7)	5 (38.5)	
Yes	5 (33.3)	8 (61.5)	
Comorbidity	4 (26.7)	4 (30.8)	1.000
ASA score			1.000
1	9 (60.0)	8 (61.5)	
2	6 (40.0)	5 (38.5)	
Tumor size (cm)	5.1 ± 1.6	7.7 ± 4.1	0.050
Spleen preservation			0.639
No	13 (86.7)	10 (76.9)	
Yes	2 (13.3)	3 (23.1)	
Combined resection			1.000
Gallbladder	0 (0.0)	1 (7.7)	
Gastric stromal tumor	1 (6.7)	0 (0.0)	

Data are expressed as *n* (%) or mean ± SD or unless otherwise specified. BMI: Body mass index; ASA: American Society of Anesthesiologists; LDP: Laparoscopic distal pancreatectomy; ODP: Open distal pancreatectomy.

was defined as death occurring within 30 d after surgery.

### Patient follow-up

Patients were followed up as outpatients by telephone. We included data up to the last follow-up in March 2013. Recurrence or distant metastasis was diagnosed pathologically by surgical resection, biopsy, or cytology and/or radiological examination. The fasting blood glucose level (normal ≤ 110 mg/dL) was used to evaluate pancreatic endocrine function. The clinical evaluation was used to assess the pancreatic exocrine function. Patients with diarrhea, weight loss, and fatty stools were considered to have pancreatic exocrine insufficiency.

### Statistical analysis

Continuous clinicopathological data were expressed as median (range) or mean ± SD as appropriate. Categorical variables were reported as number and percentage. Continuous clinicopathological data were analyzed with Student's *t* test (or Mann-Whitney *U* test). Categorical variables were analyzed with the  $\chi^2$  test (or Fisher's exact test). All statistical analyses were performed using SPSS version 16.0. *P* < 0.05 was considered statistically significant.

## RESULTS

### Baseline characteristics

Table 1 summarizes the baseline characteristics of the LDP and ODP groups. Fifteen patients underwent LDP and 13 ODP. The two groups were balanced in terms of their baseline characteristics: age, body mass index (BMI), symptoms, comorbidity, American Society of Anesthesiologists (ASA) score, tumor size, spleen preservation

**Table 2** Surgical outcomes of laparoscopic distal pancreatectomy and open distal pancreatectomy for pancreatic solid pseudopapillary tumor *n* (%)

Outcomes	LDP ( <i>n</i> = 15)	ODP ( <i>n</i> = 13)	<i>P</i> value
Operating time (min)	171 ± 54	178 ± 75	0.755
EBL (mL)	149 ± 127	580 ± 400	0.002
Transfused patients	1 (6.7)	6 (46.2)	0.029
First flatus time (d)	1.9 ± 0.5	3.5 ± 0.9	0.000
Diet start time (d)	2.3 ± 0.7	4.9 ± 2.1	0.000
Postoperative hospital stay (d)	8.1 ± 1.7	12.8 ± 6.8	0.029
Morbidity	5 (33.3)	5 (38.5)	1.000
Pancreatic fistula	4 (26.7)	4 (30.8)	0.972
Grade A	2 (13.3)	2 (15.4)	
Grade B	0 (0.0)	0 (0.0)	
Grade C	2 (13.3)	2 (15.4)	
Intra-abdominal abscess	1 (6.7)	0 (0.0)	1.000
Pleural effusion	0 (0.0)	1 (7.7)	0.464
Reoperation	0 (0.0)	1 (7.7)	0.464
Percutaneous drainage	2 (13.3)	2 (15.4)	1.000
Mortality	0 (0.0)	0 (0.0)	-

Data are expressed as *n* (%) or mean ± SD or unless otherwise specified. EBL: Estimated blood loss; LDP: Laparoscopic distal pancreatectomy; ODP: Open distal pancreatectomy.

rate, and combined resection rate, except for a significant female predominance in the LDP group: 100% women (*n* = 15) compared with 69.2% (*n* = 9) in the ODP group (*P* = 0.035).

### Surgical outcomes in the LDP and ODP groups

Table 2 summarizes the operative outcomes and hospital courses of the LDP and ODP groups. There were no significant differences in the operating time (171 min *vs* 178 min, *P* = 0.755) between the two groups. LDP produced a significantly lower amount of intraoperative blood loss (149 mL *vs* 580 mL, *P* = 0.002), lower transfusion requirement (6.7% *vs* 46.2%, *P* = 0.029), shorter first flatus time (1.9 d *vs* 3.5 d, *P* = 0.000), shorter diet start time (2.3 d *vs* 4.9 d, *P* = 0.000), and shorter postoperative hospital stay (8.1 d *vs* 12.8 d, *P* = 0.029) than ODP.

There were no significant differences in postoperative complication rates (33.3% *vs* 38.5%, *P* = 1.000), pancreatic fistula rates (26.7% *vs* 30.8%, *P* = 0.972), and reoperation rates (0.0% *vs* 7.7%, *P* = 0.464) between the two groups. One patient underwent laparotomy for acute peritonitis after open spleen-preserving DP. We found biliary and pancreatic fistulas from the pancreatic stump. A calculus (diameter 6 mm) was incarcerated in the distal common bile duct, which led to bile regurgitation through the pancreaticobiliary common channel. The procedure consisted of cholecystectomy, common bile duct exploration, T tube drainage, and suture of the pancreatic remnant. The patient was discharged 24 d after the second operation. No perioperative mortality was recorded.

### Pathological characteristics

Table 3 shows the pathological characteristics of the two groups. All patients had negative surgical margins at final

**Table 3** Pathological characteristics of patients undergoing laparoscopic distal pancreatectomy or open distal pancreatectomy for pancreatic solid pseudopapillary tumor *n* (%)

Characteristics	LDP ( <i>n</i> = 15)	ODP ( <i>n</i> = 13)	<i>P</i> value
Harvested lymph nodes	4.6 ± 4.1	6.4 ± 6.2	0.549
Negative surgical margin	15 (100.0)	13 (100.0)	-
Invasion of peripancreatic tissue	4 (26.7)	2 (15.4)	0.655
Perineural invasion	1 (6.7)	1 (7.7)	1.000
Liver metastasis	0 (0.0)	0 (0.0)	-
Lymphatic metastasis	0 (0.0)	0 (0.0)	-
Invasion of adjacent organs	0 (0.0)	0 (0.0)	-
Angioinvasion	0 (0.0)	0 (0.0)	-

Data are expressed as *n* (%) or mean ± SD or unless otherwise specified. LDP: Laparoscopic distal pancreatectomy; ODP: Open distal pancreatectomy.

pathology. An average number of 5.3 lymph nodes were resected without metastases. There was no significant difference in the number of harvested lymph nodes (4.6 *vs* 6.4, *P* = 0.549) between the two groups. In seven (25%) patients, the pathological findings were consistent with malignant features of SPT<sup>[14]</sup>. The malignant features included local invasion of peripancreatic tissue (*n* = 6), perineural invasion (*n* = 2), no liver metastasis, invasion of adjacent organs and angioinvasion. There were no significant differences in the pathological characteristics between the two groups.

### Long-term outcomes

The median follow-up was 33 (3-100) mo for the LDP group and 45 (17-127) mo for the ODP group. All patients were alive with one recurrence. A 57-year-old female patient underwent ODP, and the pathology report revealed SPT with peripancreatic tissue invasion and perineural invasion. Six years after surgery, she developed peritoneal recurrence, which was treated by open tumorectomy and traditional Chinese medicine. At a follow-up of 15 mo after the second operation, no tumor recurrence was found. After surgery, six patients developed pancreatic exocrine or endocrine insufficiency; two received pancreatic enzyme therapy; and one developed diabetes and received insulin therapy. There were three cases of hyperglycemia with diet control.

## DISCUSSION

SPT is an uncommon pancreatic neoplasm with nonspecific symptoms or completely asymptomatic<sup>[1]</sup>. A review of 718 patients with SPT showed that the most common localization of the tumor was the distal pancreas [tail (247 patients, 35.9%), body (102 patients, 14.8%), and body and tail (71 patients, 10.3%)]<sup>[1]</sup>. This was also demonstrated in our series (29 patients, 52.7%). Therefore, DP with/without splenectomy is the most common surgical procedure for SPT. Complete resection of SPT offers benefits in almost all patients, and extensive lymphatic dissection is not indicated<sup>[1,15]</sup>. With the feasibility

and safety of LDP being proven<sup>[16,17]</sup>, it seems that LDP is thought to be more appropriate for SPT of the distal pancreas.

The first surgical resection of a pancreatic SPT was performed in 1970 and laparoscopic SPT resection in 2003<sup>[18,19]</sup>. The first series of laparoscopic SPT resection (10 cases) was published by Cavallini *et al*<sup>[20]</sup> in 2011. They regarded that LDP was a safe and feasible procedure for patients with SPT. However, no comparative analysis with open surgery was done. Kang *et al*<sup>[21]</sup> found smaller tumor size, earlier oral intake, and shorter hospital stay, without increasing morbidity in the laparoscopic (8 cases)/robot-assisted (3 cases) surgery group (*P* < 0.05) compared with open surgery group. To the best of our knowledge, the present series is the largest comparison of LDP and ODP for SPT. Our results indicated that LDP for SPT was associated with less operative blood loss and transfusion requirement, earlier first flatus and diet start, and shorter hospital stay compared to ODP, without increasing surgery-related risks (Table 2). The pathological examination showed that LDP for SPT provided similar oncological outcomes (harvested lymph nodes and margin status) as compared with ODP (Table 3). Long-term outcomes of laparoscopic surgery were comparable to those of open surgery. We believe that LDP for SPT could produce better short-term outcomes than ODP, without affecting oncological and long-term outcomes.

Our data and literature<sup>[1]</sup> showed that patients with SPT are expected to have a long-term survival after resection. At a median follow-up of 39 mo, 6 patients developed pancreatic exocrine or endocrine insufficiency. Thus, quality of life should be considered when choosing surgical procedure. Function-preserving laparoscopic pancreatectomy, including laparoscopic central pancreatectomy (LCP), spleen-preserving (SP)-LDP is thought to be an ideal procedure for this tumor. Some experts have reported the surgical technique of LCP with operative outcomes in small case series<sup>[9,10]</sup>. Three patients with SPT underwent LCP in our center. Nevertheless, the number of patients was too small to draw any conclusion. With the advances in instrumentation and accumulating experience, LCP would be an alternative procedure for SPT in the neck or proximal body of the pancreas.

As compared with SP-LDP, LDP with splenectomy tends to impair quality of life, with frequent higher-grade complications and prolonged hospital stays<sup>[22]</sup>. Butturini *et al*<sup>[23]</sup> compared the results of patients who underwent SP-LDP with or without splenic vessel conservation, and showed that postoperative morbidity did not differ between the two groups. The rate of perigastric varices was 60.0% after splenic vessel resection and 21.7% after splenic vessel conservation (*P* = 0.123)<sup>[23]</sup>. No gastrointestinal bleeding occurred at a median follow-up of 69 (37-139) mo<sup>[23]</sup>. In our series, only two patients underwent SP-LDP with splenic vessel conservation and 13 patients underwent LDP with splenectomy. For the small number of cases, there was no comparability between SP-LDP with splenic vessel conservation group and LDP with



splenectomy group. Considering the low malignancy of SPT and high rate of perigastric varices after splenic vessel resection, it is best to try to preserve the spleen with splenic vessels.

Recently, Fais *et al.*<sup>[24]</sup> reported three patients with recurrences within 3 years after resection for SPT (laparoscopic biopsy with resection in one case, and laparoscopic biopsy and open resection in two cases). They considered that recurrence after laparoscopic biopsy may be due to diffusion of tumor cells caused by gas insufflation<sup>[24]</sup>. In our series, 15 patients underwent LDP without biopsy or broken specimen. At a median follow-up of 33 mo, all patients were alive without recurrence. In our opinion, laparoscopic biopsy should not be performed in patients with SPT. During laparoscopic surgery, we should make sure that the integrity of the specimen is not broken.

The limitations of this study were its retrospective design and low number of patients. These problems can be overcome only by a large, prospective randomized trial, which would be difficult to accomplish owing to the infrequent diagnosis of patients with SPT of the distal pancreas. We believe that this study could provide useful evidence in clinical practice.

In conclusion, LDP for SPT is feasible and safe, and has short-term benefits compared with ODP. Long-term outcomes are similar for LDP and ODP.

## COMMENTS

### Background

Solid pseudopapillary tumor (SPT) of the pancreas is a rare neoplasm. Some patients have benefited from laparoscopic pancreatectomy. Laparoscopic distal pancreatectomy (LDP) has not previously been compared with open distal pancreatectomy (ODP) for SPT.

### Research frontiers

Recently, several case reports and small series have shown less intraoperative blood loss and rapid recovery after LDP for SPT. However, the short-term and long-term outcomes of LDP compared with ODP for SPT required further assessment.

### Innovations and breakthroughs

In the present study, the authors compared the short-term and long-term outcomes of LDP and ODP for SPT, and showed that LDP was suitable and minimally invasive for treating SPT and could achieve similar oncological outcomes (harvested lymph nodes and margin status) and long-term outcomes as ODP.

### Applications

This study showed that LDP for SPT had the advantages of minimally invasive surgery, less intraoperative blood loss, and rapid recovery. The mortality, morbidity, oncologic outcomes and long-term results of LDP were similar to those of ODP. These findings are helpful in decision-making for the treatment of SPT of the distal pancreas.

### Peer review

The topic is interesting, and despite the rarity of SPT, the study includes a large series of patients.

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**P- Reviewers** Cienfuegos JA, Miyajima A, Sperti C  
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ISSN 1007-9327



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