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Oncological Feasibility of Laparoscopic Distal Pancreatectomy for Adenocarcinoma: A Single-Institution Comparative Study

S. Rehman · S. K. P. John · R. Lochan · B. C. Jaques · D. M. Manas · R. M. Charnley · J. J. French · S. A. White

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Abstract
Background Laparoscopic distal pancreatectomy (LDP) is performed increasingly for pancreatic pathology in the body and tail of the pancreas. However, only few reports have compared its oncological efficacy with open distal pancreatectomy (ODP). We compared these two techniques in patients with pancreatic ductal adenocarcinoma.
Methods From a prospectively maintained database, all patients who underwent either LDP or ODP for adenocarcinoma in the body and tail of the pancreas between January 2008 and December 2011 were compared. Data were analysed using SPSS® v19 utilising standard tests. A p value <0.05 was considered significant.
Results Of 101 patients who underwent distal pancreatectomy, 22 had histologically confirmed adenocarcinoma (LDP $n = 8$, ODP $n = 14$). Both groups were well matched for age and the size of tumour (22 vs. 32 mm, $p = 0.22$). Intraoperative blood loss was 306 ml compared with 650 ml for ODP ($p = 0.152$). A longer operative time was noted for LDP (376 vs. 274 min, $p < 0.05$). Total length of stay was shorter for LDP compared with ODP (8 vs. 12 days, $p = 0.05$). The number of postoperative pancreatic fistulas were similar (LDP $n = 2$ vs. ODP $n = 3$, $p = 0.5$). Complete resection (R0) was achieved in 88 % of LDP ($n = 7$) compared with 86 % of ODP ($n = 12$). The median number of lymph nodes harvested was 16 for LDP versus 14 for ODP. Overall 3-year survival also was similar: LDP = 82 %, ODP = 74 % ($p = 0.89$).
Conclusions From an oncological perspective, LDP is a *viable* procedure and its results are comparable to ODP for ductal adenocarcinomas arising in the body and tail of the pancreas.

Laparoscopic pancreatic resection has been increasingly utilised for lesions in the body and tail of the pancreas [1–3]. Several studies have compared perioperative outcomes for laparoscopic and open distal pancreatectomies for various pathologies in the body and tail of the pancreas [4–7]. These reports have consistently shown that the laparoscopic approach is associated with less intraoperative blood loss, fewer postoperative complications, and shorter hospital stays compared with the open-approach in a matched cohort [3]. In addition, laparoscopic pancreatic resections have been associated with less pain after surgery and an earlier return to normal life [6–9]. Whilst there is sufficient evidence to support the use of the laparoscopic approach for resection of benign lesions in the body and tail of the pancreas [5–10], its use for patients with adenocarcinoma of the distal pancreas has been rarely reported, especially as a direct comparison to open distal pancreatectomy [7–11].

When adopting the laparoscopic approach for resection of any malignancy, there always has been initial concern surrounding oncological safety and feasibility, but this has not been substantiated in large randomised studies for other pathologies, e.g., colon cancer [12]. It also has been adopted for many other organs, e.g., stomach and oesophagus [13, 14] where it has been shown to be safe, reproducible, and oncologically feasible equivalent to the

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S. Rehman (✉) · S. K. P. John · R. Lochan · B. C. Jaques · D. M. Manas · R. M. Charnley · J. J. French · S. A. White
Department of Hepatobiliary and Transplantation Surgery, Freeman Hospital, Freeman Road, High Heaton, Newcastle upon Tyne NE7 7DN, UK
e-mail: Srkhanswati75@yahoo.com

conventional open approaches [13, 14]. Other considerations include the risks of serious postoperative complications, which would include pancreatic fistulas. To date, few studies have reported the long-term outcomes following laparoscopic distal pancreatic resection for ductal adenocarcinoma [6, 7, 10, 11], although a preliminary comparison has been reported in the literature [15]. Thus far, only a single case series [1] has reported a comparison between LDP and ODP [1]. The aim of this study was to compare the oncological feasibility and safety of LDP versus the conventional open approach in patients with pancreatic ductal adenocarcinoma.

Methods

A prospectively maintained HPB database for patients undergoing either LDP or ODP between January 2008 and December 2011 was analysed. Three surgeons (DMM, RMC, and BCJ) performed open resections and LDP were performed by two surgeons (SAW, JJF) since 2007. This ensured focussed development of the technique with a safe learning-curve. Before surgery, each patient was individually evaluated in our weekly multidisciplinary team (MDT) meeting with surgeons, pathologists, oncologists, gastroenterologists, and radiologists. Patients were appropriately staged with a triple phase contrast-enhanced CT scan and EUS/FNA when indicated.

Patients were assessed for indication, feasibility, and the type of resection (LDP or ODP) required on a case-by-case basis. Patients with T1–T3 tumours on CT scans were selected preferentially to undergo LDP. This process of selecting patients for LDP has evolved over the years through our MDT, as experience with LDP increased. In general patients with large tumours (>10 cm) considered difficult to mobilise laparoscopically were reserved for open resections. Vascular invasion of local vessels, such as renal vessels and splenic vessels, were not contraindications. Similarly invasion of adjacent organs also were not contraindications (e.g., kidney, colon, and stomach).

Surgical and oncologic outcomes were analysed for all patients undergoing LDP and ODP for pancreatic ductal adenocarcinoma with curative intent. Patient demographics, type of resection, intraoperative blood loss, duration of surgery (time from start of skin incision to the end of wound closure), length of intensive care unit (ICU) stay, postoperative LOS, postoperative complications, postoperative fistula formation, and mortality (within 30 days from surgery) were compared. The histological reports were all reviewed to assess resection margin status and number of lymph nodes retrieved.

Our technique of LDP has been described in detail elsewhere [16] but entails the use of 4 ports (2 × 12 mm and 2 × 5 mm); the lesser sac is entered using a harmonic scalpel (Ethicon Endo Surgery Ltd., Cincinnati, OH). Briefly, the splenic flexure of the colon is taken down, then the upper and lower borders of the pancreas defined and mobilised. Intraoperative ultrasound is used to localise all tumours. The splenic artery is dissected out and divided with Weck Clips (Teleflex Medical Ltd, Athlone, Ireland). A retropancreatic tunnel is created and slung at the neck. An endovascular stapler (Echelon 3.5-mm staples) is used for division of the pancreas and in some cases incorporating the splenic vein. The spleen is then mobilised in the standard way and the specimen is removed through a Pfannenstiel incision.

Pathological results were based upon detailed histology following guidelines for the histopathological reporting of carcinomas of the pancreas, published by the Royal College of Pathologists in 2002 [17]. The diagnosis of pancreatic ductal adenocarcinoma was made in the presence of a typical pancreatico-biliary histological pattern or variants and the tumour being centred within the pancreas. Grading was performed as described by Klöppel et al. [18]. The histological examination included systematic examination of all local lymph nodes. This was further aided by photographic documentation. TNM staging was applied according to TNM staging published by the American Joint Committee on Cancer (6th edition) [19]. Resection margins were considered positive if the tumour extended to within less than 1 mm of the posterior retroperitoneal or medial margin.

Postoperative complications were recorded as per the modified Clavien–Dindo classification adapted for pancreatoduodenectomy [20]. Pancreatic fistula's were defined according to the International Study Group on Pancreatic Fistula recommendations (ISGPF) [21] as any measurable volume of fluid output from a surgical or radiologically placed drain on or after postoperative day 3 that had an amylase level three times greater than the serum level. The presence of a peripancreatic fluid collection on axial imaging with clinical suspicion for a fistula was included in the analysis [21]. Operatively placed drains may remain in situ at the time of discharge, for small volume fistulas if present.

Length of stay (LOS) was defined as the number of days from the initial operation to hospital discharge. A total of four patients (18 %; LDP $n = 2$, ODP $n = 2$) in this series had adjacent organs resected. In the LDP group, one patient also had a laparoscopic left nephrectomy and another patient underwent a laparoscopic sigmoid colectomy, whereas two patients in the ODP group also had a left nephrectomy and a left hemicolectomy. DP was defined as resection of the pancreas to the left of the portal vein. In all laparoscopic cases, a totally laparoscopic approach was performed and none were hand-assisted or "hybrid" procedures.

After initial follow-up at 6 weeks, all patients were regularly followed up at our HepatoPancreatoBiliary clinic at 3, 6, 12, 18, and 24 months and yearly thereafter for the first 5 years. Survival status was determined by review of the patients' medical record and defined as the time interval from the date of initial operation to the date of last clinical encounter or date of death if known.

Statistics

All results are expressed as median and range values. Continuous variables were analysed using Mann–Whitney *U* test, whereas categorical variables were analysed using the Chi squared and or Fisher's exact test. Kaplan–Meier plots were applied for survival. A p value of <0.05 was considered significant. All statistical analyses were performed using SPSS software for Windows (version 19; SPSS, Inc., Chicago, IL).

Results

Patient characteristics

A total of 101 patients (M:F 47:54; median age 63 (range, 20–84) years) underwent distal pancreatic resections in our unit between January 2007 and December 2011. Twenty-two patients had histologically confirmed pancreatic ductal adenocarcinoma, of which 64 % ($n = 14$) underwent open distal pancreatectomy (ODP) whilst 36 % ($n = 8$) had laparoscopic distal pancreatectomy (LDP). A further 34 patients had laparoscopic resections for other indications during this time period with 2 (5 %) being converted to an open procedure (concerns over tumour margins ($n = 1$) and technical failure of the stapler ($n = 1$). Both groups were well matched for age (median 64.2 vs. 64 years, $p = 0.95$) and size of the tumour: 22 mm (range, 13–48) LDP versus 32 mm (range, 8–64) in the ODP group ($p = 0.22$). More female patients had ODP compared with LDP. Adjuvant chemotherapy was utilised in 59 % ($n = 13$) of the patients in this series (LDP = 50 % ($n = 4$) vs. ODP = 64 % ($n = 9$; $p = 0.373$; Table 1)).

Surgical outcome

Comparative analysis of patient's demographics and intraoperative results are summarized in Table 1. The median operating time in the LDP group was 376 (range, 300–534) min compared with 274 (range, 180–420) min in the ODP group ($p = 0.009$). However, adjacent organ resection's in both groups make meaningful analysis of duration of surgery difficult as some are not just distal pancreatectomies. Intraoperative blood loss was less in the LDP group, with a median of 306 (range, 250–535) ml versus a median of 650 (range, 145–1,300) ml in the ODP group; however, this was not statistically significant ($p = 0.152$).

The total hospital stay was significantly shorter in the LDP group with a median of 8 (range, 5–14) days versus 12 (range, 6–21) days in the ODP group ($p = 0.05$, Mann–Whitney). Postoperative complications occurred in three (37 %) versus six (42 %) patients in the LDP and ODP groups respectively ($p = 0.8$). A pancreatic leak developed in two (25 %) [Grade A = 1, Grade B = 1] patients in the LDP group versus three (22 %) [Grade A = 1, Grade B = 2] patients in the ODP group ($p = 0.581$, Chi square). Postoperative radiological and/or surgical intervention was needed in one (12 %) patient in the LDP group [peripancreatic collection requiring laparoscopic washout and prolonged drain placement] versus two (14 %) in the ODP group [one patient needed CT-guided drainage of a peripancreatic collection and drain placement; a second patient developed an anterior abdominal wall abscess and left subphrenic collection requiring a relaparotomy, anterior abdominal wall debridement with prolonged drain

Table 1 Patients characteristics and postoperative outcome following LDP and ODP

Variable	ODP	LDP	p value
Median age (yr)	64	64	0.95
Female	13	3	0.01
ASA	2	2	NS
Tumour size (mm)	32	22	0.22
Operative time (min)	376	274	0.009
Blood loss	650	306	0.152
LOS (length of stay)	12	8	0.05
Conversion	N/A	None	N/A

Table 2 Histopathological characteristics of the tumour LDP versus ODP

	LDP ($n = 8$)	ODP ($n = 14$)	
Adjuvant chemotherapy (%)	50	64	0.373
Tumour stage (%)			
T1	37	17	0.196
T2	13	7	
T3	50	76	
Tumour grade (%)			
Well	13	23	0.67
Moderate	65	42	
Poor	22	35	
Nodal status (N1 disease) %	50	64	0.383

placement ($p = 0.3$). Thirty day in-patient mortality was zero in both groups (Table 2). None of the patients in the laparoscopic group were converted to an open procedure. Additionally five patients in the LDP and eight in the ODP received adjuvant chemotherapy. Patients in the LDP group had started chemotherapy almost a month earlier than patients in the ODP group.

Oncological outcome

Lymph node status

It has been suggested that the minimum number of lymph nodes that should be examined to stage pancreatic ductal adenocarcinoma of the head of pancreas accurately is 10 [17]. In this series, the median number of lymph nodes retrieved was 16 for LDP (range, 1–27) and 14 for ODP (range, 0–26). The majority of patients in this series had lymph node-positive (N1) disease: 9 of 14 (64 %) patients after ODP and 4 of 8 (50 %) patients after LDP ($p = 0.303$). Overall 3-year survival in our series of PDAC was similar in patients with N1 and N0 disease: 80 and 82 % respectively ($p = 0.373$; Table 3).

To determine whether the metastatic positive lymph nodes to total resected lymph nodes (lymph node ratio [LNR]) has greater utility than standard nodal staging, patients with N1 disease were subdivided into those having an LNR $\leq$15 % or >15 %—a cutoff that has been described previously [22]. There was no significant difference noted in overall survival for those patients with >15 % LNR or <15, 80 and 82 % respectively ($p = 0.89$), although numbers were small in this analysis (Table 3).

Resection margin

None of the patients in this series had a macroscopically positive resection margin (R2). Overall three patients (13 %) in this series had histological evidence of a microscopically positive resection margin (R1). Furthermore, there was no significant difference between LDP and ODP in terms of positive margins ($p = 0.7$, Fisher exact). Overall 3-year survival was similar in patients with R0 and R1 disease, but again numbers are too small for any meaningful conclusions.

Tumour stage

Most of the patients in this series ($n = 15/22$, 68 %) had T3 disease, i.e., tumour extending beyond the pancreas. T1 disease was present in 4 of 22 (18 %) patients, T2 in 2 of 22 (9 %) patients, whereas none of the patients had T4 disease on histology. Also there was no significant difference with regard to the tumour stage of the disease between the two groups ($p = 0.196$; Table 4).

Tumour differentiation and other histological factors

Tumour differentiation was classified as well, moderate, and poor. Tumours described histologically as spanning two categories, e.g., moderate to poorly differentiate, were classified according to the worst degree of differentiation, i.e., in this case poorly differentiated. Using this system, overall 4 (18 %) patients had well differentiated tumours, 11 (50 %) had moderately differentiated, and 7 (32 %) patients had poorly differentiated tumours in this series. Moreover, no significant difference was seen between the two groups (LDP and ODP) with regard to the tumour differentiation ($p = 0.87$; Table 4). Tumour differentiation was not able to predict survival in this series.

Table 3 Oncological outcome following LDP versus ODP

	LDP ($n = 8$)	ODP ($n = 14$)	p value
Lymph node retrieved (n, range)	16 (1-27)	14 (0-26)	0.53
Resection margins (R1) %	12	14	0.794
Complication rates (%)	37	22	0.5
Postoperative pancreatic fistula rate (%)	25	21	0.51
30-day mortality	1	1	NS

Table 4 Factors affecting overall survival following resection of pancreatic adenocarcinoma

Variable	No. of patients	3-year survival (%)	p value
Lymph node status ($n = 22$)			
N1	13	80	0.373
N0	9	82	
Lymph node ratio ($n = 22$)			
$\leq$15 %	15	82	0.89
>15 %	7	80	
Tumour stage ($n = 21$)			
T1	4	96	0.88
T2	2	58	
T3	15	70	
Resection margin ($n = 22$)			
R0	19	96	0.58
R1	3	80	
Tumour differentiation ($n = 22$)			
Well	4	96	0.89
Moderate	11	58	
Poor	7	70	

Survival

The median overall survival after distal pancreatectomy (DP) for pancreatic ductal adenocarcinoma (PDAC) for the entire series was 52 months. The median disease-free survival (DFS) for entire series was 9 (range, 7–11) months with a median follow-up of 17 months (LDP = 12 months, ODP = 23 months) after distal pancreatic resection. The median survival after LDP was not statistically different from ODP (33 vs. 52 months; $p = 0.91$; Fig. 1).

Discussion

LDP has been practiced for more than a decade, but still some institutions favour adopting a conventional open approach especially for pancreatic ductal adenocarcinoma of the distal pancreas [6, 7, 20]. Although there are many reasons for this, including training and the need for advanced laparoscopic skills, most doubts concern its oncological feasibility and safety [6, 7, 10]. In our series, we have demonstrated that LDP is an oncologically feasible and a comparably safe operation compared with the open approach. LDP also was associated with less intraoperative blood loss and a shorter hospital stay compared with ODP. These findings are in keeping with the other series published [1, 6–10].

Laparoscopic pancreatic resections are being performed with increasing frequency [7–11], but there are only limited reports of patients undergoing laparoscopic resections for pancreatic ductal adenocarcinoma [9–13]. In an initial European multicentre feasibility experience of 127 patients who had laparoscopic pancreatic resection, only 4 patients had ductal adenocarcinoma [7]. Although surgical margins were noted to be negative in these patients, limited information on other oncological outcomes were reported [7]. Fernandez-Cruz et al. [10] reported data on 13 patients undergoing LDP for pancreatic ductal adenocarcinoma with a 90 % R0 resection rate, mean lymph node count of 14.5 ± 3, and overall survival of 14 months. These data are compatible with reports of ODP, but no direct comparison was provided because this paper focused on a descriptive analysis of the technical aspects. In a single institution series of 359 patients, 24 patients had LDP for pancreatic ductal adenocarcinoma; Song et al. [11] reported a 91 % R0 resection rate, mean lymph node number of 10.3 ± 8.6, and similar overall 1- and 2-year survival rates of 85.2 %. Taylor et al. [23] in their study of 46 patients undergoing LDP reported short-term outcome for 9 patients with ductal adenocarcinoma; of those LDP was successfully completed only in 5 patients [23]. Apart from complete surgical resection achieved in all patients, no other oncological and long-term outcome was reported [23]. Kang et al. [12] in their preliminary comparative study of 5 LDP (laparoscopic = 3, robot = 2) patients, with 27 patients undergoing ODP for pancreatic ductal carcinoma, reported similar lymph node yield and margin positivity; however, longer operating time and smaller tumour size were noted in the LDP group. Kooby et al. [1] in the largest multicentre retrospective analysis to date on pancreatic ductal adenocarcinoma compared 23 patients undergoing LDP to 70 patients undergoing ODP. They reported similar outcomes following LDP and ODP with regards to lymph node yield, margin positivity, blood loss, and operative time with a strong trend for shorter hospital stay, although not reaching statistical significance [1]. Our results are consistent with these in many aspects.

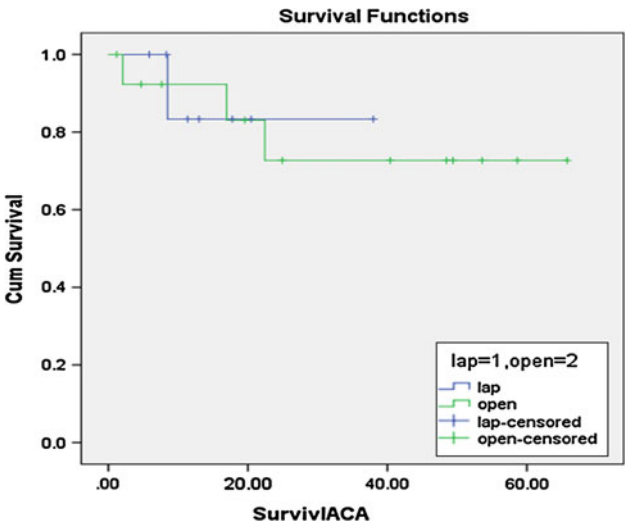

Fig. 1 Kaplan-Meier graph showing overall survival (OS) for LDP and ODP following resection of pancreatic ductal adenocarcinoma (PDAC)

In our series, the median number of lymph nodes retrieved in the LDP was 16 (range, 1–27) compared with 14 in the ODP group (range, 0–26; $p = 0.383$); this corresponds well with most of the other series in the literature [1, 7–12, 23]. Kooby et al. reported a median of 14 lymph nodes retrieved by LDP compared with a median of 12 lymph nodes retrieved in ODP, supporting the results of the current series. However, a single institution comparison by Baker et al. [24] demonstrated lower lymph node yield for LDP (mean = 4) compared with ODP (mean = 10). However, detailed analysis of their results revealed that only a single patient with pancreatic ductal adenocarcinoma undergoing LDP was compared to 18 patients undergoing ODP [24]. The most obvious hurdle in making useful comparisons between studies regarding lymph node yield is the lack of standardisation in pathological assessment and relatively small patient sample sizes [24]. However, the authors of the current series believe, with increasing experience of LDP, that lymphadenectomy will

improve but pathological examination must be standardised as has been scrutinized after pancreatoduodenectomy [25].

The status of the resection margin is well documented to be an important predictor of outcome after resection for ductal adenocarcinoma [5]. Our results revealed similar R1 resection margins (<1 mm) for LDP (1/8, 12 %) and ODP (2/14, 14 %). Song et al. [11] reported positive resection margin rates of 8 % (2/24 patients had R1 resection margins) following LDP for pancreatic ductal adenocarcinoma. Kooby et al. [1] reported positive margin rates of 26 and 27 % for LDP and ODP respectively, in a large multicentre comparative study of 212 patients with pancreatic ductal adenocarcinoma, comparing 23 LDP patients with 70 patients in the ODP group. Fernandez-Cruz et al. [10] reported a 23 % positive resection margin rate, 3 of 13 patients who underwent LDP resection for adenocarcinoma. However, the author acknowledged conversion of three patients from laparoscopic to open operation due to difficult anatomical access mainly because of adhesions in one case and invasion of the transverse colon in other two cases [10]. Indeed the need for extended multivisceral resections is not uncommon; two patients in our series required resections of the left kidney and left colon. Marangose et al. [6] in their study of 30 patients with pancreatic ductal adenocarcinoma undergoing LDP reported complete surgical resection in 93 % of patients; only two patients had an R1 resection and both of them had large tumours (57 and 60 mm). Our improved R1 resection rates may be attributable to the relatively smaller size of the tumours, and probably lower stage tumours at the time of surgery, achieving complete surgical resection in seven of eight (87 %) patients. Nonetheless, this variability could be explained by histopathological assessment as different studies often report highly variable rates of positive resection margins [1, 6–12, 21–28].

Our results revealed a median stay of 8 (range, 5–14) days following LDP for ductal adenocarcinoma. Fernandez-Cruz et al. reported a median stay of 8 (range, 5–17) days, and Kang et al. reported a median stay of 10.2 ± 5.5 days following LDP, whereas Marangose et al. [1, 6, 10, 12] reported 5 days. This has advantages of lowering hospital costs, although a detailed cost-analysis was not performed. Nonetheless, with adoption of enhanced recovery techniques, the duration of hospital stay is likely to improve in the foreseeable future for both open and laparoscopic techniques.

Pancreatic fistulae are still a problem and can prolong hospital stay. Indeed, some patients are discharged and managed as an outpatient with an abdominal drain still in situ. In our series, two patients in the LDP group and three patients in the ODP group developed postoperative pancreatic fistula. This is consistent with other previously reported results [6–10, 21]. Fernandez-Cruz et al. [10] reported a postoperative pancreatic fistulae rate of 7.7–35 % depending on the pathology. The highest rates were following laparoscopic enucleation. Similar results have been reported by others [6, 7, 21–28]. Various different techniques have been described to manage the pancreatic stump in an effort to reduce postoperative pancreatic leaks [28, 29]. Marangose et al. [28] in their study of 121 patients undergoing LDP used TachoSil®. The results demonstrated no significant difference between the two groups in terms of rates of postoperative pancreatic fistula (12 % vs. 8 %) [28]. In addition, the use of fibrin sealant's (Tisseel) has been shown to be successful in various clinical studies [15, 30–34] but does not completely abolish this problem as in our own subsequent experience [16].

Median postoperative survival of all operated patients was 52 months in the present series. The median disease-free survival (DFS) was 9 (range, 7–11) months, and median follow-up duration was 17 months (LDP = 12, ODP = 23 months). Marangose et al. reported overall survival duration of 24 months, whereas Strasberg et al. [2, 6] reported overall survival duration of 22 months. However, Song et al. reported similar 1- and 2-year survival rates of 85.2 % following LDP for pancreatic ductal adenocarcinoma [11]. The apparently improved rate of median survival in this series may be attributable to better staging, using both endoscopic ultrasound and CT along with adjuvant chemotherapy (59 %) and not because it was a LDP technique [6–8]. EUS selects out patients with less advanced disease, with the majority of patients having T2 (n = 2/22, 9 %) and T3 (n = 15/22, 68 %) disease. However, because of the relatively small sample size and limited follow-up period, this almost certainly confounds the survival analysis and underestimates the actual survival, which only future studies involving large sample sizes will be able to address. Schimada et al. [5] in their study of 88 patients with ductal adenocarcinoma reported overall 1-, 3-, and 5-year survival rates of 76, 40, and 19 % respectively following (open) distal pancreatectomy. In their series, the majority (70 %) of patients had T2 disease, 4 % had T1, and 6 % had T3 disease, whereas T4 stage tumour was present in 20 % of their patients [5].

In addition, the potential benefits of LDP include patients receiving adjuvant therapy (e.g., chemotherapy) more frequently compared with ODP. In this series, patients who underwent LDP received chemotherapy within first 2 months postresection compared with 3 months in the ODP group. This prompt instigation of adjuvant therapy in the LDP group may have a role in determining long-term outcome, i.e., improving overall survival. However, there are concerns regarding longer operating time associated with LDP. In this series, ODP

was performed more quickly compared with LDP (LDP = 376 min vs. ODP = 274 min). The longer operating time has its own implications, including longer anaesthetic time, increased risk of deep vein thrombosis, chest infections, renal failure, and changes in peritoneal physiology and increased risk of surgical site infections. However, this series represent our initial experience with laparoscopic pancreatic surgery and undoubtedly is associated with a steep learning curve. This potentially affects various outcomes, including operating time, blood loss, and in-patient length of stay (LOS) initially. However, adjacent organs resections in both groups make meaningful analysis of duration of surgery in this series difficult. Currently, the operating time has come down with the learning curve and is now 3–4 h.

Important limitations to this study include retrospective nature of the study and relatively small size of the sample, especially in the LDP ($n = 8$) group. In addition, the follow-up period is very short and for any long-term oncological outcome, a period of at least 5-year overall survival would be meaningful. Moreover, this series also contain patients from our initial experience with laparoscopic surgery associated with learning curve, which inevitably affect some perioperative outcome. Nevertheless, this series would contribute to our existing knowledge of laparoscopic pancreatic surgery in the literature.

In summary, LDP is an oncologically *viable* and technically *safe* procedure where surgical and oncological outcomes are comparable to the conventional open technique. We recommend the use of LDP in the surgical treatment of pancreatic ductal adenocarcinoma; however, further randomized, controlled studies would be required to establish further evidence. In the meantime, case series will continue to provide valuable evidence to support its use in resecting malignant tumours of the body and tail of the pancreas.

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