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Short-term outcomes after distal pancreatectomy: Laparotomy *vs.* laparoscopy – A single-center series

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HIGHLIGHTS

- Laparoscopy has been recently used more frequently for distal pancreatectomy.
- Postoperative complications and oncologic outcomes were similar in this study.
- Length of stay was shorter for the patients operated by laparoscopy.
- Laparoscopy should be offered when technically feasible.

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ABSTRACT

Background: Laparoscopic distal pancreatectomy was introduced 15 years ago, but it is still not widely used. The aim of the study was to compare the postoperative complications and length of stay between open and laparoscopic distal pancreatectomy.

Materials and methods: A search of our institutional pancreas database was performed. All consecutive distal pancreatectomy patients from 2000 to 2015 were identified. Demographics, peri- and postoperative outcomes were reviewed. Postoperative complications were graded using Clavien classification. Standard statistical analyses were performed.

Results: One hundred and five patients underwent distal pancreatectomy (45 women, 60 men, median age of 63 years). Seventy-nine cases were performed open and 26 by laparoscopy (conversion rate from laparoscopy to laparotomy: 7/26). Characteristics of both groups were similar. The tumor proportion was similar in both groups (56/79 and 23/26, $p = 0.114$). Overall complication rate was 41/79 (52%) in the open group and 9/26 (36%) in the laparoscopy group ($p = 0.175$). Two patients died during hospital stay in the open group compared to 0 in the laparoscopy group ($p = 1$). The fistula rates were comparable (17/79 and 5/26, $p = 1$). Median length of stay was shorter for the laparoscopy group (8 *vs.* 12 days, $p < 0.001$), as well as the median intermediate care stay (1 *vs.* 3 days, $p = 0.004$).

Conclusion: Short-term outcomes after open and laparoscopic distal pancreatectomy regarding postoperative complications and mortality were similar, but length of stay was significantly shorter for the laparoscopic approach. Hence, laparoscopic distal pancreatectomy should be offered to all suitable patients.

1. Introduction

Pancreas surgery is mostly performed for oncologic reasons, and despite significant technical advances during recent decades, most surgeons still prefer open surgery as the operative procedures are complex. Nevertheless, minimally invasive surgery has been increasingly adopted, in particular for distal pancreatectomy (DP) as in majority of cases only a resection is performed compared to more complex pancreatic head resection where technically demanding reconstructions are needed [1]. The initial implementation of laparoscopic DP was rather reluctant, but increased since 2000 [2]. This might be explained by the need for both thorough skills in minimally invasive techniques and in pancreas

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surgery. Such combination is often best provided in specialized centers that have been recently developed due to the centralization of pancreas surgery in many countries.

Preliminary studies have shown that laparoscopy for DP was feasible and safe [2,3], whereby a learning curve of up to 15 cases is necessary [4–6]. More recently, several studies reported favorable short-term outcomes like shorter operative times, less postoperative complications, and decreased length of stay (LoS) [7–9]. A major concern for laparoscopic DP was to maintain oncologic standards for the resection of adenocarcinomas of the body and tail of the pancreas [10,11]. The current evidence comparing postoperative outcomes of open to laparoscopic DP for pancreatic adenocarcinoma is growing, but is still scarce until now [12].

The aim of the present study was to compare a single-center experience of laparoscopic DP to open surgery with a special emphasis on postoperative complications and LoS.

2. Materials and methods

2.1. Patients

The prospective pancreas database of the Department of Visceral Surgery of the University Hospital of Lausanne (CHUV, Switzerland) was searched for DP cases. All consecutive patients from 2000 to 2015 who underwent DP were potentially eligible to be included in the study. Patient demographics, perioperative data, and postoperative outcomes were retrieved.

2.2. Perioperative outcomes

Intraoperative blood loss was measured at the end of the operation by the surgeon and the anesthesiologist based on the soaked gauze weight and the aspirated fluids. Postoperative complications were measured using the Clavien classification [13]. They were separated into minor (I–II) and major complications (III–IV). Grade V was defined as death during hospital stay or during the 60 days after the operation. LoS was calculated from operation day to discharge date. Pancreatic fistulas and postoperative hemorrhages were defined using the International Study Group of Pancreatic Surgery (ISGPS) criteria [14,15].

2.3. Operative techniques and postoperative management

Open DP was performed using subcostal incision or midline laparotomy. No somatostatin analogues were given prophylactically. After opening the lesser sac, the pancreas was freed all around beginning laterally then progressing toward the pancreas neck (left to right approach). The spleen and its vessels were preserved if possible in patients with benign disease; otherwise the spleen was resected *en bloc* with the pancreatic tail and lymph nodes. The pancreas was transected using a linear stapler or by energy device upon the individual surgeon's choice. In all cases, the pancreatic stump was closed with a running suture, while targeted suture closure of the pancreatic duct was also upon the individual surgeon's choice. One drain was left in place near the pancreatic stump at the end of the operation. This drain was removed on postoperative day 3 if amylase in the drain fluid was not 3 times higher than serum amylase level. Epidural anesthesia was usually used.

For laparoscopic DP 4 trocars were used (one camera and three working ports) with the patient in supine position. The camera was placed in the peri-umbilical trocar. The same steps as open surgery were undertaken, except that pancreas mobilization was performed from right to left (medial to lateral). The pancreas was sectioned using an Endo-GIA© stapler or an energy device upon the individual surgeon's choice. The stump was closed with a running suture. Closure of the pancreatic duct depended on the individual surgeon's choice. A closed-suction drain was also left near the pancreas resection side.

The choice of performing open or laparoscopic surgery was decided by the surgeon in charge of the patient. Decision was based on the body-mass index (BMI), previous abdominal surgery, or tumor size.

Since 2012, enhanced recovery after surgery (ERAS) pathways have been implemented for DP. They are particularly focused on early mobilization and rapid postoperative nutrition [16].

2.4. Statistical analysis

Continuous variables were compared using a Mann-Whitney *U* test or a student *t*-test depending on the normality of the distribution and the homogeneity of the variances. Discrete variables were compared using a Chi-square test. Survivals were calculated using Kaplan-Meier method, and comparisons were made using the log-rank test. Graphpad Prism for Mac OS X was used for the statistical analyses.

This study has been approved by the local ethical committee of the University of Lausanne Hospital. The study was performed in accordance with the Helsinki Declaration as revised in 2013.

3. Results

3.1. Patient characteristics and operative indications

During the study period, 105 patients underwent DP, 45 women and 60 men with a median age of 63 years (IQR 49–71 years). Median BMI was 24.5 kg/m^2 (IQR 21.1-27.5 kg/m^2). A splenectomy was added to the DP in 86 patients (82%). Indications for DP were malignancies (64), benign tumors (15), pseudocysts (9), chronic pancreatitis (8), and other benign diseases (9).

3.2. Open vs. laparoscopic DP

Open surgery was performed in 79 cases (75%) and laparoscopy in 26 cases (25%). Laparoscopy was performed more frequently in the recent years (2000–2009: 9 cases, 2010–2015: 17 cases). In the laparoscopy group, 7 cases (27%) were converted to laparotomy due to adhesions (4x), lesion of the splenic vein (2x), and tumoral infiltration of the splenic vessels close to the celiac trunk (1x). Characteristics of both groups are presented in Table 1. Splenectomy was associated to the DP in 65 patients in the open group, 52 for oncologic reasons and 13 for technical reasons (5x resection of splenic vessels, 3x due to hilar anatomical position of the pseudocyst, 2x due to portal hypertension, 2x due to splenic vein/spleen lesions, and 1x due to splenic vein thrombosis) and in 21 patients (18x for oncologic reasons, 2x due to resection of splenic vessels, and 1x due to portal hypertension and splenic vein thrombosis) in the laparoscopy group ($p = 1$).

Table 2 summarizes the final diagnoses in both groups. Median operative times were similar in both groups (225 *vs.* 213 min, $p = 0.382$). For the operations with splenectomy ($n = 86$), median operative time was 237 min in the open group and 244 min in the laparoscopy group ($p = 0.436$), whereas for DP without splenic resection ($n = 19$) the median operative times were 213.5 min and 213 min ($p = 1$). Median intraoperative blood loss was 400 ml (IQR 200–900 ml) in the open group and 300 ml (IQR 75–750 ml, $p = 0.557$) in the laparoscopy group. Blood transfusion was required in 21 patients (19 in the open group, 2 in the laparoscopy group, $p = 0.125$).

Overall complication rate was 40/79 (51%) in the open group and 9/26 (36%) in the laparoscopy group ($p = 0.179$), respectively. No

Table 1
Patient characteristics (medians with interquartile range and numbers with percentage).

Distal pancreatectomy	Open N = 79	Laparoscopy N = 26	*P*-value
Median age, *years*	63 (49–71)	64 (50–73)	0.418
Median BMI[a], *kg/m²*	23.9 (20.7–27.1)	25.5 (22.8–28.4)	0.059
Gender (men/women)	45/34	16/10	0.819
ASA[b] score 1/2/3	9/52/18	2/18/6	0.291
DP alone/DP + splenectomy	13/66	5/21	0.768
Diabetes mellitus	11 (14%)	5 (19%)	0.563
Active smokers	25 (33%)	8 (31%)	1
Previous abdominal operations	6 (8%)	1 (4%)	0.678

[a] BMI: body-mass index.
[b] ASA: American Society of Anesthesiologists.

Table 2
Histopathological diagnoses.

Distal pancreatectomy	Open N = 79	Laparoscopy N = 26	*P*-value
Ductal adenocarcinoma	22 (28%)	10 (40%)	0.333
Neuro-endocrine tumor	11 (14%)	7 (27%)	0.142
Mucinous cystadenoma	5 (6%)	1 (4%)	1
Serous cystadenoma	3 (5%)	1 (4%)	1
Cystadenocarcinoma	2 (3%)	0	1
IPMN[a]	2 (3%)	2 (7%)	0.256
Other tumors[b]	11 (14%)	2 (7%)	0.511
Pseudocyst	9 (11%)	0	0.108
Chronic pancreatitis	6 (7%)	2 (7%)	1
Normal pancreatic tissue	6 (7%)	1 (4%)	0.678
Polycystosis	1 (1%)	0	1
Ectopic spleen	1 (1%)	0	1

[a] Intraductal papillary mucinous neoplasm.
[b] Other tumors included: sarcomas (4 in the open group), metastases (2 in the open group, 1 in the laparoscopy group), gastric adenocarcinomas (2 in the open group), undifferentiated carcinoma (1 in the laparoscopy group), solid pseudopapillary tumor (1 in the open group), adenosquamous carcinoma (1 in the open group), and adrenal carcinoma (1 in the open group).

differences between minor (grade I–II) and major (grade III–IV) complications were noted (p = 0.277). Two patients died postoperatively during the hospital stay (grade V) in the open group, whereas no patient died in the laparoscopy group (p = 1). The fistula and hemorrhage rates were similar between the two groups (15/79 *vs.* 5/26, p = 1 and 17/79 *vs.* 2/26, p = 0.147). Among the fistulas, there were 12 and 4 grade A, 4 and 1 grade B, and 1 and 0 grade C in the open and laparoscopy groups, respectively. For the hemorrhages, 14 were grade A, 1 grade B, and 2 grade C in the open group, whereas in the laparoscopy group there was 1 grade A, 1 B, and 1 C.

Most patients did not need intensive care unit (ICU) postoperatively in both groups (p = 0.761). Median stay in intermediate care was 3 days (IQR 2–4) in the open group compared to 1 day (IQR 1–2.5) in the laparoscopy group (p = 0.004). Median LoS was shorter for the laparoscopy group compared to the open group (8 *vs.* 12 days, p < 0.001). Sixty-day readmission rates were similar between the two groups (12/79 and 2/26, p = 0.509). Table 3 summarizes the postoperative outcomes in both groups.

3.3. Long-term outcomes of patients with ductal adenocarcinoma

The main tumoral etiology was adenocarcinoma. There were 22 adenocarcinomas in the open group and 10 in the laparoscopy group (p = 0.333). The tumor stages were comparable (Table 4). The rates of complete resections (R0 resections) were similar between the open and laparoscopy groups (15/22 *vs.* 8/10, p = 0.681). Median numbers of harvested lymph nodes were also similar (16 *vs.* 14 lymph nodes, p = 1). Vascular invasion was observed in 15 and 7 cases (p = 1). The median overall survival and 5-year survival of

Table 3
Postoperative outcomes (medians with interquartile range and numbers with percentage).

Distal pancreatectomy	Open N = 79	Laparoscopy N = 26	*P*-value
Overall complication	40 (51%)	9 (35%)	0.179
Minor (I–II)	18	2	0.277
Major (III–IV)	22	7	0.277
Mortality (V)	2 (3%)	0 (0%)	1
Pancreatic fistula	15 (19%)	5 (19%)	1
Hemorrhage	17 (22%)	2 (8%)	0.147
Median ICU[a] stay	0 (0–0)	0 (0–0)	0.761
Median IC[b] stay	3 (2–4)	1 (1–2.5)	**0.004**
Median length of stay	12 (8–17)	8 (7–10)	**<0.001**
60-day readmission	12 (15%)	2 (8%)	0.509

Significant *P*-values appear in bold in the table.
[a] ICU: intensive care unit.
[b] IC: intermediate care.

open and laparoscopic DP were 32 months and 40%, and 31 months and 19% (p = 0.478), respectively.

4. Discussion

This study comparing the short-term outcomes of open and laparoscopic DP showed that LoS was shorter after laparoscopic DP while postoperative complications and readmission rates were similar. Moreover, intermediate care stay was also shorter in the laparoscopy group.

Several studies found a shorter LoS for laparoscopic DP [11,17,18]. Stauffer *et al.* found a median LoS diminished by 4 days for laparoscopic DP performed for pancreatic adenocarcinomas [11]. They also found less blood loss and need for intraoperative transfusion, which was not the case in the present study. Zhang *et al.* in a small case-matched study found also a diminution of the LoS (13 *vs.* 15.5 days) [7]. On the contrary a retrospective study by Hasselgren *et al.* showed no difference in the LoS but a diminution of blood loss with laparoscopy [19]. This study additionally found that severe complications and operative times decreased with experience [19]. The laparoscopy group had the same overall complication rate as the open group and was therefore judged safe even in the early period

Table 4
TNM classification of the resected adenocarcinomas in the open and laparoscopy groups.

Distal pancreatectomy	Open N = 22	Laparoscopy N = 10	*P*-value
Tumor stage T1/T2/T3/T4	1/2/18/1	0/3/7/0	0.399
Node stage N0/N1	8/14	3/7	1
Perineural invasion	21	10	1
Vascular invasion	15	7	1
Lymphatic invasion	13	7	0.703
Margins R0/R1/R2	15/5/2	8/2/0	0.587

of implementation [19]. A large national French study similarly found a decreased LoS for laparoscopy [20]. Of note, the LoS *per se* is not the best measure to compare between studies as there are wide variations related to local habits and different health care systems. What matters the most is the difference of LoS, if present, induced by the laparoscopic technique. The present study also found that the stay in the intermediate care was reduced for the laparoscopy group; reinforcing the clinical observation that smaller abdominal access allows earlier recovery. It is interesting to note that a trend for a median lower BMI was found in the open surgery group, suggesting that laparoscopy is feasible even in case of high BMI.

Most of the studies comparing open to laparoscopic DP found no difference in terms of complications between the two techniques [21,22]. Sulpice *et al.* found no difference in the overall complication rate between open and laparoscopy DP for adenocarcinoma, but decreased pulmonary morbidity [20]. In the present study, there was no difference in complications overall and if subdivided between minor and major. Moreover, there were no differences between medical and surgical complications. The pulmonary morbidity was also similar. This shows that laparoscopy is safe regarding short-term outcomes which is in line with the current evidence of the literature [10]. Similarly, a review on laparoscopic surgery published in 2016 concluded that laparoscopic DP can be safely performed in high-volume centers, but that randomized controlled trials still have to confirm the effectiveness of the procedure [23]. A large propensity score-matching comparative study from Japan even showed that morbidity was diminished with laparoscopic DP along with intraoperative transfusion, and LoS [24]. Only the operative time was longer.

An important point regarding oncologic resections is that laparoscopic DP had the same R0 rate and the same number of harvested lymph nodes as open DP. This suggests that laparoscopic PD is effective for oncologic resection. This has been corroborated by several studies [8,21,22,25,26]. The R0 rates found in this study (15/22 and 8/10) and the median harvested lymph nodes (16 and 14) are well in line with other previously published data. On the contrary, long-term outcomes for tumor resection are scarcer in the literature and further need to be analyzed in studies with longer follow-ups. A recent European survey showed that 31% of the interrogated pancreatic surgeons still considered that laparoscopic DP was inferior to open DP for oncologic resections [27].

As mentioned in the methods, an ERAS protocol for pancreas surgery was implemented in 2012 in our department [16]. Even though laparoscopy is not *per se* part of the pathway, minimally invasive surgery is more and more often used in the context of ERAS. The results of our study (diminution of LoS and intermediate care stay) confirm that laparoscopy allows having quicker recovery, so laparoscopy complements well an ERAS pathway.

Several limitations of this study need to be acknowledged. First, the retrospective nature of the study can bring some biases related to the chart reviews and the potential missing data. Moreover, a retrospective evaluation can find a difference of characteristics between the two study groups. The main characteristics were however similar in both groups as illustrated in Table 1. Secondly, the number of laparoscopic cases was quite small, and thus, interpretation of the data should be done with caution. Nevertheless, this study compares two similar groups in a single institution. Finally, laparoscopy was performed more frequently in the recent years. This could induce a temporal bias that needs to be taken into consideration in the analysis.

In summary, laparoscopic DP is as safe as open DP, and postoperative complications were similar. Laparoscopic DP allowed a quicker return to the normal ward and shorter LoS. Minimally invasive DP should therefore be offered whenever technically feasible.

Ethical approval

Local Ethics Committee (Commission cantonale d'éthique de la recherche sur l'être humain du canton de Vaud).

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None.

Author contribution

Gaëtan-Romain Joliat (GRJ) and Markus Schäfer (MS) designed the study.

GRJ and David Petermann (DP) acquired the data.

GRJ, Nicolas Demartines (ND), Nermin Halkic (NH), DP, and MS analyzed and interpreted the results.

GRJ drafted the manuscript.

ND, NH, DP, and MS revised the manuscript.

GRJ, ND, NH, DP, and MS approved the final version.

Conflicts of interest

None.

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Guarantor

Gaëtan-Romain Joliat accepts full responsibility for the work and the conduct of the study. I had accessed to the data and controlled the decision to publish.

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