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Laparoscopic left pancreatectomy: early results after 115 consecutive patients

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Abstract
Introduction Despite its proven feasibility and good results, the use of laparoscopy in left-sided pancreatic lesions is considered a challenging procedure, and therefore, its utilization is still low. In this paper, we aim to describe the early outcomes obtained after laparoscopic left pancreatectomies performed over 15 years.
Patients and methods From 1997 until 2014, 115 consecutive patients underwent laparoscopic left pancreatectomy at CHU Bordeaux and Centre Hépato-Biliaire, which were prospectively recorded in a database. An analysis of this database was performed in order to evaluate preoperative, intraoperative and immediate postoperative outcomes.
Results Laparoscopic left pancreatectomy with spleen conservation was performed in 64 patients (55.7 %). The median operative time was 220 min, and median blood loss was 200 ml. Conversion to open surgery was made in 15 (13 %) patients. Median postoperative hospital stay was 11 days, and overall postoperative complications occurred in 59 patients (51.3 %). Of these, 25.4 % were Clavien–Dindo grade III and above. The rate of clinical PF was 11.3 %. Three of the 64 patients with splenic preservation (4.7 %) developed a splenic infarction, and one of them needed splenectomy.
Conclusions Results obtained after a long series of laparoscopic left pancreatectomy confirm its favorable outcomes and its association with a low postoperative morbidity rate.

Keywords Laparoscopic pancreatectomy · Laparoscopy · Pancreas · Pancreatic surgery · Distal pancreatectomy · Pancreatectomy

Despite being almost 20 years from the first description of laparoscopic pancreatic surgery [1], the use of the laparoscopic approach for the surgical treatment of pancreatic diseases has been modest, especially when compared to other organs such as the gastrointestinal tract. The reasons behind this fact are multiple, from the difficulty of having a good exposure during surgery, to the retroperitoneal position in the abdomen, and above it all, the anatomical relationships of the pancreatic gland to major vascular structures in the abdomen.

The laparoscopic approach has shown the already known advantages of a reduced postoperative pain, reduced hospital stay, reduced blood loss, reduced overall complications and in patients with cancer, equivalent oncological outcomes [2–9]. However, when analyzing the results of the laparoscopy, we should remember the old concept of the higher the ratio of the abdominal access trauma in relation to the total surgical trauma in a determinate procedure, the more advantageous the use of the laparoscopic approach [10]. In fact, in pancreatic surgery, the trauma related to the abdominal access is a very small part of the overall surgical trauma, so the abdominal access should not be the most important factor. Another caveat related to laparoscopic pancreatic surgery is the need for reconstruction of the pancreatic stump, as well as the bile duct and the stomach after performing a pancreaticoduodenectomy (PD), which makes this intervention technically very

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challenging. For all these reasons, surgeons may still question whether there is a place for laparoscopy in pancreatic surgery.

However, laparoscopic pancreatic surgery should not be analyzed as a whole entity. Left pancreatectomy, in contrast to PD, is an intervention better suited for the laparoscopic access because of the lack of required anastomosis after pancreatic resection and a reduced operative field. Indeed, over the recent years, this intervention has gained the support for many pancreatic surgeons to become the preferred access for patients with left-sided pancreatic lesions.

In this paper, we aim to describe the results obtained with laparoscopic left pancreatectomies performed over 15 years in a high-volume pancreatic surgery institution.

Patients and methods

From January 1997 to June 2014, a retrospective analysis of prospectively maintained database was performed. All patients who underwent laparoscopic left pancreatectomy (LLP) in Centre Hospitalier Universitaire de Bordeaux, Bordeaux, France, and Centre Hépato-Biliaire Paul Brousse, Villejuif, France, were included.

Patients

From January 1997 to June 2014, a total of 115 consecutive patients underwent LLP. The median patient age was 55 (20–81) years; 90 (78 %) were female. A history of abdominal surgery existed in 49 (43 %) patients.

All patients presented solid or cystic pancreatic lesions placed on the left side of the mesenteric vessels. Diagnostic workup for the lesions included different imaging modalities, as well as pathological examination of tissue samples from the lesions. As a rule, lesions were characterized with a CT scan in virtually all cases and MRI as a basic diagnostic test. Patients with doubtful features on imaging underwent EUS, and those with suspicion or proved diagnosis of neuroendocrine tumor underwent octreoscan to define extension of the disease.

Indications for surgery were in the majority benignant or benignant with malignant potential, such as neuroendocrine tumors (NET), mucinous cystadenoma or IMPNs, which accounted for the 80 % of the lesions, although in eight patients there was a high clinical suspicion of malignant degeneration. Only seven patients with preoperatively known malignant disease were included, three patients with pancreatic adenocarcinoma, three patients with a renal carcinoma metastases and one patient with renal carcinoma metastasis or a pancreatic NET.

A laparoscopic left splenopancreatectomy (LLSP) was planned in 37 patients (32 %) and a laparoscopic spleen-preserving left pancreatectomy (LSPLP) in 78 patients (68 %). In this subgroup, a preservation of the splenic vessels was planned in 29 (25 %) patients and a division in 49 (43 %) patients.

Informed consent was obtained from each patient, and the study was approved by the local ethics committee. Patient and lesion characteristics are reported in Table 1.

Table 1 Patient and tumor characteristics

	N	%
Sex (M/F)	90/25	78/22
Age (years)	55 ± 14	
Weight (kg)	67 ± 14	
Height (cm)	164 ± 8	
BMI (kg/m^2)	24.7 ± 4.6	
ASA		
I	55	47.8
II	50	43.5
III	10	8.7
Imaging diagnostic tests		
Ultrasonography	39	34.5
Endoscopic ultrasonography	57	50
CT Scan	105	91.3
MRI	85	74.6
Octreoscan	12	10.6
Arteriography	2	1.8
Histological sample		
FNA	24	21.2
Biopsy	11	9.7
Preoperative diagnosis		
Neuroendocrine tumor	32	27.8
Mucinous cystadenoma	32	27.8
Intraductal papillary mucinous neoplasm	28	24.3
Solid pseudopapillary tumor	8	7.0
Serous cystadenoma	4	3.5
Renal cancer metastasis	4	3.5
Adenocarcinoma	3	2.6
Chronic pancreatitis	2	1.7
Splenic artery aneurism	1	0.9
Giant undetermined pancreatic cyst	1	0.9
Localization of the lesion		
Body	60	52.2
Tail	49	42.6
Neck	5	4.4
Splenic artery	1	0.9

Surgical procedure

Three senior surgeons (ASC, BM, and CL) performed all the operations. The surgical technique has been described elsewhere [11, 12]. Summarizing, after introduction of laparoscopic trocars, the pancreatic gland is exposed from the isthmus to the splenic hilum. An intraoperative ultrasound is performed to localize the tumor and its extent. Then, the pancreas is dissected from right to left in all patients. The inferior border of the pancreas is dissected at the level of the isthmus, and the mesenterico-portal venous axis is identified. The avascular plane between the anterior wall of the portal vein and the pancreas is dissected. The isthmus is encircled and retracted with tape. The splenic artery and vein are isolated at their origins and encircled with tape. Transection of the pancreatic parenchyma is achieved using an endoscopic linear stapler, in the vast majority of cases at the pancreatic neck.

Laparoscopic spleen-preserving left pancreatectomy (LSPLP)

For presumed benign or low-grade malignant tumors, laparoscopic left pancreatectomy was performed without splenectomy to avoid postoperative infectious complications. Two techniques were used to preserve the spleen according to the preoperative and intraoperative findings and the surgeon's experience.

Preservation of the splenic vessels (LSPLP-SVP)

The splenic vein and splenic artery are progressively dissected and freed from the tail of the pancreas from right to left. Small venous and arterial branches supplying the pancreas must be clipped and divided. This technique has the drawback that sparing the splenic vessels may not be possible when the lesion is close to the vessels or if local inflammation makes the dissection difficult.

Division of the splenic vessels—Warshaw's technique (LSPLP-WT)

After the splenic artery has been clipped and divided, about 1 cm from its origin, the inferior pancreatic border is freed from the mesenteric vessels to the pancreatic tail. The splenic vein close to the mesenterico-portal junction is identified and divided. Pancreatic dissection continues from right to left. The short gastric vessels must be identified and preserved, and the tail and body of the pancreas can now be easily freed from their posterior attachments. The pancreas is reflected to the right on its splenic vein pedicle, which is subsequently divided between ligatures or clips.

Laparoscopic left splenopancreatectomy (LLSP)

A splenectomy is associated with LLP in patients with suspected malignant lesions, or if local inflammation makes the dissection of the splenic vessels unsafe, or in case of failure of spleen conservation because of vascular injury.

The splenic artery and vein are divided and sectioned, the former about 1 cm from its origin and the latter 1–2 cm from the mesenterico-portal confluence. The pancreatic remnant is dissected until the splenic hilum. The left gastro-epiploic vessels are divided and then the gastro-splenic ligament is opened, dividing the short gastric vessels. The spleen is mobilized dissecting anteriorly and from right to left. Finally, the lienophrenic ligament is divided and the entire specimen is removed en bloc.

Variables

Preoperatively determined American Society of Anesthesiology (ASA) scores and the body mass index (BMI) were obtained from the prospective database. Tumor size and pathological diagnosis were obtained from the final histological report. Operative time, blood loss, need for an open conversion and intraoperative complications were mentioned.

Postoperative outcomes such as length of hospital stay and postoperative complications were evaluated. Morbidity was defined as a complication occurring within 30 days after surgery or during the hospital stay.

Complications were graded using Dindo's classification [13]. Minor complications corresponded to grades I and II, and major complications corresponded to grades III to V. A pancreatic fistula (PF) was defined as an amylase concentration, as measured in the fluid collected at days 3 and 5 from a drain placed intraoperatively, which was more than three times greater than the serum concentration. PF was classified according to the clinical impact on the patient's course (grade A, B or C) using the definition from the International Study Group of Pancreatic Fistula. A pancreatic fistula classified A was not considered as a relevant complication.

Statistical analysis

Unless explained otherwise, continuous data are expressed as the mean standard deviation (SD). Categorical variables were analyzed with the Chi-square test or Fisher's exact test, and continuous variables were analyzed with Student's *t* test. Two-tailed p values <0.05 were considered statistically significant.

All statistical analyses were based on the intention-to-treat principle and were performed using the statistical

package SPSS Statistics 17.0 (SPSS, Inc., Chicago, IL, USA) for Windows™.

Results

Operative findings

The median operative time was 220 (90–470) min and median blood loss was 200 (50–2000) ml. Blood loss exceeded 500 ml in 22 (19 %) patients. The main causes for intraoperative bleeding were splenic vein injury in five cases, partial splenic decapsulation in two cases, splenic artery injury in one case and pancreatic vein injury in one case.

A laparoscopic dissection and a "planned conversion" were performed with the aim of minimizing the extent of the laparotomy in seven patients; causes of this were gastric infiltration ($n = 2$), trouble of finding the lesion ($n = 3$), cancer suspicion ($n = 1$) and suspected neoplastic infiltration of mesocolon ($n = 1$). Conversion to open surgery due to pancreatic cause was undertaken in 15 patients (13 %), with the most important factors for conversion being difficulty of dissection (seven cases) and bleeding (four cases). An associated resection to the LLP concerned 12 (10 %) patients: cholecystectomy ($n = 5$), transverse colectomy for colonic ischemia ($n = 2$) and tumor adhesions ($n = 1$), wedge gastric resection for tumor adhesions ($n = 2$), tumorectomies and radiofrequency ablation liver metastases ($n = 1$), and suprarenalectomy ($n = 1$).

Out of the 115 patients of the series, 15 of them had a preoperative confirmed diagnosis or suspicion of malignant disease. In these patients, splenectomy was planned for oncological reasons. Of the 100 remaining patients, spleen preservation was intended in 75 patients (75 %) and finally accomplished in 62 (82.6 %) of them. On the other hand, splenic vessels' conservation was planned in 34 patients (29.6 %); this goal was achieved in 24 of these patients, which is a feasibility rate of 70.6 %. Of the ten patients in which finally splenic vessels could not be preserved, eight (80 %) underwent a LSPLP-WT. The causes for not being able to finally preserve the vessels were a non-reparable splenic vein injury (6 patients), an unexpected contact of the lesion to the vessels (2), bleeding (1) and an intrapancreatic splenic vein (1).

In all cases, pancreatic transection was carried out with an endostapler. No problems related to its use were reported. Once pancreatic resection was finished, a postoperative drain was placed in 112 (91 %) of the patients, depending on the surgeon. The preferred types of drain used were Jackson-Pratt and Blake closed drains (95 cases, 82, 6 %).

Surgical specimen extraction sites were an enlargement of a previous trocar (60 patients), Pfannenstiel incision (25 patients), iterative median laparotomy (5 patients), iterative McBurney or C-section (3 patients). In patients converted to open surgery, a subcostal incision was used in 19 patients and a median laparotomy in three patients.

The mean operative time length was 220 min, with a maximum that peaked at 470 min. In fact, a decision to convert to open surgery was made in one of the first patients of the series because of the excessive duration of the intervention. Regarding the three types of surgery performed, LSPLP-WT was the procedure associated with a shorter length (206.7 ± 75 min), when compared to LLSP (248.6 ± 66.7 min, $p = 0.009$), although no differences were found with LSPLP-SVP (242.4 ± 69.3 min, $p = 0.076$).

Operative findings are given in Table 2.

Postoperative course

After pancreatic resection, median postoperative hospital stay was 11 days (6–56). Overall postoperative complications occurred in 59 patients (51.3 %). Of these, 25.4 % were classified as major complications (Clavien–Dindo grade III and above).

Pancreas-specific complications occurred in 44 (38.3 %) of the patients. Thirty-nine patients (33.9 %) developed a pancreatic fistula (PF), although 66.6 % of the cases were ISGPF class A PF, resulting in a clinical PF rate of 11.3 %. Seven patients presented with a postpancreatectomy hemorrhage (PPH) and two patients with a delayed gastric emptying (DGE). Also, 12 patients presented an intraabdominal collection. The occurrence of a PF was related to the appearance of an intraabdominal collection (4.1 vs. 23.1 %, $p = 0.002$) and a DGE (0 vs. 5.1 %, $p = 0.046$) but not to a PPH (6.6 vs. 5.1 %, $p =$ ns). Likewise, clinically relevant PF (grade B/C) was associated with the presence of intraabdominal collection (4 vs. 61.5 %, $p < 0.0001$) and DGE (0 vs. 15.4 %, $p < 0.0001$), but not with PPH. Six patients needed blood transfusion.

Out of the 64 patients with LSPLP, only three (4.7 %) developed a splenic infarction, confirmed with CT scan. In all three patients, a LSPLP-WT was planned, but finally one underwent a LSPLP-SVP and the two others a LSPLP-WT. Two patients became symptomatic with sepsis signs, and finally one of them underwent a splenectomy 45 days after LLP, while the other two patients needed only symptomatic treatment.

Median length of stay was 11 days (6–56) with a mean of 13.2 ± 7.2 days. Patients who underwent LSPLP-SVP had a significant lower length of stay compared to those who underwent LSPLP-WT and LLSP (10 ± 2.7 vs. 14.2 ± 7.7 and 14.0 ± 7.9 days, respectively, p 0.042).

Table 2 Operative findings

	N	%
Type of resection		
LLSP	51	44.3
LSPLP-WT	39	33.9
LSPLP-SVP	25	21.8
Other organ resection		
Cholecystectomy	5	4.3
Transverse colectomy	2	1.7
Gastric wedge resection	2	1.7
Right and transverse colectomy	1	0.9
Liver resection	1	0.9
Adrenalectomy	1	0.9
Conversion to open surgery	22	19.1
Conversion due to pancreatic surgery	15	13.0
Causes of conversion		
Difficult dissection	7	6.1
Bleeding	4	3.5
Difficult vision	2	1.7
Obesity	1	0.9
Length of intervention	1	0.9
Surgical specimen extraction site		
Trocar enlargement	60	52.1
Pfannenstiel incision	25	21.7
Iterative median laparotomy	5	4.3
Iterative McBurney	2	1.7
Iterative C-section	1	0.9
Blood loss (mL) (median and range)	200 (50–2000)	
Length of intervention (min) (median and range)	220 (90–470)	

Rehospitalization occurred in eight patients due to: vomiting 8 days after surgery, treated conservatively (1); intraabdominal collection at POD 55, treated conservatively (1); intestinal occlusion due to adhesions, treated surgically (1); incisional hernia, treated surgically (1); planned surgical reintervention due to a tumor not found in the pathological analysis (1); Spleen ischemia, treated conservatively (1); spleen ischemia requiring splenectomy (1); and catheter sepsis (1).

Nine patients needed surgical reintervention in the first 60 days after pancreatic resection; the causes were: post-pancreatectomy hemorrhage (4 patients), intestinal perforation (2 patients), splenectomy after a failed Warshaw's technique (1 patient), abdominal wall hematoma requiring surgical evacuation (1 patient) and intestinal occlusion due to adhesions requiring lysis of abdominal adhesions (1 patient). In addition, two patients required late surgery after the 60-day period, for causes: pancreatic lesion not found in the pathological examination (1 patient) and incisional hernia (1 patient).

Finally, one patient died postoperatively. The patient was a 79-year-old man with a BMI of 32 kg/m^2, with previous medical history of aortic aneurism, pulmonary emphysema with an adenocarcinoma of the pancreatic tail that suffered a sudden cardiac arrest at the second post-operative day.

Pathology

The main diagnoses found at final pathological examination were neuroendocrine neoplasms in 33 (28.7 %) patients, mucinous cystadenoma in 28 (24.3 %), intraductal papillary mucinous neoplasms (IMPN) in 18 (15.7 %) and serous cystadenoma in 11 (9.6 %). Patients with serous cystadenoma were all symptomatic or appeared macrocystic on preoperative imaging, suggesting a mucinous cystadenoma.

In five patients (4.3 %), an intraductal carcinoma was found at pathological examination. Three of them were suspected to have a premalignant IMPN; two of them

underwent LLSP, and their pathological status was pT3N0; the third patient underwent LSPLP-SVP, and the pathological report showed a pTis. The fourth case was a patient with a giant pancreatic cyst (100 mm) that turned out to be an intraductal carcinoma pT3N1R0, and a LLSP with conversion to open surgery was performed. Finally, in the fifth patient a neuroendocrine tumor was preoperatively suspected, and after performing a LLSP, an intraductal carcinoma (pT3N0R0) was diagnosed instead. All of them had a disease-free surgical margin at the final examination. The median tumor size was 40 (25–100) mm. The definitive pathological report was malignant in ten patients: pancreatic adenocarcinoma (five patients, three de novo and two arising from an IPMN) and neuroendocrine tumors (five patients).

The overall concordance rate between the preoperative diagnosis and the pathological examination was 73 % (84 patients). In detail, we can observe in Table 3 that concordance between preoperative and postoperative diagnosis widely ranged from 100 to 25 % in patients with suspected ductal adenocarcinoma. None of the patients with preoperative ductal adenocarcinoma suspicion were biopsy proven.

Discussion

This study aims to describe the outcomes of 115 consecutive patients undergoing a laparoscopic left pancreatectomy in a center with highly specialized surgeons in pancreatic surgery. Since the first report in the literature of laparoscopic pancreatic surgery, almost 20 years ago [1], it is still lacking a widespread adoption when comparing it to other abdominal surgeries, such as colorectal, gastric or even hepatic resections. However, as mentioned before, we cannot talk of "laparoscopic pancreatic surgery" as a whole, since differences between surgical resection of left-sided and right-sided pancreatic lesions are important enough to warrant a separate classification. Indeed, left pancreatectomy has unique advantages over right procedures in terms of being an intervention with no need for anastomosis and being focused only on the pancreatic gland. Obviously, anatomic relationships of the pancreas to the surrounding vessels and the retroperitoneal location of the pancreas make it a difficult operation, but all experienced pancreatic surgeons will agree that PD is a far more challenging operation. This fact and the improvement in surgical expertise and development of new surgical instruments have led progressively to a wider adoption of LLP. Today, many centers consider the laparoscopic approach as the "gold standard" approach for left-sided pancreatic lesions.

Table 3 Postoperative outcomes

	N	%
Length of hospital stay	11 (6–56)	
Surgical complications	59	51.3
Minor		
I	26	22.6
II	18	15.7
Major		
IIIa	3	2.6
IIIb	9	7.8
IVa	2	1.7
IVb	0	0
V	1	0.9
Pancreatic fistula		
A	26	22.6
B	11	9.6
C	2	1.7
Delayed gastric emptying	2	1.7
Postpancreatectomy hemorrhage	7	6.1
Intraabdominal collection	12	10.6
Radiological drainage	5	4.4
Surgical reintervention	11	9.6 %
Pathological report		
Neuroendocrine tumor	33	28.7
Mucinous cystadenoma	28	24.3
IPMN	18	15.7
Serous cystadenoma	11	9.6
Solid pseudopapillary neoplasm	6	5.2
Adenocarcinoma	5	4.3
Pseudocyst	3	2.6
Metastases	2	1.7
Undetermined cyst	2	1.7
Chronic pancreatitis	2	1.7
Nesidioblastosis	1	0.9
Accessory spleen	1	0.9
Intratubullary papillary neoplasm	1	0.9
Splenic artery aneurism	1	0.9
No tumor	1	0.9
Concordance with preoperative diagnosis		
Neuroendocrine tumor	28	84.8
Mucinous cystadenoma	24	75
Intraductal papillary mucinous neoplasm	16	72.7
Solid pseudopapillary tumor	4	50
Serous cystadenoma	4	100
IPMN with carcinoma	2	33.3
Renal cancer metastasis	2	66.7
Adenocarcinoma	1	25
Chronic pancreatitis	2	100
Splenic artery aneurism	1	100
Giant undetermined pancreatic cyst	0	0

However, due to the still reduced number of centers and surgeons performing this surgical approach, even today there is not any randomized controlled trial of laparoscopic versus open left pancreatectomy. However, the aforementioned advantages of the laparoscopic approach versus the conventional open approach in many abdominal interventions have been demonstrated also in pancreatic surgery in many non-randomized comparative studies [14–21] that consistently show a reduction in intraoperative blood loss and a reduction in hospital stay. However, we should also mention that these studies also show an overall higher surgical intervention length. Of note, although less overall complications have been reported in LLPs, these comparative studies do not show any differences in PF rate between the laparoscopic and the open approach. Also, the overall cost of LLP, including intraoperative and postoperative costs, is less than the conventional open approach [22–25].

In the last 20 years in the literature, there have been a growing number of reports about LLP. However, most of these are series limited to less than 100 patients, although multicenter series with a considerable number of patients have been published. This paper aims to describe the outcomes of 115 consecutive patients over 15 years of experience in a team with previous wide experience both in pancreatic and in laparoscopic surgery. Yearly procedures ranged from 1 in the beginning of the experience to 17 in the latest years. Like all groups and all laparoscopic abdominal interventions, the majority of the cases operated were benignant lesions or presumed low-grade malignant lesions. In fact, only seven cases (6 %) had a preoperative diagnosis for malignant lesion, and neuroendocrine tumors, mucinous cystadenomas and IPMNs accounted for the 80 % of the resected lesions. Nevertheless, and despite the fact of the lack of randomized controlled trials, the oncological outcomes of laparoscopic and open pancreatectomies for cancer seem to be equivalent [26–30]. Existing data in the literature show that laparoscopic resection of left pancreatic malignant neoplasms is feasible even following the same principles as in open surgery (RAMPS). Despite not having a RCT, results published until now show an equivalent outcome [26–29, 31–34].

In our experience, the operative time was 220 min, with a maximum of 470 min. The reported intervention lengths in the literature are mostly around 200 min [24, 35–39], and some authors as the group of Bologna have shown that it is a factor mostly related to the learning curve [40], which is achieved after 17 performed procedures.

The conversion rate in our series is 13 %. Initial systematic reviews of the technique showed a conversion rate ranging from 0 to 43 % [41]. An American multicenter paper on left-sided pancreatic resections showed a conversion rate of 12.6 % of 159 cases [21], which is the paper with the higher number of cases in which conversion is showed. A further analysis of our experience showed that the cause of conversion was mainly related to a difficult surgical dissection and bleeding, which in our opinion might be closely related to the learning curve.

Postoperative morbidity of our series is about 50 %, although nearly 75 % of the cases were minor complications, classified as Dindo–Clavien grades I–II. Unfortunately, one patient died 2 days after surgery from a cardiac arrest. Since the patient was an aged man with cardiac and pulmonary comorbidities, and death was not directly related to a surgical complication, we would probably not attribute his death to the laparoscopic approach. Final pathological report of this particular patient showed a pancreatic adenocarcinoma. Undoubtedly, when analyzing surgical complications after a pancreatic surgery, one of the main points is the analysis of the pancreas-related complications, especially PF. The overall PF rate of this series was 33.9 %; clinically PF (ISGPF grades B and C) was 11.3 %. Before ISGPF classification, PF rates after LLP widely ranged from 7 to 28 % [20, 21, 42]. After the adoption of the ISGPF classification, the reported clinical PF rate after LLP is from 7 to 35 % [33, 43]. As showed by various papers, PF rates are not substantially different between the open and laparoscopic approaches when the same transection method is used, which is in the vast majority of the cases, including us, with an endostapler. Since the results of the DISPACT trial [44] and other recent papers [45], stapler transection is considered the method of choice.

Fifty-six percent of the patients underwent a spleen-preserving procedure. In 39 of them (61 %), a LSPLP-WT was undertaken. Only three patients (7.6 %) presented with splenic infarction after surgery; one patient (meaning 1.6 % of all patients in which the spleen was preserved and 2.5 % of LSPLP-WT) required splenectomy, while the other two did well with symptomatic treatment. Spleen preservation has obvious advantages for the patient due to immunologic reasons, so we believe the spleen must be preserved whenever possible [36, 37, 43, 46, 47]. Since this is a faster and less challenging procedure than LSPLP-SVP, it is a very tempting procedure to perform. However, caution must be held regarding postoperative complications, which in some cases may adversely affect postoperative outcome [48].

The overall concordance rate between preoperative and postoperative diagnosis was 73 %, with 12 cases of malignant disease confirmed by pathology. Five of them were classified as grade III NET, five were ductal adenocarcinomas and two were metastases from renal cancer. Apart from grade III NETs, which are difficult to diagnose preoperatively without biopsy and metastases from renal cancer, in which the patient's past medical history played

an essential role in the diagnosis, only three of the five patients (60 %) with ductal adenocarcinoma had a preoperative suspicion for cancer. In fact, the two misdiagnosed patients had a preoperative diagnosis of non-degenerated IPMN and NET. After analyzing all the misdiagnosed patients in the series and the use of preoperative histologic confirmation (not shown), we did not find any differences in biopsy or FNA rate between the patients with and without concordant diagnosis, so it is difficult to attribute those misdiagnosed cases to the lack of systematic preoperative biopsy. Previous series have shown a similar rate of misdiagnosis of pancreatic lesions, and, in fact, it is still today an important matter of debate [49–54].

In conclusion, our results confirm the previous experiences published with LLP. We strongly believe that randomized controlled trials comparing oncological results between open and laparoscopic approaches are warranted.

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Compliance with ethical standards

Conflict of interest We deny any conflicts of interest.

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