

Distal pancreatectomy: experience in a National Hospital

Pancreatectomía distal: experiencia en un hospital de referencia nacional

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Abstract

Aims: To compare the short-term outcomes of patients undergoing open DP (ODP) and laparoscopic DP (LDP); and to analyze the association between the section site of the pancreas and pancreatic fistula. **Materials and methods:** Clinical, perioperative, and histopathologic data of patients who underwent ODP and LDP between 2009 and 2019 were retrospectively analyzed. **Results:** 70 patients were registered. 39 (56%) underwent ODP and 31 (44%) underwent LDP. The tumor size in ODP group was 70mm and in LDP group was 45mm ($p = 0.032$) Blood loss was lower in LDP group (229mL versus 498mL) ($p = 0.001$). Operative time, spleen preservation, B/C pancreatic fistula, major morbidity, reoperation, and length of hospital stay, were similar in both groups. There was no postoperative mortality. No differences were found in B/C pancreatic fistula rate regarding to pancreatic transection site. **Conclusions:** LDP is a safe procedure, with perioperative outcomes similar to ODP and with less blood loss. The pancreatic transection site did not influence post-operative pancreatic fistula rate.

Keywords: Distal pancreatectomy. Laparoscopy. Transection site. Pancreatic fistula.

Resumen

Objetivos: Comparar los resultados a corto plazo de pacientes intervenidos mediante pancreatectomía distal abierta (PDA) y laparoscópica (PDL); y analizar si el lugar de la sección del páncreas tiene relación con la formación de fístula pancreática. **Materiales y métodos:** Serie retrospectiva y descriptiva de las PD realizadas, desde enero del 2009 a diciembre del 2019. Se compararon las características clínicas, perioperatorias e histopatológicas de pacientes con PDA y PDL. **Resultados:** Se incluyeron 70 pacientes. Treinta y nueve casos (56%) con PDA y 31 casos (44%) con PDL. El tamaño tumoral promedio en la PDA fue de 70 mm y en la PDL 45 mm ($p = 0.032$). La pérdida sanguínea fue menor en la PDL (229 vs. 498 ml) ($p = 0.001$). No se encontró diferencia significativa en tiempo operatorio, porcentaje de preservación esplénica, fístula pancreática B/C, reoperación, morbilidad mayor y estancia hospitalaria. No hubo mortalidad postoperatoria. No hubo diferencias en la formación de fístula pancreática con respecto al lugar de sección del páncreas. **Conclusiones:** La PDL es un procedimiento seguro, con resultados perioperatorios similares a la PDA y con menor pérdida sanguínea. El lugar de sección del páncreas no tuvo relación con la formación de fístula pancreática.

Palabras clave: Pancreatectomía distal. Laparoscopia. Lugar de sección. Fístula pancreática.

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Introduction

Distal pancreatectomy (DP) or left pancreatectomy is the resection of the pancreas to the left of the mesenteric portal venous axis, regardless of spleen preservation¹. This surgical procedure is performed for benign, premalignant and malignant injuries of the body and tail of the pancreas²; as well as pancreatic trauma cases. The DP has a morbidity of 30-50% and mortality of 1-4%², and pancreatic fistulas are the common surgical complication. Pancreatic fistulas are associated with other major complications, such as intraabdominal abscesses, sepsis, delayed gastric emptying, and bleeding³. There is little knowledge about the predisposing factors for the formation of a pancreatic fistula after a DP³. A soft pancreas, obesity, blood transfusion, massive intra-operative bleeding, and prolonged surgery time are associated with higher incidence of fistulas⁴. It has been suggested that the pancreatic section site would be related to the increase in the risk of pancreatic fistula, especially in cases where the resection is performed on the body or tail of the pancreas⁵. On the other hand, several techniques have been proposed for the closure of the pancreatic remnant, however, none of them has been proven to be clearly superior to another in preventing this complication^{3,6}; manual and mechanical suture are the most frequently used techniques^{3,7}.

For a long time, the approach for this procedure has been an open DP (ODP). In the last few decades, the minimally invasive approach, using laparoscopic surgery (LDP) and robotic surgery have increased gradually². Specialized research centers with high volume of pancreatic surgery have suggested that the LDP is associated with shorter hospital stays, less intra-operative bleeding, greater preservation of the spleen, and lower post-operative morbidity⁸; despite these findings, the laparoscopic approach is used in less than one fourth of DPs^{8,9}.

The objectives of this work were: first, to short-term results in patients after ODP and LDP. Secondly, to analyze if the pancreas resection site had any relationship with the formation of the clinically relevant pancreatic fistula, and to add our experience to previously published series.

Materials and methods

This study is a retrospective, descriptive, and comparative series of all DPs performed in a specialized pancreatic surgery center, from January 2009 to December 2019.

Patients with DP due to an extrapancreatic pathology were excluded.

The analysis of the data was performed according to the "treatment intention" principles, and therefore, the results of converted LDP were analyzed within the LDP group.

Surgical technique

ODP and LDP were performed using the standard technique for this procedure. In patients with benign pathology spleen preservation was performed with Kimura technique (preservation of spleen blood vessels)¹⁰. Spleen preservation was considered for cases in which a partial splenectomy was performed with or without preservation of spleen vessels. In cases where a malignant pathology is suspected a lymphadenectomy. The LDP was performed with the patient lying down on their back (body injuries) or in the right lateral decubitus position (tail injuries).

The closure of the pancreatic remnant was done with manual or mechanical sutures. Manual sutures were performed by tying the Wirsung duct with a cross-stitch with polypropylene 5/0 and 3 or 4 total transfixing sutures (U stitches) to the pancreatic parenchymal with polypropylene 3/0. The types of mechanical sutures used both for the ODP and the LDP were: Endo GIA™ 45 mm (Covidien® Surgical, Boulder, CO, USA) or Echelon Endopath™ 60 mm (Ethicon® Endosurgery; Johnson & Johnson, Cincinnati, OH, USA). Blue or green load, depending on the thickness of the parenchymal. When the pancreas was sectioned with mechanical sutures, the Nakamura¹¹ Nakamura's prolonged firing technique was used, which involves closing the stapler slowly and compressing the pancreatic parenchymal for 3 minutes, then pressing the trigger and keeping the stapler compressed for 2 minutes before the resection is performed. The purpose of keeping the trigger pressed is to avoid a traumatic fracture of the pancreatic parenchymal, which can injure then pancreatic duct system¹¹.

The section site of the pancreas was defined during surgery, based on the location of the neoplasm, and with the purpose of obtaining free margins.

Finally, two drains were placed near the pancreatic remnant and the left subdiaphragmatic space. On the first, third, and fifth days after surgery, drainage amylases were measured. Drains were removed when the drainage was lower than 20 ml in 24 hours, or when drainage amylase was lower than 3 times the normal upper serum value.

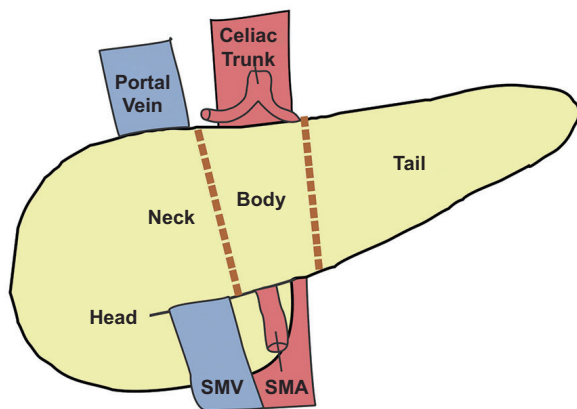


Figure 1. Limits of distal pancreatic resections. Anatomical determination of neck, body, and tail of the pancreas. SMV: superior mesenteric vein; SMA: superior mesenteric artery.

Definitions

The limit between the head and the body of the pancreas is provided by the left side edge of the superior mesenteric vein (SMV) and the portal vein (PV). The neck of the pancreas is the anterior portion of the SMV and the PV. The limit between the body and tail of the pancreas is provided by the left side edge of the abdominal aorta¹² (Fig. 1).

Pancreatic adenocarcinoma was defined according to the classification of the World Health Organization (WHO)¹³.

Intraductal papillary-mucinous neoplasm (IPMN) and cystic mucinous neoplasm (CMN) were classified as malignant when they had an associated invasive carcinoma¹⁴. Solid pseudo-papillary neoplasm (SPN) was considered malignant when there was presence of regional or distant metastatic disease¹⁵. Neuroendocrine tumors (NET) that were considered malignant was NET G3¹⁶.

Postoperative morbidity was defined as any local or systemic post-surgical complication within 90 days of surgery. Pancreatic fistula was defined as B or C degree and clinically relevant (*International Study Group on Pancreatic Fistula*)¹⁷. Surgery site infection was defined according to the criteria of the *Centers for Disease Control and Prevention*¹⁸. Intraabdominal abscess was defined with the presence of clinical signs of sepsis (tachycardia, leukocytosis, fever), tomographic finding of collection, and positive collection culture. The modified Clavien-Dindo classification was used to grade complications¹⁹. Serious complications were considered as Clavien-Dindo III degree

or higher. Post-operative mortality was defined as occurring within 90 days after surgery or during the hospital stay.

The database was created and processed using Microsoft Excel software. Quantitative variables are expressed as means and ranges. Qualitative variables are expressed as frequencies and percentages. The statistical analysis was performed using the SPSS version 25 program. Categorical variables were analyzed with the chi-square test and Fisher's exact test, for numerical values Mann-Whitney U test was used for independent samples. A p value < 0.05 was considered significant.

The work complies with current bioethical research regulations and was authorized by the ethics review committee of the institution.

Results

From January 2009 to December 2019, 83 DPs were performed. 13 patients were excluded as the DP was not the primary surgical procedure (spleen pathology, left adrenal gland, stomach, and retroperitoneum). Among the 70 patients included, 9 (13%) were males, and 61 (87%) were females. The average age among males was 51.6 years (range: 28-73 years), and the average age among females was 50.9 years (range 2-83 years).

ODP was performed in 39 cases (56%) and LDP in 31 cases (44%). There were 4 conversions (13%) in the LDP group. Two conversions were due to bleeding, and the other two due to lack of adequate exposure (Table 1).

The total number of B and C fistulas was 11 (16%), 5 were in the ODP group (13%), and 6 in the LDP group (19%). In the ODP group, there were 3 B fistulas, and 2 C fistulas; in the LDP group, there were 5 B fistulas and 1 C fistula.

There was no post-operative mortality in either group. Clavien-Dindo complications of III degree or higher were 9 (13%), 5 in the ODP and 4 in the LDP group (Table 1).

The most frequently removed pathology was NET in 17 cases (24%), followed by SPN in 13 cases (19%), CMN in 11 cases (16%), and CSN in 10 cases (14%). There was malignant pathology in 13 cases (19%), and 3 of them (4%) were pancreatic adenocarcinomas (Tables 2-3).

The section site in 48 cases was the neck, and in 19 cases, the body/tail. There is no information regarding 3 of the cases (Table 4).

Table 1. Clinical and perioperative comparison of patients with open distal pancreatectomy (ODP) and laparoscopic distal pancreatectomy (LDP)

	ODP (n = 39)	LDP (n = 31)	p value
Age, average (SD)	49 (± 19)	53.6 (± 15)	0.323
ASA	2	2	
Comorbidity, n (%)	15 (38)	15 (48)	0.405
Perioperative			
Tumor size, mm (SD)	70 (± 46)	45 (± 29)	0.032*
Surgery time, min (SD)	206 (± 50)	228 (± 60)	0.118
Blood loss, mL	498	229	0.001*
Conversion to open	NA	4 (13)	
Spleen preservation, n (%)	2 (5)	3 (9)	0.649
Resection of other organs (excluding spleen), n (%)	7 (18)	0	
Pancreatic remnant closure, n (%)			
Mechanical suture	34 (87)	31 (100)	
Manual suture	5 (13)	0	
Morbidity within 90 days, n (%)	7 (18)	8 (26)	0.459
B/C pancreatic fistula, n (%)	5 (13)	6 (19)	0.547
Intraabdominal abscess, n (%)	3 (8)	2 (6)	0.841
Pulmonary thromboembolism	1	1	
Colon fistula	0	1	
Deep surgical site infection	0	1	
Renal ischemia	1	0	
Bowel obstruction	1	0	
Re-intervention, n (%)	1 (3)	2 (6)	0.580
Greater morbidity (Clavien-Dindo III or higher), n (%)	5 (13)	4 (13)	0.992
Mortality, n (%)	0 (0)	0 (0)	
Hospital stay, medium (range)	8 (6-39)	7 (5-43)	0.079

*ASA: American Society of Anesthesiologists classification. NA: not available.

Discussion

The retroperitoneal location of the pancreas, its close relationship with major blood vessels, and the fragility of this organ contributed to the slower adaptation of pancreatic surgery to minimally invasive surgical techniques, such as laparoscopy²⁰. The PD was the procedure that facilitated the adoption of laparoscopy in pancreatic surgery, as it does not require the reconstruction of the pancreatobiliary system or the gastrointestinal tract, or an intricate dissection as in a pancreaticoduodenectomy^{20,21}. Retrospective studies have shown that LDP has a shorter hospital stay, less bleeding, and less time to begin the oral route compared to ODP^{8,21,22}. The randomized studies LEOPARD² and LAPOP²² showed that the LDP also has a shorter period of time for functional recovery and a lower impact on post-operative quality of life, without increase in cost. In addition to the advantages described, LDP does not increase the risk of serious complications or B/C pancreatic fistulas^{2,8,21,22-24}.

In our series, we found significant differences in tumor size, and lesions removed by laparoscopy were

smaller (70 mm with ODP v. 45 mm with LDP). Although there are reports for the feasibility of laparoscopic resection of lesions larger than 50 mm²⁵ and 70 mm²⁶, other works report that lesions removed by laparoscopy are smaller in size than those removed by open surgery^{8,22}. This difference in lesion size explain the lower rate of bleeding during surgery in the LDP group. In general, large pancreatic tumors located on the body and tail tend to occupy the area of the celiac axis, making it difficult to quickly control the splenic artery²⁵. Furthermore, larger tumors can extend to the lower edge of the pancreas, making the dissection of the portomesenteric axis more difficult²⁵.

In this series, surgery time, higher morbidity, B/C pancreatic fistulas, and re-intervention had no significant difference in both groups. Major complications found were 13% for ODP and LDP. Major complications reported after ODP vary between 25% and 38%, and after LDP between 14%-25%^{2,8,21,22}. Similarly, the incidence of B/C pancreatic fistulas found was 13% for ODP, and 19% for LDP. The incidence of B/C pancreatic fistulas reported varies between 7% and 38% in ODP and between 6% and 39% in LDP^{2,8,21,22-24}.

Table 2. Histopathological comparison of patients with open distal pancreatectomy (ODP) and laparoscopic distal pancreatectomy (LDP)

Histopathology	ODP (n = 39)	LDP (n = 31)	Total
NET	6	11	17
SPN	9	4	13
CMN	8	3	11
CSN	5	5	10
IPMN	2	2	4
Adenocarcinoma	3	0	3
Ectopic spleen	0	2	2
Renal cell metastasis	2	0	2
Nesidioblastosis	1	1	2
Pseudo-cyst	0	2	2
Hydatidosis	0	1	1
Acute pancreatitis	1	0	1
Chronic pancreatitis	1	0	1
Pancreatoblastoma	1	0	1

NET: neuroendocrine tumor; SPN: solid pseudo-papillary neoplasm; CMN: cystic mucinous neoplasm; CSN: cystic serum neoplasm; IPMN: intraductal papillary-mucinous neoplasm.

Table 3. Comparison of malignant neoplasm in patients with open distal pancreatectomy (ODP) and laparoscopic distal pancreatectomy (LDP)

Malignant neoplasm	ODP (n = 39)	LDP (n = 31)
Adenocarcinoma	3	0
Neuroendocrine carcinoma (G3)	2	0
Renal cell metastasis	2	0
CMN and invasive carcinoma	1	1
Metastatic SPN	2	0
IPMN and invasive carcinoma	1	0
Pancreatoblastoma	1	0
Total	12	1

CMN: cystic mucinous neoplasm; SPN: solid pseudo-papillary neoplasm; IPMN: intraductal papillary-mucinous neoplasm.

Our series was unable to show shorter hospital stays in favor of LDP. We believe this was due to two less common complications we encountered (a deep infection of the surgery site, and a colon fistula), which increased the length of the hospital stay in the LDP group.

The reported conversion varies from 8% and 30%^{2,8,21,22,24}. The most frequent conversion causes mentioned are adherence, absence of adequate exposure, and proximity of the tumor to blood vessels^{2,8,21,24}.

Table 4. Pancreatic fistula and pancreatic section site

Section site	Patients	B/C fistula (%)
Neck	48	8 (17)
Body/tail	19	3 (16)
p value		0.930

The conversion in our series was 13% and the causes were bleeding (2 cases) and lack of adequate exposure (2 cases). This low percentage of conversion could be biased due to the smaller size of the lesions in the laparoscopic approach.

When we analyzed if the section site of the pancreas would have any impact on the formation of a B/C fistula, no significant difference was found when sectioning the neck or the body/tail of the pancreas; this finding is similar to what has been reported by other series that compare the section of the pancreas on the neck vs. the body/tail⁵ or neck/body vs. tail²³.

It is known that splenectomy has some negative consequences, such as the risk of developing septic complications, thromboembolic events, and some types of cancer, and for this reason, spleen preservation is recommended for benign and pre-malignant lesions of the distal pancreas²⁷. It has been shown that a tumor size of over 30 mm represents an independent risk factor for a splenectomy²⁷. With the purpose of providing greater spleen preservation, we propose a partial splenectomy as an alternative to Kimura¹⁰ and Was-haw's²⁸ techniques.

There was no mortality in either group (ODP and LDP), similar to the reports of other publications with mortality rates of 0.5% to 2% for ODP^{8,21} and 0% to 0.5% for LDP^{8,21}. We believe that these good results are the result of the centralization effect pancreatic pathology management by trained surgeons.

The most frequently removed pathology was NET, followed by cystic neoplasms. Pancreatic adenocarcinoma represented only 4% of removed lesions, and all were removed by ODP. The absence of distal pancreas adenocarcinoma symptoms in the initial stage contributes to late diagnosis, when it is too late to remove²⁹. Studies comparing ODP with LDP for the approach to pancreatic adenocarcinoma in oncology terms (section margins, adequate node resection, and survival) are even more controversial^{13,30}.

The retrospective design, the lack *propensity score matching* or randomization, and the reduced number

of pancreatic adenocarcinoma cases are the most significant limitations of this series. Despite these limitations, this study represents a significant cohort of patients with DP of a single institution.

Conclusions

LDP is a safe procedure, with perioperative outcomes similar to ODP and with less blood loss. The pancreatic transection site did not have any relationship with the formation of a clinically relevant pancreatic fistula in our series.

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Conflicts of interest

The authors declare they have no conflicts of interest.

Ethical disclosures

Protection of people and animals. The authors declare that no experiments have been made on human beings or animals for this research.

Data confidentiality. The authors declare that they have followed the protocols of their work center regarding the publication of patient data.

Right to privacy and informed consent. The authors declare that no patient data appears in this article.

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