ORIGINAL ARTICLE

Mininvasive Distal Pancreatectomy: 10 Years' Experience of a Single Centre

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ABSTRACT

Introduction Despite its proven feasibility and good results, the use of minimally invasive surgery in left-sided pancreatic lesions is a challenging procedure, and therefore, its utilization is still low. In this paper, we aim to describe the early outcomes of a group of patients underwent distal pancreatectomy in a 10 years period. **Patients and methods** From January 2005 until July 2015, 56 consecutive patients underwent mininvasive distal pancreatectomy at Department of General Oncologic and Mininvasive Surgery, Niguarda Ca'Granda Hospital in Milan, Italy. We performed an analysis of a database in which data of patients were recorded in order to evaluate preoperative, intraoperative and postoperative outcomes. **Results** The average operative time was 261 min and average blood loss was 275 mL. Conversion to open surgery was performed in 11 patients (11/56, 19.6%). Average postoperative hospital stay was 16 days, and major postoperative complications occurred in 22 patients (22/56, 39.3%). Overall rate of pancreatic fistula was 22/56 (39.3%), the rate of clinical pancreatic fistula (B/C grade) was 16/56 (28.6%). Mininvasive distal pancreatectomy with spleen preservation was performed in 17 patients (17/56, 30.3%). The analysis of these data showed no case of splenic infarction in the group with splenic preservation. **Conclusion** The results obtained confirm favorable outcomes of minimally invasive distal pancreatectomy and its association with a low postoperative morbidity rate.

INTRODUCTION

Laparoscopy is a challenge in pancreatic surgery due to the location of the pancreas in retroperitoneal space, and its close proximity to the duodenum and major vessels. During the last two decades there was evidence that laparoscopy is feasible and safe in pancreatic surgery in well-trained centres, especially for distal pancreatectomy and enucleation. This procedure is recommended in case of benign or low-grade malignant pathologies, although in the last years many centres performed laparoscopic distal pancreatectomy also for adenocarcinoma. Laparoscopic pancreaticoduodenectomy is more complex but none-the less its feasibility has been demonstrated [1]. In 1994 Soper performed the first laparoscopic distal pancreatectomy on a porcine model to document its safetly and feasibility. Gagner first reported in 1996 five cases of spleen preserving laparoscopic distal pancreatectomy for human insulinoma [2]. The laparoscopic approach during these years was not as common as for others organs, for example for gastrointestinal disease, for many reasons: difficult organ exposure during surgery, retroperitoneal position of the pancreas and its relation with primary vascular structure. Mininvasive approach has many advantages: lesser post-operative pain, less length of stay, reduction of blood loss and overall rate of complications, without different oncologic results for malignant disease [3, 4, 5, 6]. Distal pancreatectomy (DP), resection of pancreas on the left of mesenteric vessels, is easier for mininvasive approach instead of pancreaticoduodenectomy, because it doesn't need anastomosis. This approach, during the last 10 years, has become the gold standard for the treatment of all distal pancreatic lesions. In this paper we describe the results of mininvasive distal pancreatectomy (MIDP) performed during 10 years in a single centre.

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PATIENTS AND METHODS

From January 2005 to July 2015, 56 patients with neoplasm of the left pancreas underwent mininvasive distal pancreatectomy (MIDP). The average age of the patients was 56 (range: 15 to 84y); 38 (67.8%) women, 18 men. 32 patients had received previous abdominal surgery (57.1%) and 12 (21.4%) had a history of chronic pancreatitis **(Table 1)**. All patients had left-sided pancreatic lesions, studied with different imaging, CT scan or MRI and in most cases also with Endoscopic ultrasonography (EUS) and biopsy. If a neuroendocrine

Table 1. Demographic characteristic.

Variables	Value	%
Sex (M/F)	18/38	32.2/67.8
Age (average)	56	
BMI (kg/m2) (average)	24	
ASA score		
I	14	25
II	37	66.1
III	5	8.9
Diabetes Y/N	9/47	16.1/83.9
Smoke Y/N	21/35	37.5/62.5
Ipertension Y/N	22/34	39.3/60.7
Abdominal surgery history Y/N	32/24	57.1/42.9
Preoperative serum albumin g/dL (average)	4.27	
Wirsung size mm (average)	2.7	

tumor (NET) was suspected, Octreoscan or DOTATOC with Gallium 68 PET was performed during preoperative exams, to define the lesion extension and verify the most suitable surgery strategy. Most lesions were solid or cystic benign or borderline lesions, such as NET, mucinous cystoadenoma, or Intrapapillar mucinous neoplasm (IPMN). 15 patients were affected by malignant tumor of pancreatic body or tail. Distal splenopancreatectomy (DSP) was planned for 39 patients (69.6%) and distal spleen-preserving pancreatectomy (SPDP) in 17 patients (30.4%) with splenic vessels preservation.

Technique of Left Pancreatectomy

Distal pancreatectomy can be performed with or without preservation of the spleen. Distal pancreatectomy with subsequent splenectomy is indicated in case of malignant disease of the distal pancreas to ensure extensive resection of lymph nodes located along the splenic artery and the splenic hilum [7]. Splenectomy is also often performed because of technical reasons, such as vascular tumor involvement. Sometimes spleen preserving can be technically challenging.

Distal pancreatectomy spleen preserving is indicated in benign or low-grade malignant lesions when the splenic artery are uninvolved by the tumor; spleen preserving procedures reduce the risk of post splenectomy sepsis, haematologic and immunologic disorders.

There are two techniques of spleen preservation: Kimura and Warshaw technique. In 1996 Kimura described a technique of spleen - preserving distal pancreatectomy including preservation of the splenic vessels. The authors concluded that this procedure is safe and easy.

In 1988 Warshaw introduced a spleen-preserving distal pancreatectomy with transection of the splenic vessels [8]. In this technique attention should be given to preserving the left gastroepiploic artery, as this is suspected to play an important role in the prevention of postoperative splenic ischemia [9]. For Warshaw, mild risk of post-operative splenic infarction has to be taken into account, especially in the presence of an infected collection along the resection bed. The formation of perigastric varices may be interpreted as a paraphysiologic phenomenon after interruption of the main splenic vessels, and was not associated with gastrointestinal bleeding during long term follow up [10, 11]. During a spleen-preserving procedure the surgeon should always examine the splenic perfusion at the end of the procedure. When signs of splenic ischemia are present, such as extensive ischemic zones, a splenectomy has to be performed. This may occur in 10% of patients [12].

Trocars and Pancreas Mobilization

The patient is intubated in a supine position with parted legs and 20-degree head-up tilt.

The surgeon works between patient's lower limbs with 1 assistant on each side and another assistant and the scrub nurse on his right side. After the insertion of the first 12 mm Hasson cannula with open technique for instuitution of $C0_2$ pneumoperitoneum, the peritoneal cavity is inspected by a 30-degree optic view. One 12 mm trocar (Ethicon endosurgery Inc, Cincinnati OH) for the operating instruments is inserted in the left paraumbelical side on the median axillary line and two more 5 mm trocars are inserted, 1 in the right upper quadrant and 1 in the left upper quadrant.

The stomach is lifted with 2 or 3 stiches through the sieromuscolar layer to anterior abdominal wall, to permit access to the lesser sac and good exposure of the pancreas. Alternatively the stomach can be retracted with a laparoscopic retractor device.

After the inspection of peritoneal cavity, the first step is the opening of the lesser sac and the gastrocolic ligament to expose the tail of pancreas and the splenic artery by harmonic scalpel Ultracision® (Ethicon Endosurgery Inc, Cincinnati, OH), with a shaft diameter of 10 mm, or by Harmonic Ace ultrasound scalpel, with a shaft diameter of 5.5 mm (Ethicon Endosurgery Inc, Cincinnati, OH). The second step is the mobilization of the splenic flexure.

Before pancreatic dissection, laparoscopic ultrasonography is routinely performed to rule out the presence of multifocal lesions in case of endocrine tumor, to assess the size and the site of the lesion, its closeness to Wirsung duct and splenic vessels.

The inferior margin of the pancreas is in the Roger quadrilater area comprised between portal vein, splenic vein, and inferior mesenteric vein. The body and the tail are mobilized by dissecting the avasculare plane between mesogastric fascia and Gerota fascia.

The pancreas is suspended by a rubber band and transaction in carried out, leaving the superior mesenteric vein on the right side. Then the pancreatic isthmus is dissected: the maneuver starts by the median colic vein or Henle trunk, freeing the inferior margin of pancreas. Pancreas is transected by Harmonic scalpel or by linear stapler with polypropylene interrupted suture.

Pancreatic transection is also performed with ENDOGIA 45 or 60 mm articulating linear cutter with blue or green

Cartridge (Ethicon Endosurgery Inc, Cincinnati, OH) with reinforcement of the staple line by plyglicolic acid-trimethylene carbonate BSG (Bioabsorbable Seamguard, WL Gore & Associates, Flagstaff, AZ), a material absorbable within 6 months.

Before transection all the patients received subcutaneous octreotide.

Lymphadenectomy including splenic and celiac nodes is carried out.

The splenic artery is cut at its by linear cutting stapler or with clips. The splenic vein is cut at the confluence with SMV by linear cutting stapler or between clips.

During spleen-preserving distal pancreatectomy, we use a bulldog arterial clamp for 10-15 minutes to free the pancreatic tissue from small vessels arising from the splenic artery and vein that are interrupted with absorbable clips. This maneuver decreases the splenic blood flow and is safe. In our experience there were no cases of post-operative spleen ischemia or vascular thrombosis documented by Doppler ultrasound.

At the end, the pancreas is removed with endobag and an aspirative drain is inserted near the pancreatic stump.

Perioperative Data

Preoperative American Society of Anesthesiology (ASA) score, Body Mass Index (BMI), average age, and preoperatory serum albumin value are described in **Table 1**. Operative time, blood loss, conversion data and intraoperative complications are described in **Table 2**. Pathological examination analysis is described in **Table 3**. Postoperative results and complications are described in Table 4. Clavien Dindo Classification **(Table 4)** was used for complications, grade I and II for minor complications, III, IV and V for major complications [12]. The definition of post-operative pancreatic fistula (POPF) according to ISGPF [13] is: drain fluid after postoperative day 3 with amylase content greater than 3 times the upper normal serum value. The main parameters for POPF grading according to ISGPF definition are based on 3 grades A, B and C **(Table 5)**. Grade A fistula is not considered as major complication. We considered readmissions within 30 post-operative days and within 90 post-operative days.

Intraoperative Data

The average operative time was 261 min (140-495) and average estimated blood loss was 275 mL (50-1000 mL). The main causes for intraoperative bleeding were splenic vein injury in one case, splenic decapsulation in one case and splenic artery injury in another case.

In 11 cases (19.6%) conversion to open surgery was performed: causes of this were adhesion, splenic vein injury and others **(Table 2)**. The most important factor for conversion were bleeding, technical difficulties, and strong adhesion. An associated resection to MIDP concerned 13 patients (23.2%): cholecystectomy (n=5), umbilical hernia repair (n=1), appendectomy (n=2), left adrenal gland lesion excision (n=2), pararectal lesion excision (n=1), transabdominal preperitoneal inguinal hernia repair (TAPP) and antireflux plastic (n=1), right nephrectomy (n=1). Fifteen patients had a confirmed diagnosis of malignant disease (ductal adenocarcinoma). In these patients, splenectomy was planned for oncological reasons. Of the 41 remaining patients, spleen preservation was accomplished in 17 (30.4%) of them, using Kimura technique, preserving splenic vessels in all of these patients. In 5 cases pancreatic transection was carried out with an endostapler (8.9%), in 29 cases (51.8%) with endostapler and reinforcement of staple line with Seamguard, in 22 cases (39.3%) with harmonic scalpel Ultracision® (Ethicon Endosurgery Inc, Cincinnati, OH). No problems related to their use were reported. Once the pancreatic resection was finished, a postoperative Jackson-Pratt drain was placed in all the patients. Surgical specimens were extracted by a Pfannenstiel incision or from an enlargement of umbilical trocar incision. In all patients converted to open surgery, a median laparotomy was used. The average operative time was 261 min (140-495). In the laparoscopic distal pancreatectomy group the average operative time was 244 min (140-485), in the robot assisted distal pancreatectomy group the average operative time was 384 min (225-495), in the group of patients converted to open surgery group the average operative time was 281 min (190-450).

The decision to convert to open surgery was due to strong adhesions (n=2), technical difficulties (n=4), size of lesion (n=2) and intraoperative bleeding caused by lesion of splenic vessels (n=3) **(Table 2)**.

Table 2. Intraoperative data.

Variables	Value N	%
Surgical procedure		
Laparoscopic distal splenopancreatectomy	35	62.5
Laparoscopic distal pancreatectomy spleen-preserving	17	30.3
Robotic distal splenopancreatectomy	4	7.2
Conversions	11	19.6
Causes of conversions		
Technical difficulties	4	
Bleeding	3	
Adhesions	2	
Sizelesions	2	
Surgical combined procedures	13	
Cholecystectomy	5	
Appendectomy	2	
Left adrenalectomy	2	
Others	4	
Estimated blood loss (mL) (average and range)	275 (50-1000)	
Operative time (min) (average and range)	261 (140-495)	
Pancreas resection devices		
Ultracision	22	39.3
Endostapler	5	8.9
Endostapler plus Seamguard	29	51.8
Gastric lifting with transparietal stiches	24	
Wip stitches over suture line with monofilament thread	35	

Statistics Methods

All the variables were analyzed with the usual descriptive methods. The Fisher exact test was used to compare categorical variables, whereas t Student test and Welch test were used for continuous variables. Logistic regression was used to verify the association between a binary dependent variable and one or more continuous or binary independent variables.

The Receiver Operating Characteristics (ROC) analysis was used to dichotomize, where possible, the continuous variables by finding the best cutoff with Youden J statistics.

The statistics significance is $p<0.05$.

RESULTS AND DISCUSSION

Postoperative Care

After pancreatic resection, average postoperative hospital stay was 16 days (6-82).

Overall postoperative major complications (Clavien-Dindo grade III and above) occurred in 22 patients (39.3%) **(Table 6)**. Twenty-two patients (39.3%) developed a pancreatic fistula (PF), 6 (27.3%) of the cases were ISGPF class A PF, while B grade and C grade pancreatic fistula respectively occurred in 14 cases (63.6%) and 2 cases (9.1%).

In 19 patients (33.9%) a surgical reintervention in the first 90 postoperative days was necessary.

In 1 case endoscopic transgastric drainage of a peripancreatic collection was performed; an endoscopic treatment with pancreatic stent placement was performed in 7 cases; in 5 cases a radiological drainage of postoperative fluid collections was performed;

In 2 cases a laparotomy was necessary for haematoma drainage.

In 1 case an endoscopic control of gastric bleeding was performed.

In 2 patients a radiological drainage of peripancreatic fluid collection followed by endoscopic pancreatic stent placement was performed.

In 2 cases radiological drainage of peripancreatic fluid collection infected followed by surgical revision of the abdominal cavity had to be performed.

Twelve patients presented a deep incisional or an organ/space surgical site infection (21.4%); three patients presented superficial incisional surgical site infection (5.4%).

A Wirsung diameter over 3.2 mm and an age <60 present an increased risk of PF in a statistically relevant way.

No patient of spleen preserving distal pancreatectomy developed a splenic infarction.

Average length of stay was 16 days (6–82). Average length of stay in fully MIDP was 16 days, while in converted to open surgery group was 17 days **(Table 7)**.

Rehospitalization <30 postoperative days occurred in 4 patients due to: Small gastric vessels bleeding 18 days after surgery, treated with emergency surgery (1); intra-abdominal collection at post-operative day 16, treated with radiological drainage (1); space surgical site infection in POD 26 treated with endoscopical transgastric drainage (1) and peripancreatic infected fluid collection in POD 13 treated with endoscopic pancreatic stent placement. Rehospitalization <90 postoperative days occurred in 8 patients due to: two patients needed radiological placement or replacement of drainage; one patient underwent radiological drainage because of sepsis due to infected peripancreatic collection in POD 36 und; 3 patients needed endoscopic stent for peripancreatic fluid collection in POD 42, 45 and 70; in one case the peripancreatic stent previously positioned was removed in POD 77. No patient died in postoperative time. In five patients (8.9%) an ICU recovery was necessary. In two of these 5 patients ICU recovery was due to a clinical monitoring after a copious intraoperative bleeding due to splenic lesion; in two cases a severe respiratory failure required ICU recovery; the fifth patient who requested ICU recovery was a 77-year-old woman with ASA 3 score, with previous medical history of BPCO, cardiac insufficiency and other severe comorbidities for whom postoperative ICU recovery had already been planned during preoperative anesthesiologist evaluation.

Histological examination

The main diagnoses in final pathological examination were: neuroendocrine neoplasms in 20 (35.7%) patients, adenocarcinoma in 15 (26.8%) cases, mucinous cystoadenoma in 4 (7.1%), solid pseudopapillary tumor in 4 (7.1%) patients, secondary pancreatic lesion/ metastases in 3 (5.3%) patients, serous cystadenoma in 2 cases (3.6%), cystic lesions not better classified in 4 cases (7.1%), intraductal papillary mucinous neoplasms (IPMN) in 2 cases (3.6%), one lymphoma (1.8%) and one pancreatic duct lithiasis in chronic pancreatitis (1.8%)

In fifteen patients (26.8%), a pancreatic ductal adenocarcinoma was found.

Table 3. Histological examination.

Histological diagnosis	Number of Patients (%)
Neuroendocrine tumors	20 (35.7)
Ductal adenocarcinoma	15 (26.8%)
Mucinous cystoadenoma	4 (7.1%)
Pseudopapillarsolid tumor	4 (7.1%)
Intraductal Papillar Mucinous Neoplasia	2 (3.6%)
SerousCystoadenoma	2 (3.6%)
Metastases	3 (5.3%)
Chronic pancreatitis	1 (1.8%)
Lymphoma	1 (1.8%)
Cystic lesions and others	4 (1.8%)
Overallpatients	56
Lesion size (mm) (average and range)	33 (3-140)
Chronic pancreatitis Y/N	10/46

Table 4. The Clavien – Dindo Classification of surgical Complications.

Grades	Definition
I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic and radiological interventions. Allowed therapeutic regimens are: drugs as anti-emetics, antipyretics, analgesics, diuretics and electrolytes and physiotherapy. This grade also includes wound infections opened at the bedside
II	Requiring pharmacological treatment with drugs other than such allowed for grade I complications. This grade also includes blood transfusion and total parenteral nutrition.
III	Requiring surgical, endoscopic or radiological intervention. A: intervention not under general anesthesia B: intervention under general anesthesia
IV	Life-threatening complication (including central nerve system complications)requiring IC/ICU- management. A: single organ dysfunction (including dialysis) B: multi organ dysfunction
V	Death of patient

Table 5. Postoperative pancreatic fistula grade according to the international Study group on pancreatic Fistula classification.

Grade	Definition
Grade A	• No therapeutic intervention required • No prolongation for hospitalization
Grade B	• Therapeutic intervention required • Prolongation of hospitalization • Discharge with drain(s) in situ
Grade C	• Surgical re-intervention required and/or • Prolongation of hospitalization • IC/ICU management required and/or • Death of patients

Table 6. Results, complications, and postoperative data.

Variables	Value	%
Hospitalizatione time (days) (average and range)	16 (6-82)	
Major complications (Clavien-Dindo)	22	39,3
IIIa	16	
IIIb	4	
IV	2	
POPF (Postoperative Pancreatic Fistula)	22	39,3%
Grade A	6	
Grade B	14	
Grade C	2	
Invasive procedures within 90 days	20	35,7%
Surgery	4	
Operative endoscopic and radiological procedures	16	
Riadmissions within 30 days	4	7,1%
Riadmissions within 90 days	8	14,3%

Thirteen of them had a disease-free surgical margin at the final examination. The average number of nodes retrieved was 15 (3-34), the average of positive nodes retrieved was 1.7 (0 -7).

DISCUSSION

Because of the limited number of surgeons and centers skilled in mininvasive pancreatic surgery, controlled randomized trial between ODP and LDP haven't yet been carried out. Even so, the advantages of mininvasive approach versus the traditional one, were demonstrated in many non-randomized comparative studies [14, 15, 16].

Of the 56 patients enrolled, 18 (32.1%) were men and 38 (67.9%) women; the average age of sample (56.2 y) is spread equally between the sexes (test di Welch: p=0.0916), even if the men are generally older (61.3±12.7 y *vs.* 53.7±20.1 y).

The POPF has occurred in 22 patients (39.3%), and was not associated with sex (Fisher exact test: p=0.573), nor with previous surgery (p=0.406), nor with preoperative serum albumin levels (t Student test: p=0.876). Also cigarette smoking (Fisher exact test: p>0.999), arterial hypertension (p=0.785), (p>0.999), chronic pancreatitis (p=0.724), maximum lesion diameter (Welch test: p=0.366), and body mass index (t Student test: p=0.538) were not associated with POPF.

Analyzing pancreatic transection, we had performed transection with Ultracision, with stapler and with stapler and Seamguard.

The observed rate of fistula was 45.5 % for stump treated with Ultracision, (10/22), 24.1% for stump treated with stapler and Seamguard (7/29) and 100% for the stump treatment with only stapler (5/5).

We analyzed the three types of treatment of pancreatic stump with Fisher 's exact test (p=0.003), suggesting significant differences between the techniques employed.

The numerosity of the sample analyzed doesn't seem to have the power to asses these results : the group treated with stapler was composed only by 5 patients and all these patients have had fistula.

(97.5% CI ranging from 0 to 52.2%).

If we remove the patient treated with stapler (5/5) and analyze the two others type with exact Fish er's test, there isn't correlation between stump treatment and fistula(p=0.140).

A comparison between laparoscopic and robotic approach in determining pancreatic fistula cannot be ruled out because of the small number (4) of robotic treatments.

Using Fisher's exact test conversion doesn't correlate with risk of fistula (p>0.999).

The age results associated with POPF, because every single unit increase of this one, decrease fistula odds of 4.0% (Wald test: p=0.014), whereas the Wirsung duct diameter effect is borderline, because a unit increase of the maximum diameter corresponds to an increase of 78.2% of the POPF odds ratio (Wald test: p=0.061).

Using the ROC analysis with the Youden J statistics for these two continuous variables, we get an optimum cut-

Table 7. Comparative findings between converted to open (CONV) and no converted (fully MIDP) procedures.

Results	CONV	Fully MIDP
Average operative time (min)	281	256
Averagebloodloss (ml)	431	236
POPF (n):	4	18
- Grade A	1	5
- Grade B	3	11
- Grade C	0	2
Medianhospitalizationdays	17	16
Invasive procedure within 90 days	3	17
Major complications according to Clavien-Dindo classification	4	18
Mortality	0	0

off at the age of 60 years and at 3.2 mm Wirsung duct diameter. More precisely, there is a decrease of POPF odds ratio of 85.9%. (CI95%: from 95.9% to 51.9%) for a ≥60 years of age patient compared with a patient <60 years of age (Wald test: p=0.002), while the maximum Wirsung duct diameter ≥3.2 mm means increasing POPF odds ratio of 329% (CI95%: from 10.3% to 15.64%), compared to a duct diameter <3.2 mm.

In terms of POPF relative risk, this is equal to 29.4% (Fisher exact test: p=0.002) in ≥60 years of age patients compared to the < 60 patients, whereas the relative risk is equal to 209.5% (p=0.045) for patients with a ≥3.2 mm Wirsung duct diameter, compared to patients with the < 3.2 mm Wirsung duct diameter.

Using the age of 60 as a no-fistula diagnostic test (because of the age over l60 is a protective factor), we get the positive predictive value (always of no-fistula, obviously) of 82.1% (CI95%: from 63.1% to 93.9%). Using instead the 3.2 Wirsung duct diameter as *POPF* diagnostic test (because it is a risk factor), we get a positive predictive value of 66.7% (CI95%: from 34.9% to 90.1%).

By using simultaneously the two binomial variables, generated by research of optimal cutoff, in a bivariate logistic model (even with the limit due to the very small sample dimension), we obtain that the age of ≥60 years, checked for the duct diameter, decreases POPF odds ratio 92.7% (Wald test: p=0.001), whereas the ≥3.2 mm Wirsung duct diameter, checked for the age, increases fistula odds ratio of del 995.2% (p=0.011). It is interesting to observe that this logistic model with two independent binary variables, despite its simplicity and limits, due to the reduced sample size, has a variance equal to 26%, high enough.

The variables to take into consideration are operating time, blood loss, conversion rate, and incidence of fistula, length of hospital stay, oncologic outcomes, re-operation, morbidity, mortality and costs.

The average operative time reported in literature is 200 min, and a recent paper showed it is related to surgical learning curve. A series that compares operating time for LDP and ODP reports ranges of 180 [17] to 383 [18] min (LDP) and 152 to 330 min (ODP) [19]. The reported operating time for RDP is 164–458 min in major series [20]. In our patients, the average operative time was 261 min (140-495): 244 min (140-485) in laparoscopic group, 384 min (225-495) in robotic group, 281 min (190-450) in the converted group of patients. Blood loss is lower for mininvasive distal pancreatectomy compared to open procedures in many series [20] and this is one of the most important advantages of this approach. In our experience the average blood loss was 275 ml (50-1000): 236 mL in mininvasive group (laparoscopic and robotic), 431 mL in converted group. The main causes of intraoperative bleeding in our experience were the spleen or splenic vessels injury. The conversion rate varies from 0% to 30% in major LDP series [21] and from 0% to 11.7% in major RDP series [22]. The conversion rate in our experience was 19.6%. An American multicenter paper [23] on left-sided pancreatic resections showed a conversion rate of 12.6% of 159 cases. Reasons for conversion include intraoperative bleeding and adhesions. After the adoption of the ISGPF classification, the reported clinical PF rate after LLP is from 7 to 35% [24]. As showed by various papers, pancreatic fistula 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. Given the results of the DISPACT trial [25] and other recent papers [26], the stapler transection is considered the method of choice. Pancreatic fistula after a DP is due to a later and incomplete closure of the pancreatic duct system after the resection of the parenchyma. Moreover, some series report the entire incidence, while others report only clinically relevant cases requiring interventions. A large meta-analysis also demonstrated that different treatment of the stump (stapler, suture or nothing) is not associated with variation of incidence of pancreatic fistula [27]. The rate of POPF in our experience was 39.3%: 28.6% B/C grade, so clinically relevant. Eighteen patients (40%) developed POPF after mininvasive surgery: 13 B/C grade, 5 A grade POPF; 4 patients developed POPF (36.3%) in the converted group: 3 B grade and 1 A grade. Length of hospital stay is shorter after mininvasive distal pancreatectomy than the open surgery. We reported an average hospital stay of 16 days (6-82). Long-term results in terms of oncologic adequacy of minimally invasive technique for malignancy are not yet available. In the group of 15 patients with final diagnosis of adenocarcinoma, we performed 13 R0 resections with a positive margin rate of 13.3%. The average number of nodes harvested for patient was 15 (3-34). Reoperation is generally <10% after an LDP [20]; after an RDP it is 0% (20), except one that reports 6.2% [28]. In our experience in 20 (35.7%) patients a surgical or no surgical reintervention was necessary in the first 90 postoperative days. The MIDP-related morbidity is generally high (12–70%), but lower than ODP in several studies (20); although most series do not report any severity classification, most morbidity is of low-grade severity. Mortality is rare (<1%) for LDP and RDP. In our group of patients we had no mortality. In our experience,

22 patients developed major complications, according to Clavien-Dindo classification, 16 IIIa grade, 4 IIIb grade and 2 IV grade. Costs are one of the most debated aspects of MIDP, in particular for RDP, which requires high maintenance costs. About POPF prognostic factors, in our experience the statistics analysis has showed an association between the <60 years of age and the > 3.2mm Wirsung duct diameter. The age data seems in line with recent papers [29]. In a recent Ansari and co paper there is a post distal pancreatectomy comparison between two groups of patients with age > and <of 75 years. The type A fistula rate in the group of patients with >75 years of age is statistically inferior to the one with <75 years of age. The lower risk of type A fistula in older patients could be interpreted as the result of fibrotic pancreatic gland devolution during the aging [30]. In our study no statistically significant correlation was observed between POPF and other variables sac as the sex, preoperatory serum albumin value, previous surgery, la chronic pancreatitis, diabetes and lesion size. The small number of sample and the retrospective analysis of this could be considered the limits of this study.

CONCLUSION

In summary, MIDP up to now is considered safe and feasible. LDP has become the operation of choice for distal pancreatic lesions, except for bulky, locally advanced and proximal tumors. When indicated, the minimally invasive approach has better outcomes. This paper aims at describing the outcomes of 56 consecutive patients over 10 years of experience in a team with previous wide experience in pancreatic surgery. Our results confirm the previous experiences published about mininvasive distal pancreatectomy. We found two predictive factors of pancreatic fistula. We believe that randomized controlled trials comparing oncological results between open and laparoscopic approaches are should be carried out.

Conflict of Interest

The Authors certify that there are no conflicts of interest in relation to this article.

References

1. Venkat R, Edil BH, Schulick RD, Lidor AO, Makary MA, Wolfgang CL. Laparoscopic distal pancreatectomy is associated with significantly less overall morbidity compared to the open technique: a systematic review and meta-analysis. Ann Surg 2012; 255:1048-59. [PMID: 22511003]

2. Gagner M, Pomp A, Herrera MF. Early experience with laparoscopic resections of islet cell tumors. Surgery 1996; 120:1051-4. [PMID: 8957494]

3. Nakamura M, Nakashima H. Laparoscopic distal pancreatectomy and pancreatoduodenectomy: is it worthwhile? A meta-analysis of laparoscopic pancreatectomy. J Hepatobiliary Pancreat Sci 2013; 20:421-8. [PMID: 23224732]

4. Gagner M, Pomp A. Laparoscopic pylorus-preserving pancreatoduodenectomy. Surg Endosc 1994; 8:408-10. [PMID: 7915434]

5. Liang S, Hameed U, Jayaraman S. Laparoscopic pancreatectomy: indications and outcomes. World J Gastroenterol 2014; 20:14246-54. [PMID: 25339811]

6. Pugliese R, Maggioni D, Sansonna F, Scandroglio I, Forgione A, Boniardi M, Costanzi A, et al. Laparoscopic distal pancreatectomy: a retrospective review of 14 cases. Surg Laparosc Endosc Percutan Tech 2008; 18:254-9. [PMID: 18574411]

7. de Rooij T, Sitarz R, Busch OR, Besselink MG, Abu Hilal M. Technical Aspects of Laparoscopic Distal Pancreatectomy for Benign and Malignant Disease: Review of the Literature. Gastroenterol Res Pract 2015; 2015:472906. [PMID: 26240565]

8. Warshaw AL. Conservation of the spleen with distal pancreatectomy. Arch Surg 1988; 123:550-3. [PMID: 3358679]

9. Egorov VI,Yashina NI,Zhurenkova TV, Petukhova MV, Starostina NS,Zarinskaya SA, Dmitriyeva KA, Shevchenko TV, petrov RV. Spleen-preserving distal pancreatectomy with resection of the plenic vessels. Hould one rely on the short gastric arteries? JOP 2011; 12:445-587. [PMID: 21904069]

10. Butturini G, Inama M, Malleo G,Manfredi R, Melotti GL, Piccolo M, Perandini S, Pederzoli P, Bassi C.Perioperative and long-term results of laparoscopic spleen-preserving distal pancreatectomy with or without splenic vessels conservation:a retrospective analysis. J Surg Oncol 2012; 105:387-92. [PMID: 22025322]

11. Warshaw AL. Distal pancreatectomy with preservation pf the spleen. J hepatobiliary Pancreat Sci 2010; 17:808-12.

12. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004; 240:205-13. [PMID: 15273542]

13. Bassi C, Dervenis C, Butturini G, Fingerhut A, Yeo C, Izbicki J, Neoptolemos J, et al. International Study Group on Pancreatic Fistula Definition. Postoperative pancreatic fistula: an international study group (ISGPF) definition. Surgery 2005; 138:8-13. [PMID: 16003309]

14. Limongelli P, Belli A, Russo G, Cioffi L, D'Agostino A, Fantini C, Belli G. Laparoscopic and open surgical treatment of left-sided pancreatic lesions: clinical outcomes and cost-effectiveness analysis. Surg Endosc 2012; 26:1830-6. [PMID: 22258300]

15. Cho CS, Kooby DA, Schmidt CM, Nakeeb A, Bentrem DJ, Merchant NB, Parikh AA, et al. Laparoscopic versus open left pancreatectomy: can preoperative factors indicate the safer technique? Ann Surg 2011; 253:975-80. Erratum in: Ann Surg 2011; 254:391. [PMID: 21394014]

16. Mardin WA, Schleicher C, Senninger N, Mees ST. Laparoscopic versus open left pancreatectomy: can preoperative factors indicate the safer technique? Ann Surg 2014; 259:e60. [PMID: 24263306]

17. Butturini G, Partelli S, Crippa S, Malleo G, Rossini R, Casetti L, Melotti GL, et al. Perioperative and longterm results after left pancreatectomy: a single-institution, non-randomized, comparative study between open and laparoscopic approach. Surg Endosc 2011; 25:2871-8. [PMID: 21424200]

18. Soh YF, Kow AW, Wong KY, Wang B, Chan CY, Liau KH, Ho CK. Perioperative outcomes of laparoscopic and open distal pancreatectomy: our institution's 5-year experience. Asian J Surg 2012; 35:29-36. [PMID: 22726561]

19. Bruzoni M, Sasson AR. Open and laparoscopic spleen-preserving, splenic vessel-preserving distal pancreatectomy: indications and outcomes. J Gastrointest Surg 2008; 12:1202-6. [PMID: 18437500]

20. Damoli I, Butturini G, Ramera M, Paiella S, Marchegiani G, Bassi C. Minimally invasive pancreatic surgery-a review. Wideochir nne Tech Maoinwazyjne 2015; 10:141–9. [PMID: 26240612]

21. Liang S, Hameed U, Jayaraman S. Laparoscopic pancreatectomy: indications and outcomes. World J Gastroenterol 2014; 20:14246-54. [PMID: 25339811]

22. Milone L, Daskalaki D, Wang X, Giulianotti PC. State of the art of robotic pancreatic surgery. World J Surg 2013; 37:2761-70. [PMID: 24129799]

23. Kooby DA, Gillespie T, Bentrem D, Nakeeb A, Schmidt MC, Merchant NB, Parikh AA, et al. Left-sided pancreatectomy: a multicenter comparison of laparoscopic and open approaches. Ann Surg 2008; 248:438–446. [PMID: 18791364]

24. Song KB, Kim SC, Park JB, Kim YH, Jung YS, Kim MH, Lee SK, et al. Single-center experience of laparoscopic left pancreatic resection in 359 consecutive patients: changing the surgical paradigm of left pancreatic resection. Surg Endosc 2011; 25:3364–3372. [PMID: 21556993]

25. Diener MK, Seiler CM, Rossion I, Kleeff J, Glanemann M, Butturini G, Tomazic A, Bruns CJ, et al. Efficacy of stapler versus hand-sewn closure after distal pancreatectomy (DISPACT): a randomised, controlled multicentre trial. Lancet 2011; 377:1514–1522. [PMID: 21529927]

26. Zhang H, Zhu F, Shen M, Tian R, Shi CJ, Wang X, Jiang JX, et al. Systematic review and meta-analysis comparing three techniques for pancreatic remnant closure following distal pancreatectomy. Br J Surg 2015; 102:4–15. [PMID: 25388952]

27. Zhou W, Lv R, Wang X, Mou Y, Cai X, Herr I. Stapler vs suture closure of pancreatic remnant after distal pancreatectomy: a meta-analysis. Am J Surg 2010; 200:529-536. [PMID: 20538249]

28. Zhan Q, Deng XX, Han B, Liu Q, Shen BY, Peng CH, Li HW. Robotic-assisted pancreatic resection:a report of 47 cases. Int J Med Robot 2013; 9:44-51. [PMID: 23225335]

29. Ansari D, Aronsson L, Fredriksson J, Andersson B, Andersson R. Safety of pancreatic resection in the elderly: a retrospective analysis of 556 patients. Ann Gastroenterol 2016; 29:221-5. [PMID: 27065736]

30. Detlefsen S, Sipos B, Feyerabend B, Klöppel G. Pancreatic fibrosis associated with age and ductal papillary hyperplasia. Virchows Arch 2005; 447:800-5. [PMID: 16021508]