

# Laparoscopic Central Pancreatectomy: A Review of 51 Cases

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**Background:** Central pancreatectomy is an alternative technique for benign or low-grade malignant tumors. Laparoscopic central pancreatectomy has been rarely performed, with only 48 cases reported in the English literature. The aim of this paper was to review all published cases together with 3 cases from our institution.

**Methods:** All published articles indexed on PubMed were included. Terms used were “laparoscopic central pancreatectomy” or “laparoscopic middle pancreatectomy.” Variables studied were the operative time, the type of reconstruction, indications, the use of robotic or hand assistance, blood loss, transfusion, pancreatic fistula, hospital stay, follow-up, development of exocrine and/or endocrine insufficiency, morbidity, and mortality.

**Results:** A total of 51 patients were identified. Twenty-one patients underwent total laparoscopy (41.2%), 27 required robotic assistance (52.9%), one required hand assistance (1.9%), and there were 2 conversions. In 18 cases (35.3%), pancreatic reconstruction involved a Roux-en-Y pancreatojejunostomy, and in 32 cases, pancreatogastrostomy (62.7%). The mean operative time was 356 minutes. Blood loss was minimal in most cases, and only 1 patient required blood transfusion (1.9%). Mortality was nil, but morbidity was high, mainly because of pancreatic fistula (46%). The mean hospital stay was 13.8 days. All patients underwent laparoscopic central pancreatectomy for benign or low-grade neoplasms. The mean follow-up duration was 19.6 months (range, 2 to 48 mo). No patient presented exocrine or endocrine insufficiency.

**Conclusions:** Laparoscopic central pancreatectomy is a feasible and useful technique for the removal of tumors located in the neck of the pancreas. There are very few centers performing this operation, and therefore, a literature review was necessary to identify its indications and technical possibilities, and to promote its use.

**Key Words:** pancreas, laparoscopy, central, middle, pancreatectomy, review

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Central pancreatectomy is an alternative technique for benign or low-grade malignant tumors of the neck of the pancreas.<sup>1,2</sup> This pancreas-sparing technique was developed to avoid exocrine and/or endocrine insufficiency that could be detrimental to the patient’s quality of life, especially for benign or low-grade malignant neoplasms.<sup>1,2</sup> Laparoscopic pancreatic resection has been used increasingly since the last decade.<sup>3</sup> However, patients who require central pancreatectomy are still being treated with the open approach or with laparoscopic distal pancreatectomy.<sup>1,4</sup> Laparoscopic central pancreatectomy has been rarely

performed, with only 48 cases reported so far in the English literature.<sup>4–15</sup>

There are still some concerns about the feasibility of this technique and its advantages over laparoscopic distal pancreatectomy or open central pancreatectomy. The best technique of laparoscopic central pancreatectomy is not yet established. The use of robotic assistance has gained evidence in recent years; however, no advantage over the totally laparoscopic technique has been proven so far. The best reconstruction method is also another point of discussion. Pancreatogastrostomy is easier to perform and does not require Roux-en-Y reconstruction, whereas pancreatojejunostomy may have better long-term outcomes in terms of endocrine and exocrine function. The aim of this paper was to review all published cases in the English literature together with 3 cases from our institution and discuss advantages and disadvantages of the current techniques.

## METHODS

This article reviews the literature regarding laparoscopic central pancreatectomy. All published articles in English that were indexed on PubMed were included. Terms used for the search were laparoscopic central pancreatectomy or laparoscopic middle pancreatectomy. Data overlap between different papers was excluded.<sup>8,9,16,17</sup> The variables studied were the operative time, the type of pancreatic reconstruction, diseases treated, the use of robotic or hand assistance, estimated blood loss, the transfusion rate, pancreatic fistula, hospital stay, follow-up, development of exocrine and/or endocrine insufficiency, morbidity, and mortality. Sex and age of the patients were also recorded. Three additional cases performed by the authors were included and quoted as present series.

### Case 1

A 54-year-old woman with epigastric pain underwent ultrasound examination that disclosed a solid tumor in the neck of the pancreas. A computed tomography scan revealed a 1-cm lesion, with enhancement during the arterial phase consistent with neuroendocrine tumor. A preoperative endoscopic ultrasound showed contact with the main pancreatic duct, and biopsy confirmed the diagnosis. She was then referred for surgical treatment. Because of the location and absence of any signs of diabetes or exocrine pancreatic insufficiency, a minimally invasive and pancreas-sparing technique, that is, laparoscopic central pancreatectomy, was chosen.

### Case 2

A 36-year-old man with epigastric pain underwent ultrasound examination that disclosed a cystic tumor in the neck of the pancreas. Magnetic resonance cholangiopancreatogram showed a 3.5-cm cystic lesion, consistent with a branch-duct-type intraductal papillary mucinous neoplasm.

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He was then referred for surgical treatment. Because of the location and absence of any signs of diabetes or exocrine pancreatic insufficiency, laparoscopic central pancreatectomy was chosen.

### Case 3

A 40-year-old woman underwent routine ultrasound examination that disclosed a cystic tumor in the neck of the pancreas. A computed tomography scan revealed a 4-cm cystic lesion. Magnetic resonance imaging was consistent with mucinous cystadenoma, with no sign of overt malignancy. She was referred for surgical treatment. Because of the low-grade nature of this neoplasm, the location, and the absence of any signs of diabetes or exocrine pancreatic insufficiency, laparoscopic central pancreatectomy was chosen.

The technique used in all cases is described as follows:

## Surgical Technique

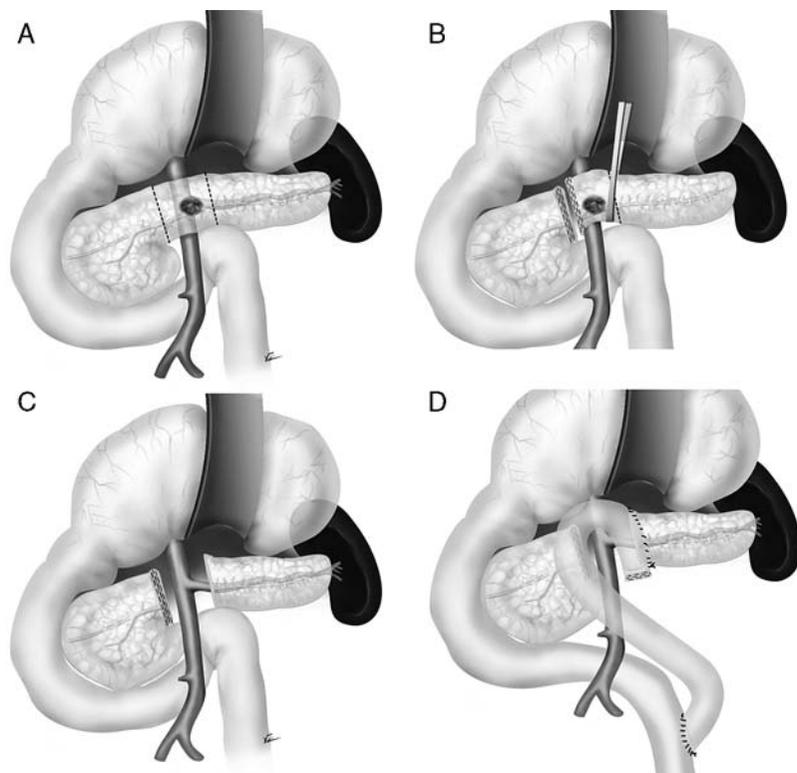
### Central Pancreatectomy

The patient is positioned supine, with the surgeon standing between the patient's legs. Four trocars are used. The operation begins with the retraction of the left liver and exposure of the upper abdominal organs. With the reverse Trendelenburg position, the transverse colon and the stomach were displaced inferiorly and the neck and body of the pancreas could be seen through the small omentum. The lesser sac is then opened and the anterior surface of the pancreas is exposed. Intraoperative ultrasound is used to locate the tumor and the position of the main pancreatic

duct (Fig. 1A). The inferior border of the pancreas is dissected carefully using a blunt instrument to create a tunnel and expose the portal vein. The superior border of the pancreas is then dissected, and a tape is passed around the neck of the pancreas. The next step is to dissect the proximal and distal parts of the neck of the pancreas. This can be achieved by removing lymph nodes along the hepatic, the gastroduodenal, and the splenic arteries. At this moment, splenic vessels and the portal vein are completely dissected free from the pancreatic neck. The pancreas is transected with an endoscopic linear stapler on the right side of the tumor followed by transection of the distal pancreas (Fig. 1B). Laparoscopic central pancreatectomy is completed (Fig. 1C). The surgical specimen is put inside a plastic bag and removed through the umbilical port. The specimen is examined, and frozen sectioning is performed to evaluate surgical margins.

### Roux-en-Y Pancreatojejunostomy

After completion of pancreatic resection, a Roux-en-Y jejunal loop is prepared. The jejunum is identified and divided using a stapler, 40 cm from the Treitz ligament. Jejunojunctionostomy is performed with end-to-end mechanical anastomosis. The mesenteric breach is closed at this time. A small mesocolic window is created and the jejunal limb is transposed to the supramesocolic region to be anastomosed to the pancreas. The staple line is removed and the pancreatic duct is identified. A small pediatric urethral tube is inserted in the pancreatic duct and used as a stent. An end-to-side pancreatojejunostomy is then



**FIGURE 1.** The surgical technique for laparoscopic central pancreatectomy. A, Schematic drawing. The tumor is identified and the local region for future pancreas transections is established. B, Schematic drawing. View after division of the proximal pancreas. The distal pancreas is pulled up for pancreas transection. C, Schematic drawing. Neck of the pancreas is removed completely. Central pancreatectomy is completed. D, Schematic drawing. A Roux-en-Y duct-to-mucosa end-to-side pancreatojejunostomy is performed.

**TABLE 1.** Published Cases of Laparoscopic Central Pancreatectomy (Surgical Technique)

References	n	Robotic Assistance	Hand Assistance	Type of Reconstruction	Conversion	Reoperation
Ayav et al <sup>5</sup>	1	0	0	NR	0	0
Orsenigo et al <sup>6</sup>	1	0	0	PJ	0	0
Sa Cunha et al <sup>4</sup>	6	0	0	PG	1	0
Rotellar et al <sup>13</sup>	9	0	1	PJ	1	1
Giulianotti et al <sup>12</sup>	3	3	0	PG	0	0
Sucandy et al <sup>7</sup>	1	0	1	PG	0	0
Kang et al <sup>8</sup>	5	1	0	PG	0	0
Gumbs et al <sup>10,18</sup>	2	0	0	PG	0	0
Boggi et al <sup>11</sup>	3	1	0	PJ	0	0
Abood et al <sup>9</sup>	9	9	0	7 PG;2 PJ	0	0
Cheng et al <sup>14</sup>	7	7	0	PG	0	0
Gonzalez et al <sup>15</sup>	1	0	0	PG	0	0
This study	3	0	0	PJ	0	0

NR indicates not reported; PG, pancreatogastrostomy; PJ, pancreatojejunostomy.

performed in a double-layer technique (Fig. 1D). The outer layer included the capsule and the parenchyma of the pancreas and the seromuscular layer of the jejunum secured with a nonabsorbable 4-0 prolene suture. The inner layer is a duct-to-mucosa anastomosis carried out using an interrupted 6-0 prolene suture with a stent. After completion of the pancreatojejunostomy, the mesocolic breach is closed using an interrupted suture. A hemostatic tissue is placed in the resection area. The abdominal cavity is reviewed and drained.

## RESULTS

We performed 3 consecutive cases of totally laparoscopic central pancreatectomy with duct-to-mucosa Roux-en-Y pancreatojejunostomy. No robotic or hand assistance was used. The operative times were 360, 395, and 430 minutes, respectively, for all 3 cases, with an estimated blood loss of < 100 mL in all cases. Postoperative recovery was uneventful, and patients were discharged on the fifth and the eighth postoperative days, respectively. The second patient developed a grade A pancreatic fistula that resolved spontaneously after 3 weeks. No patient developed exocrine or endocrine pancreatic insufficiency at 6, 8, and 16 months of follow-up.

## A Literature Review of Laparoscopic Central Pancreatectomies

Since 2005, 51 patients who underwent laparoscopic central pancreatectomy were reviewed. The median age was 55 years (range, 18 to 75 y). Ten patients were men, and 38 were women (information regarding sex not available for 3 patients). Of these, 21 underwent total laparoscopy (41.2%), 27 required robotic assistance (52.9%), and 1 required hand assistance (1.9%). Two patients (3.9%) required conversion: 1 because of the loss of specimen and the other because of the need for a minilaparotomy because the Wirsung duct could not be located. In 18 cases (35.3%), pancreatic reconstruction was carried out by a Roux-en-Y pancreatogastrostomy, and in 32 cases, pancreatojejunostomy was the reconstruction of choice (62.7%). In one case, the type of reconstruction was not reported (Table 1). The operative time varied from 150 to 509 minutes. The mean operative time was 356 minutes and the median 388 minutes, on the basis of the papers reviewed (48 cases). Blood loss was minimal in most cases and varied from 50 to 600 mL. No patient except 1 required blood transfusion (1.9%). Mortality was nil, but morbidity was high, mainly because of pancreatic fistula (46%; Table 2). However, most cases were grade A and only 1 patient in this review needed reoperation. The mean hospital stay was 13.8 days, whereas the median hospital stay was 10 days

**TABLE 2.** Published Cases of Laparoscopic Central Pancreatectomy (Surgical Results)

References	n	Operative Time (Min)	EBL (mL)	Pancreatic Fistula	Morbidity	Hospital Stay (d)
		Mean (Range)	Mean (Range)	(%)	(%)	Mean (Range)
Ayav et al <sup>5</sup>	1	NR	NR	NR	NR	NR
Orsenigo et al <sup>6</sup>	1	330	300	0	0	10
Sa Cunha et al <sup>4</sup>	6	225 (180-365)	125 (50-300)	33.3	33.3	18 (15-25)
Rotellar et al <sup>13</sup>	9	435 (357-509)	< 100	22.2	33.3	13.5 (3-41)
Giulianotti et al <sup>12</sup>	3	320 (270-380)	233 (100-400)	33.3	33.3	15 (9-27)
Sucandy et al <sup>7</sup>	1	180	200	100	100	9
Kang et al <sup>8</sup>	5	480 (360-480)	200 (100-600)	20	20	12 (9-28)
Gumbs et al <sup>10,18</sup>	2	NR	NR	50	50	NR
Boggi et al <sup>11</sup>	3	426 (390-450)	NR	66.6	66.6	14.3 (7-26)
Abood et al <sup>9</sup>	9	425 (305-506)	190 (50-350)	78	78	10 (7-19)
Cheng et al <sup>14</sup>	7	210 (150-300)	200 (50-400)	71.4	85.7	21 (13-33)
Gonzalez et al <sup>15</sup>	1	250	< 100	0	0	6
This study	3	395 (360-430)	< 100	33	33	7 (5-10)

EBL indicates estimated blood loss; NR, not reported.

**TABLE 3.** Published Cases of Laparoscopic Central Pancreatectomy (Late Follow-up Data)

References	n	Follow-up (mo) Mean (Range)	Exocrine/ Endocrine Insufficiency
Ayav et al <sup>5</sup>	1	NR	NR
Orsenigo et al <sup>6</sup>	1	20	0
Sa Cunha et al <sup>4</sup>	6	15 (4-34)	0
Rotellar et al <sup>13</sup>	9	13 (2-36)	0
Giulianotti et al <sup>12</sup>	3	44 (38-48)	0
Sucandy et al <sup>7</sup>	1	3	0
Kang et al <sup>8</sup>	5	19 (16-24)	0
Gumbs et al <sup>10,18</sup>	2	NR	NR
Boggi et al <sup>11</sup>	3	26.3 (21-31)	0
Abood et al <sup>9</sup>	9	NR	NR
Cheng et al <sup>14</sup>	7	23 (10-25)	0
Gonzalez et al <sup>15</sup>	1	NR	NR
This study	3	10 (6-16)	0

NR indicates not reported.

(range, 3 to 41 d). All patients underwent laparoscopic central pancreatectomy for benign or low-grade neoplasms. Fifteen patients (29.4%) were operated on for serous cystadenomas, 13 for neuroendocrine tumors (25.4%), 7 for mucinous cystadenomas (13.7%), 6 for solid pseudopapillary tumors (11.8%), 4 patients (7.8%) for intraductal papillary mucinous neoplasms (1 patient with in situ adenocarcinoma), 1 for focal pancreatitis,<sup>4</sup> 1 for a migrated pancreatic stent,<sup>15</sup> 1 for lipoma,<sup>14</sup> and 3 patients for non-malignant lesions of the pancreas<sup>5,10</sup> (the exact histologic diagnosis was not available). Follow-up and late outcomes were reported in only 38 cases. The mean follow-up was 19.6 months (range, 2 to 48 mo). No patient presented exocrine or endocrine pancreatic insufficiency (Table 3). One patient operated on for gastrinoma presented recurrence<sup>4</sup> and 1 patient developed umbilical hernia.<sup>13</sup> The patient with in situ adenocarcinoma was alive with no recurrence at 21 months of follow-up.<sup>4</sup>

When we compare the group of patients who required robotic assistance with those who underwent totally laparoscopic central pancreatectomy, we did not find any statistical differences in terms of age, sex, the duration of stay, the operative time, and the incidence of pancreatic fistula. The estimated blood loss was higher in the robotic group ( $P < 0.01$ ). Among the robotic group, the preferred method of reconstruction was pancreatogastrostomy (22 of 27 cases or 81.5%). Pancreatojejunostomy was the most used type of reconstruction (56.5%) among laparoscopic central pancreatectomy.

## DISCUSSION

Laparoscopic pancreatic surgery has experienced significant development in the past few years. The majority of the procedures are left pancreatectomy and enucleations.<sup>19-21</sup> More complex pancreatic resections such as pancreatoduodenectomies,<sup>18,22</sup> resections of uncinate process of the pancreas,<sup>23</sup> and central pancreatectomies are performed in a few centers.<sup>4-15</sup> Our experience with laparoscopic pancreatic resections began in 2001.<sup>24</sup> Improvement of our expertise in advanced laparoscopic surgery and laparoscopic proximal resections such as pancreatoduodenectomy and resection of the uncinate process has allowed us to perform totally laparoscopic central pancreatectomies.<sup>20,21</sup>

Data from all laparoscopic central pancreatectomies published in the English literature are shown in Tables 1 and 2. This information included 48 patients from 12 series and 3 patients from our study. The worldwide experience is small. The resection of the neck of the pancreas is not difficult. However, it entails reconstruction of the main pancreatic duct, which may be difficult and sometimes hazardous. The popularity of laparoscopic left pancreatectomy certainly reduced the number of patients undergoing open or laparoscopic central pancreatectomy.<sup>19</sup> However, this was at the expense of the endocrine and exocrine deficiency that the left pancreatectomy may cause. For benign or low-grade neoplasms, left pancreatectomy may alter too much functioning of the pancreatic parenchyma. Considering long-term functional results, central pancreatectomy is an effective technique to preserve the pancreatic function.<sup>1,2,4,13</sup> In a comparative study, the outcomes after central pancreatectomy (100 cases) were compared with a control group (45 patients) that underwent extended left pancreatectomy for neoplasms in the mid-pancreas.<sup>1</sup> After a median follow-up of 54 months, the incidences of endocrine and exocrine insufficiency after a central pancreatectomy were 4% and 5%, respectively, compared with 38% and 15.6% in patients who underwent extended distal pancreatectomy.<sup>1</sup> In the present review of laparoscopic central pancreatectomy, regardless of the technique used, no patient developed endocrine and exocrine insufficiency. Therefore, we advocate pancreas-preserving techniques for all patients with benign or low-grade pancreatic neoplasms. In patients with the tumor located at the neck of the pancreas, we must not sacrifice pancreatic parenchyma to perform this operation laparoscopically.

After the removal of the neck of the pancreas or some segment located in the middle of the pancreas, the distal pancreatic duct must be reconnected to the alimentary tract. The management for the distal pancreas can be pancreatogastrostomy<sup>4,7,8,10,12</sup> or Roux-en-Y pancreatojejunostomy.<sup>6,9,11,13</sup> Pancreatogastrostomy is easier and faster, but it may delay oral feeding and it prolongs the length of stay.<sup>4</sup> Pancreatojejunostomy is a more complex reconstruction, but has better long-term outcomes in terms of endocrine and exocrine function. As central pancreatectomy is indicated in patients with an expected long survival, some authors consider pancreatojejunostomy as the best management for the distal pancreas after central pancreatectomy.<sup>13</sup> We also prefer reconstruction with Roux-en-Y pancreatojejunostomy, and this was the technique of choice in our 3 cases.

The use of robotic assistance has been used increasingly in recent years. The main reason is that it may facilitate pancreatoenteric anastomosis, given the superior dexterity possible with robot-assisted surgery.<sup>9</sup> However, when we reviewed the robotic group of patients, the preferred method of reconstruction was pancreatogastrostomy (81.5%). This reconstruction is easier than pancreatojejunostomy, the preferred method among totally laparoscopic central pancreatectomies. A comparative analysis showed no benefit from the use of the robotic assistance. The hospital stay, the operative time, and the incidence of pancreatic fistula were similar. The estimated blood loss was statistically higher in the robot-assisted group, but it did not result in more transfusion.

The technique of pancreatic division varies widely among surgeons, and there is no evidence that identifies a single method as superior. In the literature, the technique of

pancreatic transection has evolved from a cut-and-sew to a staple technique with or without staple-line reinforcement. We have been using a vascular cartridge since the beginning of our experience. A recent comparative study has shown that division of the pancreatic parenchyma with vascular cartridges resulted in a significantly lower fistula rate compared with standard cartridges.<sup>25</sup> It is still unclear if the use of staple-line reinforcement may reduce the risk of pancreatic fistula.<sup>13,26</sup>

Laparoscopic pancreatojejunal anastomosis is a major challenge because of its technical complexity. According to Rotellar et al,<sup>13</sup> the use of a high-definition equipment is essential for the success of this anastomosis. Indeed, we have used a high-definition set for laparoscopic central pancreatectomy, and we were able to identify a 1-mm Wirsung duct and to perform a safe duct-to-mucosa anastomosis using a 6-0 prolene suture. In our cases, we used a small feeding tube to tutor the duct-to-mucosa anastomosis. Our previous experience with laparoscopic pancreatoduodenectomy was essential to perform pancreatojejunosomy safely after central pancreatectomy.<sup>22</sup>

### CONCLUSIONS

Totally laparoscopic central pancreatectomy is a feasible and useful technique for the removal of tumors located in the neck of the pancreas. There are very few centers performing this operation on a regular basis, and therefore, a review of all cases is necessary to clarify its indications, to describe different technical possibilities, and to promote its use. This may be of particular importance in benign or low-grade pancreatic neoplasms to avoid the development of endocrine and/or exocrine insufficiency.

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