

# Laparoscopic enucleation of pancreatic neoplasm

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## Abstract

**Background** Enucleation is an alternative procedure for treating benign and borderline neoplasms of the pancreas, which preserves healthy parenchyma and pancreatic function. This study aimed to evaluate the postoperative and long-term results after laparoscopic enucleation.

**Methods** Data collected prospectively from 23 consecutive patients who underwent laparoscopic pancreatic enucleation were analyzed.

**Results** Laparoscopic enucleation was achieved successfully for 21 patients (91.3%). One death (4%) occurred. A postoperative pancreatic fistula was observed in three cases (13%), and was clinically significant in one case (4%). Enucleation was performed for endocrine neoplasm in 15 patients (65%) and for cystic neoplasm in eight patients (35%). All the patients had benign tumors at the final histopathologic diagnosis. During a median follow-up period of 53 months, no patient experienced tumor recurrence or new-onset exocrine or endocrine insufficiency.

**Conclusion** Laparoscopic enucleation is a safe and effective procedure for the radical treatment of benign and borderline pancreatic tumors. The laparoscopic approach seems to be associated with a decrease in operative time, hospital stay, and pancreatic fistula after enucleation. Laparoscopy should become the standard approach in the future for enucleation of presumed benign lesions.

**Keywords** Enucleation · Laparoscopy · Pancreas

Benign or low-grade malignant neoplasms of the pancreas traditionally have been treated by pancreaticoduodenectomy or left pancreatectomy. Therefore, even when the pancreatic parenchyma is normal, pancreaticoduodenectomy usually leads to exocrine insufficiency needing enzyme therapy. The risk of diabetes related to pancreaticoduodenectomy is less than 10% [1, 2]. Conversely, left pancreatectomy can induce diabetes even when the pancreatic parenchyma is normal, especially when pancreatic resection exceeds 75% [3, 4].

In this setting, enucleation can be considered as an alternative procedure. In recent years, several series have reported the feasibility of laparoscopic enucleation [5, 6]. After enucleation, the most important complication is pancreatic fistula, with a rate ranging from 27% to 50% [7–9]. Due to the small number of patients in the series studied and the short follow-up periods, the long-term results of pancreatic enucleation have not been well described. The current series analyzed indications as well as short- and long-term outcomes after laparoscopic pancreatic enucleation for presumed benign lesions.

## Methods

### Patients

Patients who underwent pancreatic laparoscopic enucleation between September 1999 and September 2007 were identified from a database that collects all our pancreatic surgeries. Demographics, clinical presentation, preoperative evaluation, intraoperative details and pathologic data, postoperative

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complications, blood transfusion, and length of hospital stay were recorded. Perioperative mortality was defined as death in the hospital or within 30 days after treatment.

### Surgical technique

The surgical technique of laparoscopic pancreatic enucleation has been described previously [10]. Patients are placed supine in a lithotomy position. The surgeon stands between the legs of the patient, with the first assistant on the right side and the scrub nurse on the left side of the patient.

The laparoscopic approach requires four trocars. First, the body and the tail of the pancreas are exposed through a large window in the gastrocolic ligament by lifting the great curvature of the stomach using the trocar close to the xiphoid process. The window may be created using a scissors with electrocautery or an ultrasonic device (Ultracision; Ethicon, Sommersville, NJ, USA). The window must be large enough to allow inspection beyond the gastroduodenal artery to the hilum of the spleen.

For lesions located in the head of the pancreas, a left semilateral decubitus and a fifth trocar are used. The head of the pancreas can be exposed by dissection of the pancreatic head from the mesocolic and dorsal gastric attachments. The posterior aspect of the head can be inspected after a Kocher maneuver. Then an ultrasonic examination of the pancreas is performed with a laparoscopic 7-Mhz probe (Model PEF 704LA; Toshiba).

Ultrasonic examination of the pancreas is essential for locating tumors totally covered by a thin layer of pancreatic tissue and for determining the relationship between the tumor and the main pancreatic duct. Dissection is performed using a 5-mm bipolar electrocoagulation instrument with cautery between the normal parenchyma and the tumor itself. The vessels of the tumor are secured with clips. A single drain is placed near the site of the enucleation (Fig. 1).

### Postoperative course

For this study, pancreatic fistula was defined as a drain output of any measurable fluid volume on or after postoperative day 3 with an amylase content greater than three times the serum amylase activity, according to the recommendations of the International Study Group on Pancreatic Fistula [11].

Follow-up evaluation consisted of clinical, radiologic, and laboratory assessments. Tumor recurrence and long-term exocrine and endocrine impairment were evaluated. The presence of new-onset or worsening diabetes was demonstrated by measuring serum glucose levels. New-onset exocrine insufficiency was defined as the development of steatorrhea and weight loss requiring oral pancreatic enzymes.

### Statistical analysis

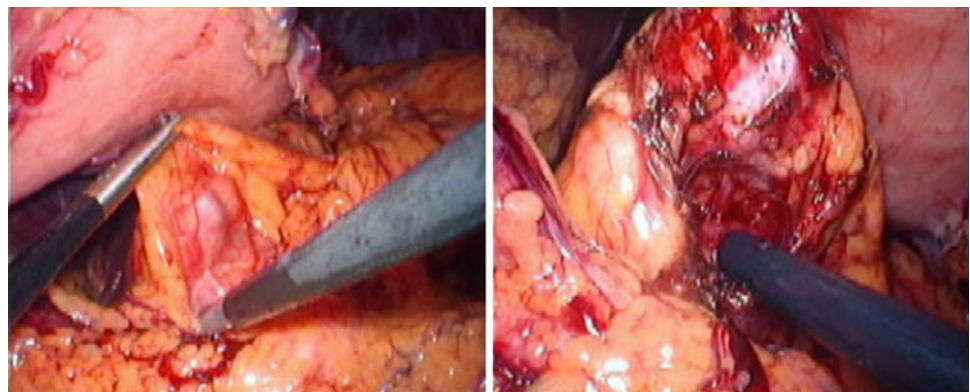
Statistical differences were studied using the chi-square test with Yate's correction for small samples and Student's *t*-test when indicated. Statistical significance was determined at a *p* level less than 0.05. This study did not involve an intent-to-treat approach.

### Results

During the study period, 70 patients had laparoscopic pancreatic resection at our institution. Of these 70 patients, 23 (12 men and 11 women) (33%) underwent laparoscopic enucleation. The mean age of these patients was  $49 \pm 16$  years. Nine patients (39%) were asymptomatic, and their pancreatic lesion was discovered incidentally. Of the remaining patients, eight had symptomatic hypoglycemia and six had abdominal pain or anorexia. Two patients had diabetes mellitus.

Abdominal ultrasonography and computed tomography (CT) were used for preoperative evaluation. Other

**Fig. 1** Laparoscopic enucleation of an insulinoma



radiologic procedures included cholangio-Wirsungo resonance imaging for 13 patients (57%) and endoscopic ultrasonography for 10 patients (43%). For patients with suspected insulinoma, hyperinsulinism was diagnosed on the basis of the clinical symptoms, the serum levels of glucose and insulin determined during prolonged fasting up to 72 h, and the determination of serum C-peptide. Factitious causes of hyperinsulinism were ruled out for all the patients.

To locate insulinoma, a standard preoperative imaging workup was performed including CT scan, magnetic resonance imaging (MRI), endoscopic ultrasound, and octreotid scintigraphy. For the patients with suspected endocrine tumors, the preoperative workup was extended to include chromogranin A and serum hormone concentrations. Pancreatic lesions were believed to be benign in all the patients.

After the exploration, the laparoscopy for two patients (8.7%) was converted to open laparotomy because of inability to locate the tumor. The tumor was situated in the head of the pancreas in six patients (26%), the neck in two patients (8.7%), and the body or tail in 15 patients (65%). The mean duration of surgery was  $124 \pm 80$  min, and the mean blood loss was  $64 \pm 162$  ml.

Postoperative complications occurred for four patients (17%), pancreatic fistula for three patients (13%) (grade A for two patients and grade C for one patient), and mesenteric ischemia for one patient. The patient with mesenteric ischemia required a further laparotomy and died in the postoperative course. The mean length of hospital stay was  $8.4 \pm 3.6$  days for the patients without a pancreatic fistula and  $13.3 \pm 2$  days for those with pancreatic fistula ( $p = 0.025$ ).

Table 1 shows the final histopathologic diagnoses. All the patients had benign tumors. The mean diameter of the resected lesions was  $24.5 \pm 18$  mm. The tumors were larger among the eight patients with cystic lesion ( $41 \pm 20$  mm) than among the 15 patients with endocrine lesions ( $14 \pm 5$  mm) ( $p = 0.007$ ).

During a median follow up of 53 months, no patient experienced tumor recurrence, new-onset exocrine, or endocrine insufficiency. The eight patients who underwent pancreatic enucleation for insulinoma remained asymptomatic.

## Discussion

In recent years, parenchyma-sparing procedures have been performed with increasing frequency for patients with benign or low-grade malignant pancreatic tumors. The rationale for parenchyma-sparing procedures is preservation of long-term exocrine and endocrine pancreatic function [7, 8, 12, 13]. Enucleation has become an alternative procedure for the treatment of benign or low-grade malignant lesions. Otherwise, several series have shown that laparoscopic pancreatic procedures are feasible and safe [5, 6, 11, 14].

The current large series of laparoscopic enucleation shows that laparoscopic enucleation for benign or low-grade malignant pancreatic tumors is feasible and safe. Furthermore, it preserves long-term pancreatic function.

Enucleation has become the reference treatment of endocrine tumors [6]. Other indications are serous and mucinous cystadenoma [8] and branch-duct intraductal papillary mucinous tumor (IPMT). With regard to endocrine tumors, enucleation is considered safe and effective for the treatment of insulinomas and nonfunctioning tumors with a diameter less than 4 cm and benign or uncertain biologic behavior. Considering the biologic behavior of IPMTs, their risk of malignancy, and the need for a clear negative resection margin, such tumors should be resected using standard procedures [20].

In this series, laparoscopic enucleation was achieved successfully for 21 patients (91.3%). Two patients required a laparotomy because of inability to locate the tumor. In contrast to open surgery, laparoscopic surgery lacks

**Table 1** Histologic diagnosis after pancreatic enucleation

	No. of lesions ( $n = 23$ ) $n$ (%)	Mean size (mm) (+/- SD)
Endocrine tumors	15 (65)	14 (5)
Benign	15 (65)	
Nonfunctioning	7 (30)	
Insulinoma	8 (35)	
Cystic tumors	8 (35)	41 (20)
Cystic lymphangioma	3	
Epithelial pancreatic cyst	2	
Mucinous cystadenoma	1	
Branch-duct IPMT	1	
Bronchogenic cyst	1	

IPMT intraductal papillary mucinous tumor

**Table 2** Summaries of pancreatic enucleation series

Series	<i>n</i>	Laparoscopy <i>n</i> (%)	Mean duration of surgery (min) (+/- SD)	Mortality (%)	Morbidity (%)	Pancreatic fistula (%)	Reoperation (%)	Hospital stay (days) (+/- SD)
Talamini et al. [9]	10	0	272 (42)	0	60	50	0	19.5
Kiely et al. [8]	11	0	199	0		27		12.6
Crippa et al. [7]	61	4 (7)	162 (51)	0	43	38	8	14 (9)
Mabrut et al. [5]	24	21 (87.5%)	120 <sup>a</sup>	0	33	29	0	–
Current series	23	21 (91.3%)	124 (80)	4%	17	13	4	9 (3)

<sup>a</sup> Median

manual palpation. For these reasons, preoperative localization is the key to allowing a laparoscopic enucleation.

A preoperative workup allows clear identification of the lesion and evaluation of its morphology and site. Moreover, it helps in the decision to perform an enucleation. In our experience, this is best accomplished by a CT study optimized for pancreatic imaging. Cholangio-Wirsungo magnetic resonance can measure the distance between a lesion and the main pancreatic duct and assists in the decision to perform enucleation.

For enucleation to be performed safely, the lesion should at least 2–3 mm from the main pancreatic duct and not too deep in the parenchyma [7, 9, 15]. In this study, laparoscopic ultrasonography was required for invisible intrapancreatic lesions in patients for whom an enucleation was planned according to preoperative localization tests. In these cases, laparoscopic ultrasound is the only way to locate the tumor during laparoscopy and to confirm the possibility of tumor enucleation. In case of tumor proximity to the main pancreatic duct, a standard resection is preferred to avoid the risk of pancreatic fistula.

Our findings showed that laparoscopic enucleation is at least as safe as open enucleation, with a shorter surgical time and hospital stay, as shown in Table 2. The length of the hospital stay in our study can be compared with that in the literature [16]. At our institution, we maintain the drain until postoperative day 6 to perform a dosage of amylase in the drain for the diagnosis of pancreatic fistula.

In the literature, the main drawback of enucleation is the high risk of pancreatic fistula (27–50%), and the main factor predisposing to pancreatic fistula is the vicinity of the main pancreatic duct [7–9]. In the current series, 13% of the patients had a pancreatic fistula according to the definition of the International Study Group of Pancreatic Fistula, but the rate of clinically significant grade B or C fistula was only 4.5% [10]. The incidence of pancreatic fistula after laparoscopic enucleation was lower than that reported after open enucleation.

These results confirm the results of a previous case-control study in which we found a significantly lower incidence of pancreatic fistula after laparoscopy enucleation than after laparotomy [17]. This improvement in

pancreatic duct control could be explained by the slower and more meticulous pancreatic enucleation.

In the current study, enucleation was performed for endocrine (65%) and cystic tumors (35%), as reported in the literature [7–9]. In the case of endocrine tumors, enucleation is considered safe and effective for the treatment of insulinomas and nonfunctioning tumors with a diameter less than 4 cm [15, 18, 19]. This study included eight insulinomas and seven nonfunctioning tumors, and no recurrences were recorded during a median of 53 months after enucleation. With regard to cystic tumors, the current results confirm published data, with no recurrences reported after enucleation of serous or mucinous tumors [8, 9].

In the current series, enucleation was performed for a branch-duct intraductal papillary mucinous adenoma in only one patient. Pancreas-preserving procedures for IPMT remain controversial due to their risk of malignancy and the need for a clear negative margin [20]. However, Blanc et al. [21] reported no recurrence among 26 patients who underwent enucleation for branch-duct IPMT.

With regard to long-term functional outcome, the current series showed no evidence of new-onset exocrine or endocrine insufficiency. These results confirm the published findings, which show that enucleation preserves pancreatic exocrine and endocrine function.

Laparoscopic enucleation is a safe and effective procedure for the treatment of benign and borderline neoplasms. It preserves pancreatic function and is not associated with recurrence. Laparoscopy should become the standard approach in the future for enucleation of presumed benign lesions. A controlled comparative trial between open and laparoscopic enucleation seems clearly justified.

**Disclosures** Dedieu Arnaud, Rault Alexandre, Collet Denis, Masson Bernard, and Sa Cunha Antonio have no conflicts of interest or financial ties to disclose.

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