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Outcome of Laparoscopic Pancreatic Surgery: Endocrine and Nonendocrine Tumors

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Abstract. Laparoscopic pancreatic surgery (LapPS) for management of benign pancreatic tumors has still not been defined. This paper evaluates the feasibility and outcome of LapPS in patients with endocrine pancreatic tumors (EPTs) and cystic neoplasms of the pancreas (CyNP). Eighteen patients with benign pancreatic tumors underwent LapPS between January 1998 and May 2001. The indications were 10 EPTs (6 sporadic insulinomas, 1 multiple insulinoma of multiple endocrine neoplasia type 1, 2 nonfunctioning tumors, 1 VIPoma) and 8 CyNPs (3 serous cystadenomas, 5 mucinous cystic neoplasms). The laparoscopic procedure was performed using four ports with patients in the half-lateral position. Laparoscopic ultrasonography (LapUS) was used in all cases. Laparoscopic enucleation (LapE) was planned in five patients and performed in four (one conversion for tumor not found during laparoscopy). Laparoscopic pancreatic resection (LapPR) with spleen salvage was planned in 13 patients and performed in 12 (one conversion for metastatic VIPoma), with splenic vessel preservation in 11 patients and short gastric vessel preservation in 1. The average operating time was 3.5 hours after enucleation, 4.0 hours after distal pancreatectomy, and 5.0 hours after subtotal pancreatectomy. Pancreatic fistula was observed in two patients after LapE and in three patients after LapPR. Splenectomy for splenic abscess was performed 1 week after surgery in a patient with short gastric vessel splenic preservation. The average hospital stay was 5 days. We concluded that LapPS is a safe method for removing EPTs and CyNPs, although the incidence of pancreatic fistulas remains high. In selected patients LapPS offers significant benefit to patients: reduced trauma to the abdominal wall, short hospital stay, and a quick postoperative recovery.

Laparoscopic pancreatic surgery is currently used for staging malignant pancreatic tumors, occasional management of inflammatory disorders of the pancreas, and resection of benign pancreatic tumors [1–6]. Endocrine tumors of the pancreas (EPTs) are slowly growing neoplasms and are of a relatively benign nature in 70% to 80% of individuals [7–10]. With the exception of gastrinomas and somatostatinomas, which are found in the pancreatic head in 60% to 70% of cases, other EPTs (e.g., insulinomas, VIPomas) are located predominantly (65–80%) in the body and tail of the pancreas [8–10]. This localization makes EPTs suitable for the laparoscopic approach. However, EPTs are rare neoplasms with an annual incidence of 0.1/100,000 to 0.4/100,000 [7], and the evaluation of laparoscopic surgery is difficult to establish for an individual surgeon.

Analysis of the reported cases and an extensive review by Burpee et al. [11] of laparoscopic pancreatic surgery for EPTs clearly reveals a small collective experience with the laparoscopic approach [12–15]. There have been 10 successfully completed distal pancreatectomies and only 4 successful laparoscopic enucleations. The conversion rate in the large series of Gagner et al. [16] was 33%. Berends et al. [17] reported five successful enucleations and one laparoscopic distal pancreatectomy for treatment of 10 patients with organic hyperinsulinism; the conversion rate was 40%. The high rate of conversion is presumably dependent on the surgical experience with the procedure. Therefore this advanced laparoscopic surgery should be practiced on the relatively more common tumors, such as cystic neoplasms of the pancreas (CyNPs): cystic serous adenomas (universally benign) and mucinous cystic neoplasms (premalignant or potentially malignant tumors). In this way, the pancreatic surgeon can gain confidence with laparoscopic techniques, ensuring proper oncologic surgery, maximal tumor clearance, and minimal tumor recurrence. This paper evaluates the feasibility and outcome of laparoscopic pancreatic surgery in patients with EPTs and CyNPs.

Patients and Methods

In January 1998 a prospective study was initiated using the laparoscopic approach in patients with neuroendocrine tumors or cystic neoplasms of the pancreas.

Patients with Neuroendocrine Tumors

The neuroendocrine tumor group included 10 patients. The patients' characteristics and the localization and size of the tumors are presented in Table 1. Two women (age 47 and 61 years) had abdominal pain for 2 and 6 months, respectively. Spiral computed

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Table 1. Clinical characteristics of patients with neuroendocrine pancreatic tumors.

Parameter	Nonfunctioning	Functioning MEN-1	VIPoma	Insulinoma
No. of patients	2	1	1	6
Age (years)	47–61	38	72	48 (25–67)
Male/female	0/2	0/1	0/1	1/5
Size, by location (cm)				
Head	—	—	—	1 (2)
Body	6.1/6.8	2.5	3	3 (1.5–2.0)
Tail	—	5.6	—	2 (1.6–1.8)

MEN-1: multiple endocrine neoplasia type 1.

tomography (CT) scanning showed well defined tumors 6.1 and 6.8 cm in size, respectively, in the body-tail of the pancreas, with moderate to high contrast enhancement and no infiltration of the visceral vessels, suggesting a nonfunctioning endocrine tumor. Basal plasma hormone levels, including gastrin, insulin, serotonin, glucagon, somatostatin, and pancreatic polypeptide, were normal in both patients.

One woman (38 years old) had a family history of multiple endocrine neoplasia type 1 (MEN-1). She had had abdominal pain and clinical symptoms of hypoglycemic crisis for 13 months. CT showed a 5.6 cm tumor in the tail of the pancreas. Octreoscan uptake localized another tumor in the body of the pancreas. This patient had plasma elevations of calcium, insulin, glucagon, somatostatin, and parathyroid hormone (PTH).

The other woman (72 years old) had had profuse watery diarrhea, hypokalemia, and hypotension for 6 months. Her diagnosis was based on elevated plasma vasoactive intestinal polypeptide (VIP) levels. CT showed a 3 cm tumor in the body of the pancreas.

There were six patients (five women, one man) with hyperinsulinism. The mean age of all patients was 48 years (range 25–67 years). All patients had the classic symptoms of Whipple's triad. The duration of the symptoms ranged from 2 to 48 months (mean 20 months). The biochemical diagnosis of organic hyperinsulinism included measurements of serum glucose and serum insulin during hypoglycemia. Fasting tests were performed in all six patients.

Five solitary tumors were detected in five patients by endoscopic ultrasonography (EUS): in the head of the pancreas in one patient and in the body-tail of the pancreas in four patients. In one patient EUS was not conclusive and suggested the presence of a tumor at the periphery of the gland or possibly an enlarged lymph node in this area.

Patients with Cystic Neoplasms of the Pancreas

The cystic neoplasms of the pancreas (CyNP) group included eight patients: three with serous cystoadenomas and five with mucinous cystic neoplasms (MCNs) of the pancreas. The patients' characteristics and the location and size of the tumors are presented in Table 2. All patients with serous cystoadenomas were women (average age 54 years; range 34–68 years). Abdominal or back pain was the most common complaint. The tumors in this group were characterized by CT. On average, the size was 4.5 cm (range 4–5 cm) and they were located in the body-tail of the pancreas. Three of the five MCNs were in women, with a mean age of 60 years (range 45–70 years). The most common symptom was abdominal pain. CT showed a cystic tumor in the body-tail of the pancreas in all patients. The mean size of the tumor was 5.2 cm (range 5–6 cm).

Table 2. Clinical characteristics of patients with cystic pancreatic tumors.

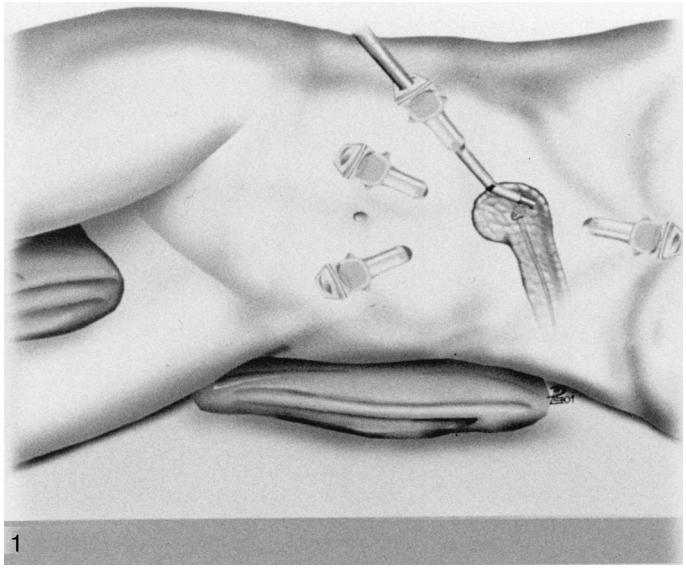
Parameter	Serous cystoadenomas	Mucinous cystic neoplasms
No. of patients	3	5
Age (years)	54 (34–68)	60 (45–70)
Male/female	0/3	2/3
Size (cm), mean and range	4.5 (4–5)	5.2 (5–6)
Location	Body-tail	Body-tail
Abdominal pain (%)	100	100

Laparoscopic Surgery

Using our approach, the patient is placed in the half-lateral position with the left side up for tumors located in the body-tail of the pancreas or with the right side up for tumors in the head of the gland, and reverse Trendelenburg (Fig. 1). The surgeon and assistant stand on the left of the patient and the camera person and scrub nurse on the opposite side when tumors are localized in the left side of the pancreas (Fig. 2). Four 10- to 12-mm trocars are inserted in the abdominal wall 3 to 4 cm above the umbilicus, on the xiphoid area, subcostal on the midaxillary line, subcostal to the midclavicular line. Two monitors were used. CO_2 pneumoperitoneum was used. Abdominal pressure was monitored and maintained at less than 14 mmHg. A 30-degree laparoscope was used. The liver was explored visually and by laparoscopic ultrasonography (7.5 MHz probe, 10 mm in diameter; B-K Medical, Gentolfe, Denmark).

For left-sided pancreatic lesions the first step is to start with sectioning the lienorenal ligament and dissecting the subjacent fascia lateral to the spleen. The splenocolic ligament is divided using the Harmonic Scalpel. The splenic flexure of the colon is mobilized downward. The gastrocolic omentum is widely opened up to the level of the mesenteric vessels, and the body-tail of the pancreas is then visualized. The anterior aspect of the pancreas is exposed by dividing the adhesions between the posterior surface of the stomach and the pancreas. Care must be taken to preserve the short gastric vessels. Laparoscopic ultrasonography (LapUS) was used in all cases to facilitate operative decision-making (Figs. 1, 2), enucleation, or pancreatic resection.

LapUS was particularly helpful in cases of enucleation to perform the dissection safely between the tumor and normal parenchyma. The dissection begins using the cautery in the plane surrounding the tumor; small pancreatic vessels feeding the tumor are coagulated with the LigaSure device (Tyco, U.S. Surgical) or clipped with titanium clips (Fig. 3). The Harmonic Scalpel (Ul-



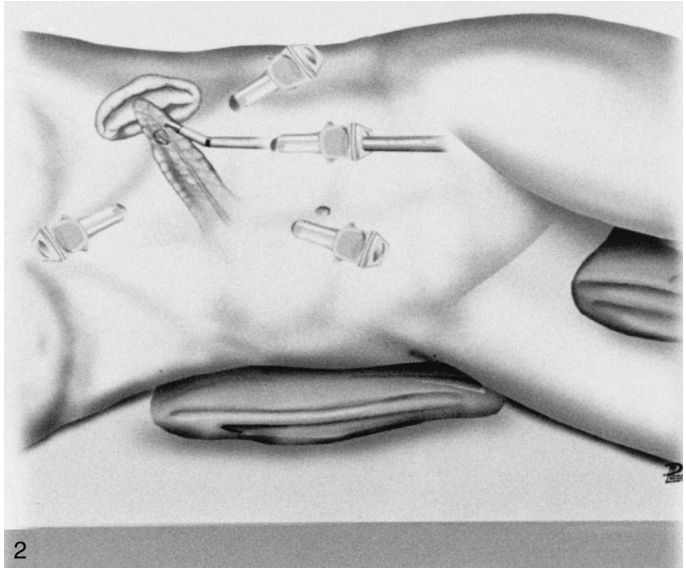


Fig. 1. Patient is placed in a half-lateral decubitus position with the right side up for tumors in the head of the pancreas. Typical port sites for resection of lesions in the head of the pancreas are shown. Laparoscopic ultrasonography is used to localize the tumor.

Fig. 2. Patient is placed in a half-lateral decubitus position with the left side up for tumors in the body-tail of the pancreas. The surgeon and assistant stand on the left of the patient and the cameraman and scrub nurse on the opposite side. Typical port sites for resection of lesions in the body-tail of the pancreas are shown. Laparoscopic ultrasonography is used to localize the tumor.

tracision; Ethicon, Sommersville, NJ, USA) was used to remove tumors when located at the lateral border of the pancreas. The specimen is extracted using a nonpermeable nylon bag through an enlarged trocar incision. A silicon drain was left in the bed of the insulinoma.

Distal pancreatectomy with splenic preservation involves the following surgical steps. The inferior border of the pancreas is dissected and the body and tail of the pancreas are completely detached from the retroperitoneum. This mobilization of the left

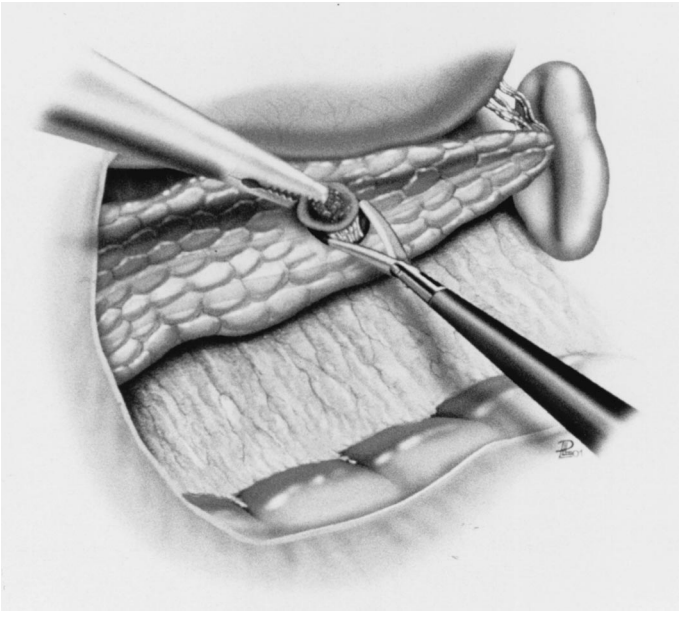


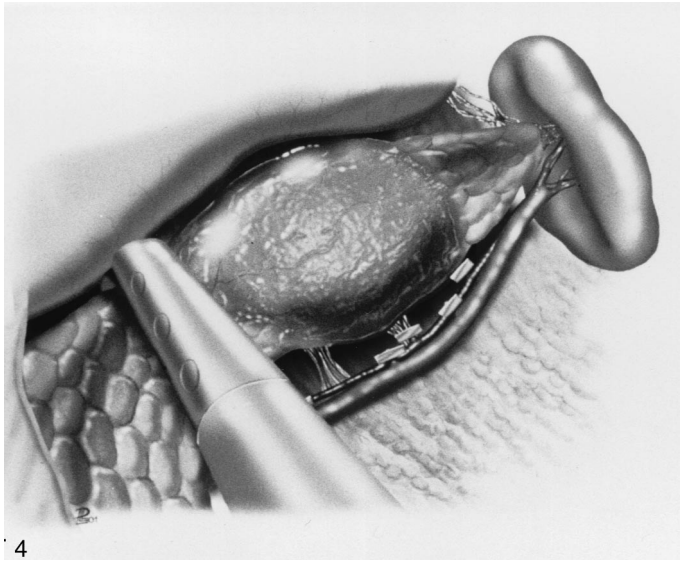
Fig. 3. Once the lateral borders of the insulinoma are defined by laparoscopic ultrasonography, the tumor is enucleated. First, electrocautery scissors are used to dissect the layer of pancreatic parenchyma covering the tumor. Next, the tumor is bluntly separated from normal pancreas. Finally, bleeding is controlled using clips or coagulating shears.

pancreas allows us to visualize the posterior wall of the gland, where the splenic vein is easily identified. The splenic vein is pushed away from the posterior pancreatic wall with gentle blunt dissection. Visual magnification through the laparoscope permits excellent control of the small pancreatic veins, which are coagulated using the LigaSure device, with the Harmonic Scalpel, or clipped with titanium clips. A tunnel is created between the splenic vein and the pancreas. The splenic artery is identified through this space using blunt careful dissection with a curve dissector. The pancreas is then transected with a 30 mm endoscopic linear stapler (Endo-GIA II, 3.5 mm staples; US Surgical, Norwalk, CT, USA) (Fig. 4). Usually two stapler applications are necessary. The tail of the pancreas is then grasped and retracted anteriorly with a 5 mm forceps, and traction is applied to expose the small branches of the splenic artery and vein, which are coagulated using the LigaSure device (Fig. 5). The dissection is continued laterally until the splenic hilum (Fig. 6). All the specimens were extracted in an endoscopic plastic bag (Endocatch; US Surgical). A silicon drain was left in the pancreatic bed close to the pancreatic stump.

Results

Patients with Neuroendocrine Tumors

In the group of patients with organic hyperinsulinism and tumors localized preoperatively by EUS, LapUS confirmed the presence of insulinomas in five. In one patient LapUS detected the tumor in the tail of the pancreas in close proximity to the pancreatic duct performing laparoscopic distal pancreatectomy with splenic vessel preservation (Fig. 6). Laparoscopic enucleation was performed in four patients: three patients with tumors in the body of the gland



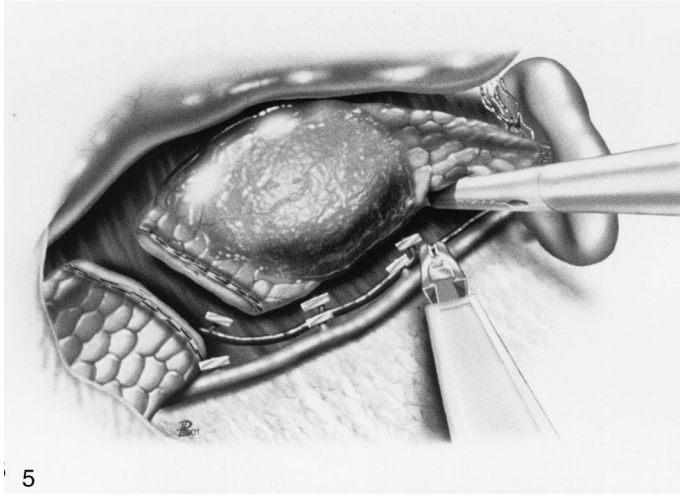


Fig. 4. Pancreatic transection with endo-GIA linear staplers (30 mm). Two applications are usually necessary. The jaws of the stapler should include only pancreatic tissue, taking care to avoid injury to the splenic vessels.

Fig. 5. Transected distal pancreas is kept on traction. The remaining vascular branches from the distal splenic vessels to the tail of the gland are divided between clips or coagulated using a LigaSure or ultrasonic device (Ultracision; Ethicon, Sommersville, NJ, USA).

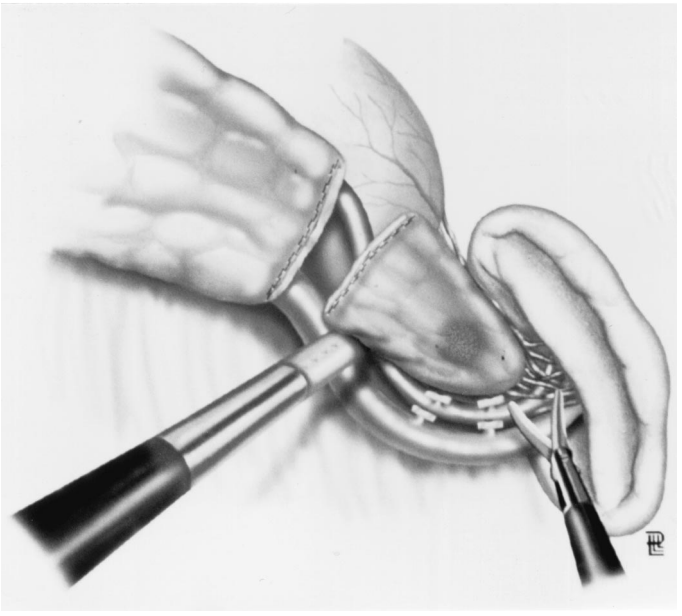


Fig. 6. Limited pancreatic resection for tumors in the tail of the pancreas. The spleen is salvaged by preserving both splenic vessels and short gastric vessels.

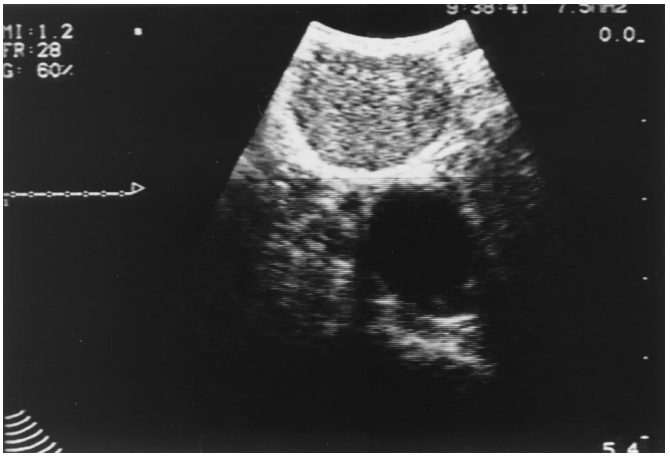


Fig. 7. Laparoscopic ultrasonography (LapUS) scan demonstrating the tumor near, but a safe distance from, the mesenteric vein. Under the guidance of LapUS, the tumor was enucleated without complications.

and one patient with the tumor in the pancreatic head (Fig. 7). LapUS missed the tumor in one patient. A pendunculated insulinoma was resected by open surgery at the inferior border of the pancreas.

In the MEN-1 patient with a 6.5 cm tumor in the tail of the gland, LapUS was useful for confirming the presence of another 2.5 cm tumor demonstrated preoperatively by Octreoscan. Laparoscopic subtotal pancreatectomy with splenic vessel preservation was performed. In the patient with VIPoma, at the time of laparoscopic pancreatic dissection a biopsy of enlarged lymph nodes demonstrated metastasis. The operation was converted to open surgery. A distal pancreatic resection with splenectomy and radical lymphadenectomy (including lymph node clearance in areas of the celiac trunk and superior mesenteric artery) was performed. Laparoscopic subtotal pancreatectomy proximal to the level of the superior mesenteric vein with splenic vessel preservation was performed in two patients with nonfunctioning tumors.

After laparoscopic enucleation the mean operating time was 3.4 hours (range 3–5 hours), and the mean blood loss was 200 ml (range 100–300). After laparoscopic distal pancreatectomy with splenic vessel preservation the operating time was 4 hours and the blood loss 400 ml. After laparoscopic spleen-preserving subtotal pancreatectomy the mean operating time was 5 hours and the mean blood loss 500 ml (range 300–700). After open subtotal pancreatectomy (with splenic vessels preservation) and radical lymphanedectomy the operating time was 6 hours and the blood loss 850 ml.

The postoperative course was uneventful except for two patients after laparoscopic enucleation; both developed a low-vol-

Table 3. Intraoperative and postoperative parameters after laparoscopic procedures.

Type of tumor	Planned laparoscopic procedure	No.	Laparoscopic procedure performed	Operating time (hours) (mean)	Blood loss (ml) (mean)	Complications	Hospital stay (days) (mean)
Insulinoma	Enucleation	5[a]	4	3.4 (3–5)	200 (100–300)	Two pancreatic fistulas	5
Insulinoma	Distal pancreatectomy (spleen salvage) + splenic vessel preservation	1	1	4	400	—	5
Mucinous cystic neoplasms	Distal pancreatectomy (spleen salvage) + short gastric vessel preservation	1	1	5	800	Splenic abscess[b]	14
Functioning MEN-1 (1 patient), nonfunctioning (2 patients), cystic neoplasms (7 patients), VIPoma (1 patient)	Subtotal pancreatectomy (spleen salvage) + splenic vessel preservation	11[c]	10	5	500 (300–700)	Three pancreatic fistulas	5

[a]One patient was converted to open surgery because the insulinoma was not found during laparoscopic exploration.
[b]Reoperation 1 week after the laparoscopic procedure: splenectomy by open surgery.
[c]Patient with VIPoma, found lymph node metastasis during laparoscopic exploration, converted to open surgery.

ume pancreatic fistula (50–100 ml). They were discharged home with the drain in situ; and the drains were removed 2 and 3 weeks after the operation, respectively. All patients undergoing laparoscopic surgery returned to previous activities 3 weeks after the operation. All insulinomas were benign, with enucleation or resection achieving a cure in all patients.

Nonfunctioning tumors were classified as benign with an absence of morphologic variables related to malignancy: vascular microinvasion, perineural microinvasion, mitosis, nuclear atypia. The pancreatic specimen from the patient with MEN-1 showed multiple macroadenomas and microadenomas. The VIPoma tumor had all the histologic criteria of malignancy, and the presence of lymph node metastasis was demonstrated in 4 of 15 nodes.

Patients with Cystic Neoplasms of the Pancreas

Laparoscopic subtotal pancreatectomy with splenic vessel preservation was planned in all eight patients with cystic pancreatic neoplasms. In one patient bleeding from the splenic vein required division of the splenic vessels using the stapler with a vascular cartridge. In this case a spleen-salvage laparoscopic distal pancreatectomy was performed by preserving the short gastric blood supply to the spleen. The operating time was 5 hours and the blood loss 800 ml. This patient experienced clinical sepsis and abdominal pain 1 week after laparoscopic resection. CT revealed a splenic abscess. Splenectomy was performed through a left subcostal incision. The hospital stay was 14 days and the period to return to previous activities 2 months. In the other seven patients, laparoscopic subtotal pancreatectomy with splenic vessel preservation was performed. The mean operating time was 4 hours and the mean blood loss 350 ml (range 200–600). Low-volume pancreatic fistulas (60 cc [two patients] and 80 cc, respectively) were observed in three patients 3 days after laparoscopic resection. The hospital stay was 5 days, including the patients with pancreatic fistulas. The latter were discharged home with the drains in situ; and the drains were removed 12 days after the operation. All patients returned to their previous activities 3 weeks after the operation (Table 3).

Serous cystoadenomas exhibited typical cuboidal to almost flat serous epithelium, characterized by clear cytoplasm and round nuclei. Periodic acid-Schiff-positive, diastase-sensitive intracytoplasmic material was present in all cases. MCNs were well circumscribed with fibrous pseudocapsules and multiple locules; they were characterized as four mucinous cystoadenomas and one proliferative cystic mucinous neoplasm.

Discussion

The use of laparoscopy for managing benign pancreatic tumors has still not been defined. With the introduction of each new laparoscopic technique, there have been predictable cycles characterized by an introductory phase (in which the surgical technique is developed), a definition phase (with exploration of technical variations and classification of the operative indications), and an educational phase. The definition phase is currently underway for laparoscopic pancreatic surgery.

Laparoscopic pancreatic surgery must be considered an advanced laparoscopic procedure and should be performed only in institutions with expertise in both endocrine and pancreatic surgery by a team with advanced laparoscopic skills.

Most published reports on laparoscopic pancreatic surgery resections are on single cases or limited series of patients [2, 3, 11–20]. Moreover, the follow-up is short, so little is known about the long-term results.

Patients with benign cystic lesions of the body and tail of the pancreas are appropriate candidates for laparoscopic resection, although the reported experience is limited [5, 21, 22]. The appropriate treatment of CyNPs varies considerably based on the specific type of neoplasm [23, 24]. Serous cystoadenoma of the pancreas affects predominantly women, with an average age of 62 years (range 35–84 years). Most patients experience vague abdominal pain and symptoms seemingly related to the mass effect

of the tumor [25, 26]. Serous cystoadenoma can often be distinguished quite reliably by their characteristics: multiple small (< 2 cm) cystic areas, often resembling a honeycomb both grossly and on imaging tests. Occasionally they have a starburst appearance with a centrally located calcified scar. These neoplasms are universally benign, although there have been unusual reported patients with histologically documented malignant serous cystoadenocarcinomas [27, 28]. Surgical treatment is indicated in symptomatic patients. These tumors are suitable for the laparoscopic approach.

Mucinous cystic neoplasms are the most frequently encountered cystic tumors of the pancreas, accounting for 45% [29]. These neoplasms predominate in women with an average age of 53 years (range 19–82). The most common symptoms seem to be related to a local mass effect. These neoplasms, more common in the body or tail of the pancreas (70%), are composed of cystic areas filled with viscous mucous material, and the cyst walls are dense and fibrous with occasional calcification [30]. Pathognomonic findings on CT include the presence of thin or thick papillary fronds or septae in the individual cysts. A detailed clinicopathologic correlation has been proposed by Sarr et al. [31], separating these tumors into three groups: (1) mucinous cystoadenomas (comprising 65% of mucinous tumors); (2) proliferative cystic mucinous neoplasms (30% of mucinous neoplasms) composed of varying degrees of atypia, dysplasia, and even changes of carcinoma in situ but without tissue invasion; and (3) mucinous cystadenocarcinomas (< 10% of all mucinous cystic neoplasms) with frank stromal invasion beyond the epithelium. The latter group behaves like ductal adenocarcinoma of the pancreas. However, according to the Mayo Clinic experience, there were no recurrences in patients with either cystoadenoma or proliferative mucinous cystic neoplasms on follow-up of up to 30 years [31].

Adequate treatment for CyNP requires pancreatic resection [25, 29, 31–33]. Tumor enucleation does not address the malignant potential of these tumors and should be used (in selected cases) with caution to avoid inadequate tumor margins. In addition, the incidence of pancreatic fistulas after tumor enucleation was reported to be 30% to 50% [25, 34].

In the literature, when the tumors were located in the body or tail of the pancreas, the technique most frequently used was distal pancreatectomy with en bloc resection that included the spleen [31, 34]. Talamini et al. [34] reported that 74% of patients with mucinous cystoadenomas undergoing distal pancreatectomy had splenectomy. One late septic death occurred in this group.

We encourage spleen-preserving pancreatectomy to prevent the potential long- and short-term complications associated with splenectomy [35–37]. Spleen-preserving distal pancreatectomy with splenic vessel preservation is a technically demanding, more time-consuming procedure. As an alternative, Warshaw [38] has reported distal pancreatectomy and conservation of the spleen by dividing the splenic artery and vein but preserving the short gastric vessels.

In this report, laparoscopic distal pancreatectomy with spleen salvage was successfully performed, preserving the splenic vessels in both EPT and CyNP patients. The magnification view using the laparoscopic approach facilitates separation of the splenic artery and vein from the pancreatic parenchyma and identification of the small arteries and veins that are easily controlled with use of the laparoscopic instruments such as the Harmonic Scalpel or the LigaSure device. However, one of our patients after spleen-preserving laparoscopic distal pancreatectomy with division of the splenic vessels, but preserving the short gastric blood supply to the spleen, developed a splenic abscess that required reoperation and splenectomy.

We believe that serous cystoadenomas and mucinous cystic neoplasms are suitable for the laparoscopic approach based on the frequent location of these tumors in the body and tail of the pancreas and the high frequency of these neoplasms being benign or premalignant lesions. Furthermore, only a small number are truly cystoadenocarcinomas [31]. In a previous paper we discussed the possible indications and limits of the laparoscopic approach in patients with EPTs [39]. Knowledge of the clinical, biochemical, and morphologic features of EPTs provides the information needed to ascertain the suitability of the procedure for any particular patient. EPTs are described in relation to the hormone responsible for the clinical syndrome (e.g., insulinomas, VIPomas). However, nonfunctioning tumors account for 15% to 52% of EPTs [7]. The term nonfunctioning is applied because of the current inability to detect a clinical relevant syndrome or a functional agent linked to a symptom.

Insulinomas represent up to 70% to 80% of clinically symptomatic EPTs and occur in all age groups, with a peak incidence during the third to fifth decades [7]. Because of characteristic neuroglycopenic symptoms, insulinomas are usually diagnosed when they are still small, resectable, and not metastatic. Insulinomas are located in the pancreas in almost all patients. This is the typical tumor that is suitable for the laparoscopic approach. The tumors are occasionally (10%) multicentric, in which case they are usually associated with MEN-1.

Notwithstanding recent refinements in imaging techniques for patients with an insulinoma, preoperative diagnostic studies still have some limitations when assessing the number and exact locations of the tumors [40–42]. EUS is the most sensitive modality [43] for detecting insulinomas, and CT scanning or magnetic resonance imaging (MRI) may contribute additional information in the presence of a suspected malignancy [10]. Approximately 89% to 90% of insulinomas are < 2 cm in size, and the lesions are distributed equally throughout the head, body, and tail the pancreas.

Therefore an insulinoma may be occult and difficult to localize both before and during surgery [44, 45]. The most sensitive method for localizing an insulinoma at surgery is intraoperative ultrasonography (IOUS) [46]. Laparoscopy and LapUS provide information similar to that obtained by means of open IOUS and can identify lesions that are undetectable by preoperative imaging techniques [47–51]. Despite the advantages of LapUS, it is still worthwhile to attempt preoperative imaging, as it provides useful information for patient positioning and port placement. LapUS also facilitates operative decision-making. Ultrasonographically, islet cell tumors are typically hypoechoic and easy to differentiate from the surrounding pancreatic parenchyma. The information helps the surgeon choose between enucleation (in an attempt to preserve healthy pancreatic parenchyma) or resection and whether an anterior or a posterior surgical approach would help avoid injury of the pancreatic duct or large blood vessels. In addition LapUS identifies the demarcation between normal pancreas and the tumor and is useful for determining the optimal site of transection.

Our experience showed that when an insulinoma is localized preoperatively by EUS the patients benefited because LapUS

confirmed the localization of the tumor in all cases. In one patient the insulinoma was located in the tail of the pancreas close to the splenic hilum, and a spleen-preserving distal pancreatectomy was performed. In four patients successful enucleation of the tumor was performed. Conversion was necessary in one patient in which EUS misinterpreted the insulinoma as an enlarged lymph node at the border of the pancreas (later not found by LapUS). This was a pedunculated tumor at the inferior border of the gland found easily at operation and successfully removed.

The MEN-1 syndrome is genetically transmitted in an autosomal dominant fashion and is characterized by endocrinopathies of the parathyroid glands, the anterior pituitary, and the endocrine pancreas [7]. Whereas the pancreatic islet cell tumors overall are most frequently gastrinomas, in young patients the most frequent is the insulinoma [48].

Some authors believe that the presence of MEN-1 predisposes patients to premature death, most commonly from pancreatic neoplasms [52]. In two reported series, metastatic islet cell tumors accounted for 20% and 28% of the deaths, respectively, of patients with pancreatic islet cell tumors [52, 53]. For these reasons, it appears that an aggressive surgical approach to the islet cell tumors of MEN-1 should be adopted [54–56]. However, the surgical management of MEN-1 pancreatic disease remains controversial and ranges from subtotal distal pancreatectomy, to the level of the portal vein, to total pancreatectomy [56].

In our MEN-1 patient, preoperative localization imaging (by CT scanning) revealed a large (6.5 cm) tumor in the tail of the pancreas and another smaller tumor (2.5 cm) by octreotide scans. LapUS did not identify any tumor in the head of the pancreas but was of great help when deciding on the plane of transection. A laparoscopic subtotal distal pancreatectomy with splenic vessel preservation was performed in this patient.

Pancreatic VIPomas are rare, with an estimated incidence of 0.2 to 0.5 per million per year [57]. Most VIPomas exhibit a malignant pattern of behavior (80%) [7]. However, determining malignancy by histology is difficult. Typical histologic features of malignancy (e.g., cytologic atypia, angioinvasion, perineural infiltration) are often lacking in most tumors [7]. The only well accepted proof of malignancy is evidence of local invasion, spread to regional lymph nodes, or metastatic disease in the liver or other distant sites [58, 59]. Surgical therapy offers the only chance for cure. Analysis of the Mayo Clinic data reported by Smith et al. [57] showed that in only 44% of patients were the VIPomas resectable, and of those tumors only 28% were resectable for cure. Of the patients with resectable disease, subtotal pancreatectomy (resection of the body and tail of the pancreas) followed by distal pancreatectomy were the most common procedures performed [57].

We attempted laparoscopic pancreatic resection in one patient with VIPoma, but the case was converted to open surgery after documenting lymph node metastasis. The laparoscopic approach may be indicated when the tumor is localized in the body-tail of the pancreas and has no metastatic spread.

Nonfunctioning tumors are indistinguishable from the functional form in terms of cytologic characteristics and inmunohistochemical positivity to neuroendocrine markers [7]. The usual histologic pattern of malignant neoplasms (nuclear pleomorphism, mitotic activity, infiltration into the surrounding tissue) is often unreliable, with the diagnosis of malignancy indicated by local invasion and metastasis. The preoperative evaluation with CT scans or MRI is important when attempting to differentiate benign from malignant lesions [60]. In this report, two large nonfunctioning tumors were successfully removed using the laparoscopic approach. However, this procedure should not be recommended for nonfunctioning tumors that are malignant or localized in the head of the pancreas.

Using the criteria of Cushieri and Jakimowicz [5], the probable benefit of minimally invasive surgery over conventional open surgery depends on the ratio of access trauma to procedural trauma. Laparoscopic enucleation or laparoscopic pancreatic resection for solitary, small, benign insulinomas is better achieved using the laparoscopic approach (rather than laparotomy) in terms of parietal damage to the abdomen. Laparoscopic pancreatic resections are feasible and safe in patients (EPTs, CyNPs) with left-sided pancreatic lesions, thereby avoiding long abdominal incisions. Spleen salvage should be attempted with splenic vessel preservation.

The aims of minimally invasive surgery are not only to minimize parietal damage but to diminish the incidence of postoperative complications. In patients with EPTs undergoing open surgery, significant morbidity follows enucleation or resection. Pancreas-related complications have occurred in 12% to 43% of patients and have included abscesses, pseudocysts, and fistula formation [48, 61]. In our current series, two of four patients (50%) after laparoscopic enucleation, and 3 of 11 patients (27.7%) after laparoscopic pancreatic resection developed a low-volume pancreatic fistula that was not life-threatening. The hospital stay was relatively short, and an early return to previous activities was observed in most patients.

Conclusions

The position of the patient, half-lateral with the left side uppermost, allows complete exposure of the left pancreas, whereas the half-lateral position with the right side up exposes the head of the pancreas. Small insulinomas can be treated effectively by either laparoscopic enucleation or laparoscopic pancreatic resection. LapUS facilitates operative decision-making and demonstrates anatomic details, such as the relation of the tumor to the splenic vessels and to the pancreatic duct. For insulinomas, when enucleation is indicated LapUS allows safe dissection between the tumor and normal parenchyma. Laparoscopic distal pancreatectomy is feasible and safe in patients with small insulinomas located close to the splenic hilium or embedded in the posterior aspect of the pancreas.

The appropriate treatment of CyNP and most EPTs is laparoscopic pancreatic resection. Splenic salvage with splenic vessel preservation is possible during distal or subtotal pancreatic resection.

The rate of pancreatic fistula formation remains high after either laparoscopic enucleation or laparoscopic pancreatic resection, albeit self-limiting. It is associated with low volume, high amylase output (< 80 cc).

The advantages of the laparoscopic approach are a reasonably short hospital stay and an early return to previous activities. A cosmetic advantage is also clear because of the absence of long abdominal incisions. Surgical cure can be achieved in most patients with an insulinoma, with complete relief of symptoms in patients with nonfunctioning EPTs or CyNPs. No tumor recurrences were observed with either EPTs or CyNPs, but the fol-

low-up is relatively short. The laparoscopic approach is unsuitable for large tumors with evidence of malignancy and when pancreaticoduodenectomy is indicated.

Résumé. La place de la chirurgie pancréatique par voie laparoscopique (CPL) dans le traitement des tumeurs pancréatiques bénignes n'est pas encore définie. Ce travail évalue la faisabilité et les résultats de la CPL dans le traitement des tumeurs endocrines du pancréas (TEP) et de lésions kystiques du pancréas (KP). Dix-huit patients porteurs de tumeurs bénignes du pancréas ont eu une CPL entre jan 1998 et mai 2001. Les indications ont été: 10 TEP (6 insulinomes sporadiques, un insulinome multiple MEN-1, 2 tumeurs non-fonctionnelles, 1 vipome) et 8 KP (3 cystadénome séreux et cinq cystadénomes mucineux). On a utilisé quatre trocarts, le patient placé dans une position sémi-latérale. L'échographie laparoscopique (EGLap) a été employée dans tous les cas. On a réalisé quatre des cinq énucléations prévues par voie laparoscopique (ELap) (une conversion a été nécessaire pour tumeur non retrouvée par voie laparoscopique). La conservation splénique a été possible dans 12 des 13 résections laparoscopiques prévues (une conversion pour ViPome métastatique) avec conservation des vaisseaux spléniques chez 11 patients et conservation des vaisseaux courts chez un patient. La durée moyenne d'intervention a été de 3.5 heures après énucléation, de quatre heures après pancréatectomie distale et de cinq heures après pancréatectomie subtotale. On a observé une fistule pancréatique chez deux patients après ELap et chez trois patients après CPL. On a eu besoin de pratiquer une splénectomie une semaine après chirurgie pour abcès splénique chez un patient opéré avec conservation des vaisseaux courts. La durée moyenne de séjour a été de cinq jours. Nous concluons que la CPL est une méthode sure pour enlever les TEP et les KP, avec, cependant, un taux de fistule relativement élevé. Chez certains patients sélectionnés, la CPL offre des bénéfices significatifs: moins d'aggression parièta le, durée d'hospitalisaiton plus courte et récupération postopératoire plus rapide.

Resumen. Todavía no se han establecido las indicaciones de la cirugía laparoscópica pancreática (LapPS) en el tratamiento de los tumores benignos del páncreas. Este trabajo evalúa las posibilidades y los resultados de la LapPS en pacientes con tumores pancreáticos endocrinos (EPT) y en las neoplasias quísticas de páncreas (CyNP). Desde enero de 1998 a mayo de 2001, se trataron mediante LapPS 19 pacientes con tumoraciones benignas de páncreas. Las indicaciones para los 10 EPT fueron (6 insulinomas esporádicos, 1 insulinoma múltiple MEN-1, 2 tumores no funcionantes y 1 VIPoma) y para los 8 CyNP (3 cistoadenomas serosos y 5 neoplasias quísticas mucinosas). La LapPS se practicó a través de 4 puertas con el paciente en decúbito semi-lateral. La ecografía laparoscópica (LapUS) se utilizó en todos los casos. La enucleación laparoscópica (LapE) se planificó en 5 pacientes, pudiéndose realizar en 4 (se precisó una reconversión al no localizarse la tumoración durante la laparoscopia). La resección pancreática laparoscópica (LapPR) se indicó en 13 pacientes, pudiéndose realizar en 12 (hubo de reconvertirse un VIPoma metastásico). Se consiguió preservar los vasos esplénicos en 11 casos y los vasos gástricos cortos en 1 paciente. Duración media de la operación 3.5 h para la enucleación, 4 h para la pancreatectomía distal y 5 horas para la pancreatectomía subtotal. Se produjeron fístulas pancreáticas en dos casos tras LapE y en 3 tras LapPR. A la semana de la intervención hubo de practicarse una esplenectomía, por absceso esplénico, en 1 paciente al que se preservaron los vasos cortos gastro-esplénicos. La hospitalización media fue de 5 días. la LapPS es un método seguro para la extirpación de tumores EPT y CyNP pancréaticos, pero la aparición de fístulas pancreáticas es frecuente. En pacientes seleccionados la LapPS resulta beneficiosa pues disminuye el trauma abdominal, acorta la estancia hospitalaria y permite una rápida recuperación postoperatoria.

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