

PRESENT STATUS OF LAPAROSCOPIC PANCREATIC SURGERY

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Abstract : Pancreatic surgery has higher morbidity and mortality than other forms of gastrointestinal tract surgery because of problems like pancreatic fistula and loss of pancreatic function. However, advances in laparoscopic techniques and equipment have expanded the role of laparoscopic surgery to a degree that could not have been imagined like as Whipple's procedure. This review discusses the current status of laparoscopic pancreatic surgery and the role of the procedures involved, i.e., laparoscopic pancreatic resection, pancreatic cancer staging and diagnosis, and laparoscopic applications for the treatment of pancreatitis. Recent reports on laparoscopic surgery of the pancreas are encouraging and support the advantages of laparoscopy. We consider that well selected enucleation and laparoscopic distal pancreatectomy, with or without spleen preservation, are acceptable and recommendable for the treatment of benign or low malignant diseases of the pancreas. Moreover, surgeons and the laparoscopic industry have developed new techniques and devices that increase convenience, ease, and the safety of complicated laparoscopic surgeries, and these efforts will undoubtedly increase the role of laparoscopic or minimal invasive surgery for the treatment of pancreatic disease.

INTRODUCTION

Pancreatic surgery has higher morbidity and mortality than other forms of gastrointestinal tract surgery, due to associated problems like pancreatic fistula formation and loss of pancreatic function. Until recently laparoscopic surgery of the pancreas was limited to laparoscopic staging or to the evaluation of periampullary cancer for detecting small metastatic nodules or local invasion.^{1,2}

Advances in laparoscopic techniques and instrumentation have expanded the role of laparoscopic surgery to a degree that could not have been imagined like as Whipple's procedure.³

This review discusses the current status of the laparoscopic pancreatic surgery and the role of its associated procedures for the treatment of pancreatic disease.

PANCREATIC RESECTION

1. Distal pancreatectomy

Although laparoscopic pancreatic surgery is considered to be an advanced and demanding procedure, many surgeons have tried laparoscopic distal pancreatectomy due to its technical simplicity and its avoidance of the need for anastomosis as compared with other difficult pancreatectomy.⁴⁻¹⁸ The most desirable and acceptable indication of laparoscopic distal pancreatectomy is chronic pancreatitis and benign/low grade malignant lesions of pancreas.

Over 200 cases of laparoscopic distal pancreatectomy have been reported in the English literature, largely in association

with the treatment of benign or low malignant diseases of the pancreas. Laparoscopic distal pancreatectomy has been associated with reductions in blood loss, morbidity, and hospital stay and much improved cosmetic results as compared with open surgery.(Table 1) However, the role of laparoscopic distal pancreatectomy for the treatment of malignancy remains controversial. Although the short-term results of the limited number of laparoscopic distal pancreatectomies reported to date appear favorable, at least in cases of benign or borderline malignancy.⁴

Table 1. Published articles (with over 10 cases) on laparoscopic distal pancreatectomy¹³⁻¹⁸

Author (year)	Number of patients	Morbidity (%)	Distal pancreatectomy with splenectomy (%)	Spleen-preserving distal pancreatectomy (%)
Patterson et al. (2001)	15	26%	12 (80%)	3 (20%)
Park and Heniford (2002)	23	17.4%	11 (48%)	12 (52%)
Fabre et al. (2002)	13	30.7%	3 (23%)	10 (77%)
Edwin et al. (2004)	17	38%	12 (71%)	5 (29%)
Dulucq et al. (2005)	21	23%	5 (23.8%)	16 (76.2%)
Mabrut et al. (2005)				
-European multicenter study-	82	32.6%	24 (29.2%)	58 (70.8%)
Our series (submitted in Surg Endosc)	31	35.4%	18(58%)	13(42%)

Between 2000 and 2006, we performed 31 laparoscopic distal pancreatectomies in our department. The most common indication for laparoscopic distal pancreatectomy was a cystic pancreatic tumor, e.g., a mucinous cystic neoplasm or a solid pseudopapillary neoplasm. (Table 2) When we compared the clinical results of laparoscopic surgery by

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Table 2. Clinicopathological characteristics of our laparoscopic distal pancreatectomy cases

	Laparoscopic DP (n=31)	Open DP (n=62)	p-value
Age	46.7±16.7	47.5±14.9	0.821
BMI (kg/m ²)	22.2±2.2	23.0±3.4	0.233
Size (cm)	3.95±2.3	6.15±4.1	0.006
Pathology			1.000
MCN	8	16	
SPN	7	14	
IPMN	6	12	
SCA	4	9	
Islet cell tumor	2	3	
*Etc.	4	8	
Malignancy			0.079
Benign	16	22	
Borderline	12	35	
Malignancy	3	4	

Abbreviations : MCN=mucinous cystic neoplasm, SPN=solid pseudopapillary neoplasm, IPMN= intraductal papillary mucinous neoplasm, SCA=serous cystadenoma.

*, pancreatic pseudocyst (3), lymphoepithelial cyst (2), acinar cell tumor (2), pancreatic endocrine carcinoma (1), SPEN (1), cystic lymphangioma (1), insulinoma (1), endocrine tumor (1)

age and sex and with pathologic diagnosis-matched open surgery results (n=62), no statistical differences were found in terms of operation time, morbidity, or recurrence. (Table 2) However, differences between mean lengths of hospital stay and mean hospital charges were statistically significant. Mean length of hospital stay was shorter in the laparoscopic group than in the open surgery group (11.5 vs. 13.5, $p=0.04$), whereas mean hospital charge in the laparoscopic group was more expensive (USD 4884 vs. 3401, $p<0.001$) (Table 3). No mortality occurred in either group.

We conclude that laparoscopic distal pancreatectomy is a safe and feasible equivalent to open distal pancreatectomy in terms of early and late outcome for benign and borderline lesions of pancreas. Moreover, high hospital charges are offset cosmetic results and early functional recovery.

Spleen preservation and method of preservation are important issues of laparoscopic distal pancreatectomy, and surgeons showed diverse surgical method preferences. (Table 1) Spleen-preserving distal pancreatectomy was introduced by Mallet, et al in 1943,⁵ and as knowledge of the immunologic role of the spleen has increased, so efforts have intensified to conserve the organ.^{6,7} Two techniques are employed during spleen-preserving operations. The first involves splenic artery and vein transection such that the left gastroepiploic vessels and short left gastric vessels

will supply the spleen (Warshaw's technique),⁸ whereas in the second the splenic artery and vein are preserved. This second method demands more advanced instrumentation and skill in terms of dividing the transverse branch of splenic vessels, whereas the former technique is usually selected for laparoscopic surgery because of its technical accessibility and shorter operative time.^{9,10} However, this technique may result in splenic infarction and splenic abscess formation due to insufficient blood flow to the spleen.^{11,12}

In our series, 13 patients underwent laparoscopic spleen-preserving distal pancreatectomy and splenic vessels were mostly preserved. (Figure 1)(Table 4) The rate of complication was 30.7%, but no splenic infarction or



Figure 1. Laparoscopic spleen preserving distal pancreatectomy. Black arrow: preserved splenic artery
White arrow: preserved splenic vein

Table 3. Perioperative outcomes of laparoscopic and open distal pancreatectomy at our center.

	Laparoscopic DP (n=31)	Open DP (n=62)	p-value
OP time (min)	217.7±55.8	194.8±63.7	0.093
Transfusion (yes)	1	7	0.261
Postoperative hospital stay (days)	11.5±4.1	13.5±4.9	0.049
Complication			
Total	11	12	0.167
Pancreatic leakage	4	5	
Fluid collection	6	3	
Others	1	4	
Mortality	0	0	1.000
Recurrence	0	1	1.000
Cost (US dollar)	4884.2±1845.1	3401.4±1247.5	<0.001

Table 4. Perioperative outcomes: Spleen sacrificing vs. preserving laparoscopic distal pancreatectomy

	Spleen-sacrificing LDP (n=18)	Spleen-preserving LDP (n=13)	p-value
OP time (min)	193.9±53.0	250.8±42.1	0.020
Transfusion (yes)	0	1	0.419
Postoperative hospital stay (days)	11.3±4.30	11.7±3.92	0.782
Complication			1.000
Total	7	4	
Pancreatic leakage	2	1	
Fluid collection	5	2	
Others	0	1*	
Mortality	0	0	1.000
Recurrence	0	1	0.419
Cost (US dollars)	4,240.1±1364.6	5,600.8±2210.1	0.740

abscess was encountered. The only difference noted between the spleen-preserving group and the spleen-sacrificing group was operation time. Therefore, we conclude that spleen-preserving laparoscopic distal pancreatectomy is a technically feasible procedure, although it requires more operative time.

2. Pancreatoduodenectomy

Laparoscopic pancreatoduodenectomy is a technically challenging but feasible procedure.^{14, 19}

Our group described several of pancreatoduodenectomy for a low grade malignancy lesion of the pancreatic head.²⁰ However, a lack of tactile sensation, difficulties localizing lesions, and the anatomic complexity of peripancreatic organs combined to make laparoscopic pancreatoduodenectomy difficult.²¹

Even Dr. Gagner, the initiator of laparoscopic pancreatoduodenectomy, concluded that this procedure offers no advantage in terms of patient outcome and may be associated with increased morbidity.²² Nevertheless, laparoscopic experience has allowed some surgeons to claim promising results for laparoscopic pancreatoduodenectomy.^{17,23}

However, this operation has many pitfalls, because pancreatoduodenectomy requires meticulous anastomosis to reduce morbidities associated with pancreatic leakage, and adequate dissection to remove diseased tissue. On the other hand, it can be expected that technical advances, like robotic surgery, will continue to make pancreatoduodenectomy by minimal invasive surgery more feasible and safe.

3. Other miscellaneous pancreatectomy or palliative procedures

Enucleation is the second most common procedure conducted using laparoscopic pancreatectomy. According to a review by Tagaya et al,²⁴ laparoscopic enucleation has

been used to treat relatively small benign or low grade malignancies (<2 cm in diameter), e.g., islet cell tumors and tumors located on the surface of the pancreas removed from the pancreatic duct. Tumor location is an important success factor of laparoscopic enucleation, and some advocate that enucleation is a safe and simple procedure under laparoscopic ultrasonographic guidance.²⁵ The enucleation of pancreatic cystic tumors offers the possibility of complete tumor removal without loss of pancreatic parenchyma, possible diabetes, and splenectomy. However, enucleation seems to be a debatable procedure in patients with pancreas cystic tumors, and does not address the malignant potential of these tumors, and thus, should be used cautiously in selected cases to avoid inadequate tumor margins.¹² In addition, the incidence of pancreatic fistula after tumor enucleation has been reported to be 30% to 75%, which is relatively higher than that of conventional pancreatectomy.²⁶⁻²⁸ Moreover, considerations of oncological and operational safety require that surgeons exercise caution when selecting indications for laparoscopic enucleation.

Some pioneers have developed more intricate procedure like laparoscopic central pancreatectomy and ventral pancreatectomy.²⁹ Laparoscopy may also be used in a palliative context for locally invasive or metastatic pancreatic/periampullary cancers. Many patients with periampullary cancer have symptoms associated with biliary or gastric outlet obstruction, and traditionally these patients have been managed by open bypass surgery.⁴ More recently, however, minimally invasive laparoscopic approaches to gastric and biliary bypass have been successfully applied, and have been shown by non-randomized comparative studies to be safer and to be associated with reduced periods of hospitalization than open surgery.³⁰⁻³³

However, although endoscopic procedures for palliative treatment have been enormously developed and have achieved early success rates for endoscopic stent which is comparable to those of surgery with reduced morbidity and hospital stays, the long-term results of endoscopic procedures are not as satisfactory.³⁴ Thus, randomized comparisons of laparoscopic biliary bypass and metal biliary stents in unresectable periampullary cancer are warranted.

LAPAROSCOPIC DIAGNOSIS/STAGING

Laparoscopic diagnosis and staging are controversial in patients with suspected pancreatic cancer. Its main role is to detect occult intra-abdominal metastatic disease, though during the procedure any suspicious lesion can be biopsied and peritoneal cytology can also be obtained by instilling normal saline into the peritoneum.³⁵⁻³⁷

The yield of laparoscopy for the detection of metastatic disease, especially of small peritoneal lesions not been detected by imaging modalities, ranges from 15 to 46%.³⁸⁻⁴² Moreover, recent studies have showed lower yields for

laparoscopy than for improved non invasive imaging modalities like multi detector CT. The yield of laparoscopy alone is clearly impaired by its inability to detect locally advanced or intra-parenchymal liver disease. To overcome this obvious limitation, laparoscopic ultrasound has been added to laparoscopic staging, and this leads to a marked increase in yield and accuracy.³⁵ Studies that have compared laparoscopy and laparoscopic ultrasound with radiological staging modalities have produced controversial results. However, several studies have found that laparoscopy and laparoscopic ultrasound are more accurate than contrast-enhanced CT at determining T Stage.^{43,44}

In contrast, three recent large studies using contrast-enhanced multi-detector CT imaging as a baseline radiological investigation were unable to confirm this, and found yields as low as 10-15% and accuracies of 35-56% for laparoscopy.^{45,46} Despite the use of a pre-operative staging algorithm including laparoscopic ultrasound, up to 20% of patients were still found to be unresectable at the time of laparotomy, mainly because of local invasion.⁴⁷ Moreover, as diagnostic yields have effectively fallen, due to improvements in non-invasive imaging, the additional costs of laparoscopy have been called into question, particularly since it requires separate anesthesia. Thus, at present, laparoscopy has a limited role in the staging of peripancreatic malignancies.³⁵

LAPAROSCOPIC APPLICATION TO PANCREATITIS

The role of surgery in the management of acute pancreatitis is markedly reduced because less invasive intervention and intensive medical care are evolved. Although some clinicians advocate a non surgical approach even in cases of infected necrotizing pancreatitis, due to the improved results of medical or interventional treatment,⁴⁸ current indications for surgery in pancreatitis are infected necrotizing pancreatitis, an organizing pseudocyst, or related complications.

The treatment of infected necrosis has changed dramatically during the last few years, and a multimodality approach has emerged, whereby a combination of several techniques are used in a single patient, and the risks of intervention are weighed against the need for adequate sepsis control.⁴⁹

Minimally invasive surgery has consistently been shown to be associated with reduced inflammatory response activation than equivalent open surgery, and some evidence suggests that local sepsis and inflammatory response may also be lessened by minimally invasive rather. It has been suggested that by minimizing the massive inflammatory injury associated with open pancreatic necrosectomy, a minimally invasive approach to the management of infected pancreatic necrosis may lessen the risk of multiple organ failure, and reduce respiratory and wound morbidity in necrotizing pancreatitis.^{49,50}

The laparoscopic approach depends on the localization of pancreatic necrosis. The alternatives are an intraperitoneal approach, direct entry of the retroperitoneal space, and an intraperitoneal transgastric approach. Our group experienced three successful cases of laparoscopic necrosectomy using a multiple approach technique for necrotizing pancreatitis. (Figure 2) The potential benefits of minimal invasive techniques have yet to be proven, because of a sparsity of reports that deal with severely ill patients, and thus, the superiority or inferiority of laparoscopic over endoscopic or radiologic intervention must be proved by randomized prospective study.

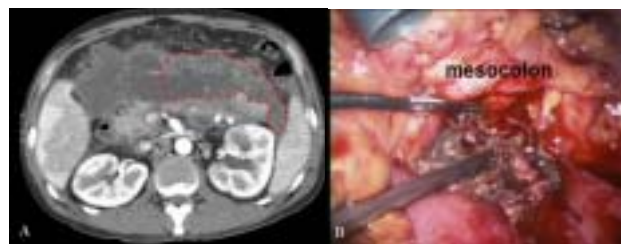


Figure2. A 30 year old man, with severe necrotizing pancreatitis. (A) CT shows severe necrosis around pancreas. Demarcated area was approached and debrided using the transmesocolic method (B), the other was approached using a transgastric or extrapancreatic approach

The management of pancreatic pseudocyst complicated acute or chronic pancreatitis represents another important role of laparoscopy in pancreatitis. Pseudocysts complicate 5-10% of acute pancreatitis attacks and often arise as a result of disruption of the pancreatic duct in the presence of gland necrosis. Large (≥ 6 cm diameter), persistent (≥ 6 weeks), and symptomatic pseudocysts are indications for drainage, which is best achieved endoscopically or surgically.⁴

Endoscopic transmural (transgastric or transduodenal) drainage may be possible in some patients with pancreatic pseudocysts, and is best reserved for pseudocysts that complicate chronic pancreatitis (rather than acute pancreatitis) in the head or body of the gland, and those with a wall thickness of < 1 cm.⁵¹ Surgery remains the gold standard for the management of large, persistent and symptomatic pseudocysts. Internal drainage is conventionally achieved through a pseudocyst-gastrostomy or pseudocyst-jejunostomy, procedures that are now safely and effectively accomplished laparoscopically.⁴ Transgastric (via anterior gastrostomy),⁵² endogastric,^{53, 54} a posterior approach through the lesser sac, and Roux-en-Y pseudocyst-jejunostomy have been described.⁵⁵ Although reported cases of laparoscopic management of pseudocysts are limited, the data presented is promising, and support the advantages of a relatively short postoperative hospital stay and rapid recovery.⁵²⁻⁵⁵

Because no randomized controlled trial has compared the laparoscopic, open approaches and endoscopic procedures

in terms of the internal drainage of pseudocysts, it is impossible to clarify which provides the most effective treatment for patients with pseudocysts in different situations.

CONCLUSION

The anatomical complexity of the pancreas and high postoperative morbidity have hindered evaluations of laparoscopic surgery with respect to early functional recovery, and thus, have probably retarded the adoption of laparoscopic surgery for the management of pancreatic diseases. Nevertheless, recent reports on pancreatic laparoscopic surgery are encouraging and maintain consensus option concerning the merits of the technique. The authors believe that well selected cases of enucleation and laparoscopic distal pancreatectomy with or without spleen preservation are currently both acceptable and recommendable for the treatment of benign or low malignant diseases of pancreas. Most reports on advanced laparoscopic pancreatectomy have concluded that these procedures are feasible and safe when conducted by skilled laparoscopic surgeons. However, technical feasibility does not obviate sound clinical judgment, and caution should be exercised before new technologies are adopted in the absence of well designed clinical trials.⁵⁶

However many surgeons and the laparoscopic industry have developed new techniques and devices that are more convenient and increase the safety of laparoscopic surgery, and their efforts will undoubtedly increase the role of laparoscopic or minimal invasive surgery for the treatment of pancreatic disease.

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