



## Initial experience with hand-assisted laparoscopic distal pancreatectomy

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### Abstract

**Background:** Hand-assisted laparoscopic distal pancreatectomy, with or without splenectomy, is gradually gaining acceptance, although its ultimate benefit is yet to be confirmed. This study aimed to report our initial experience with hand-assisted laparoscopic distal pancreatectomy.

**Methods:** A retrospective review of a prospectively collected database including 17 patients during the period 2002–2004 was conducted. The median age was 60 years (range, 29–85 years), and the female-to-male ratio was 13:4. The preoperative diagnoses included benign and malignant conditions. Besides two to three ports, a hand port was placed in the upper midline to aid in dissection. The pancreas was divided with a stapler in all the patients, and drains were placed in 10 patients (70%).

**Results:** One patient was found to be unresectable because of celiac artery involvement, and 2 of the remaining 16 patients underwent conversion to an open procedure. The median operating time was 196 min (range, 128–235 min). The mean tumor size was 4 cm (range, 2–7 cm), and the estimated blood loss was 125 ml (range, 50–1,250 ml). The median time to resumption of a regular diet was 3.5 days (range, 2–9 days), and the time to conversion to oral pain medications was 3 days (range, 2–9 days). The length of hospital stay was 5.5 days (range, 4–18 days), with a majority of the patients (11 patients, 78%) staying less than 7 days. There were no mortalities. The overall postoperative morbidity rate was 25%, and the morbidities consisted of pancreatic leak/fistula (2 patients, 14%) and fever (1 patient). The margins were negative in 10 (76%) of the relevant 13 patients. At a median follow-up period of 3.8 months (range, 5–14 months), 11 (84%) of 13 patients had no evidence of disease recurrence.

**Conclusion:** The minimally invasive approach to pancreatic disease is safe and technically feasible. Further

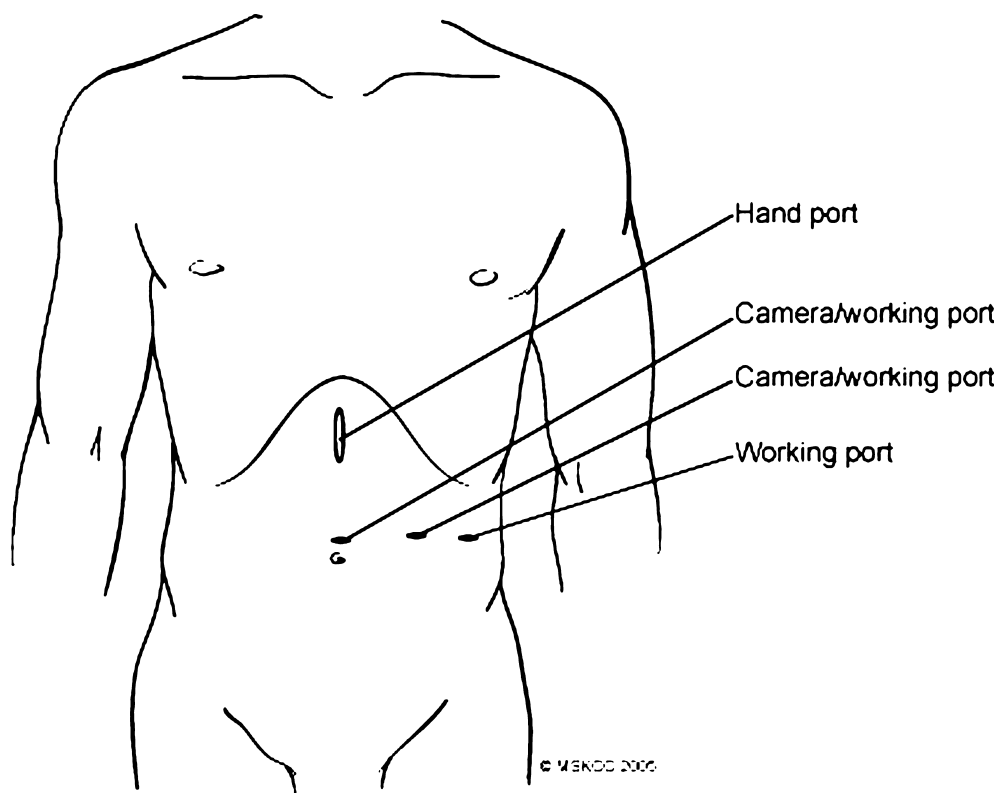
large studies with longer follow-up periods are necessary to determine the role of laparoscopic surgery in the management of pancreatic disease.

**Key words:** Hand-assisted — Laparoscopic distal pancreatectomy — Minimally invasive — Pancreatectomy — Pancreatic disease

Partial pancreatectomy is the standard therapy for pancreatic neoplasms. In selected cases, pancreatectomy also is a valuable treatment for chronic pancreatitis. Laparotomy used for operations on the pancreas generally requires a midline or subcostal incision and is associated with postoperative pain and ileus.

Minimally invasive surgery has revolutionized surgical approaches and currently is considered standard for many operations including cholecystectomy, Nissen fundoplication, splenectomy, and adrenalectomy. The benefits of laparoscopic surgery include decreased pain, less postoperative ileus, shorter hospital stay, and faster outpatient recovery [30]. Laparoscopy also provides excellent visualization of anatomic areas that otherwise would require a large incision for adequate exposure. The disadvantages of laparoscopic surgery include limited instrumentation, lack of dexterity, and lack of tactile sensation. Hand-assisted laparoscopic surgery is an effective method for maintaining a minimally invasive approach while preserving the ability to use tactile sensation and the complex retracting ability of the human hand [19, 27].

Although many laparoscopic operations such as laparoscopic cholecystectomy have become standard over the past decade, there has been a reluctance to approach pancreatic resections with this technique. Laparoscopic techniques for pancreatectomy have been developed recently, but there is limited reported experience. Laparoscopic pancreaticoduodenectomy has been reported [13], but has largely been abandoned



**Fig. 1.** Position of ports and hand port.

because of morbidity rates similar to those for the open technique, and because of the operation's technical complexity. Laparoscopic distal pancreatectomy, on the other hand, has been accepted by many as a potentially feasible operation. Experience with this operation, however, has been limited [8, 9, 11, 16, 24, 25]. We report our initial experience with hand-assisted laparoscopic distal pancreatectomy.

## Materials and methods

A retrospective review of a prospectively maintained pancreatic surgery database was conducted. All patients undergoing attempted laparoscopic distal pancreatectomy were identified, and chart reviews were performed. Demographics and operative, postoperative, radiologic, and pathologic data were obtained from the medical records. This study was approved by the hospital Institutional Review Board and complied with Health Insurance Portability and Accountability Act (HIPAA) regulations.

Over a 19-month period, from December of 2002 to July of 2004, 64 patients underwent a distal pancreatectomy. Hand-assisted laparoscopic distal pancreatectomy was attempted for 17 of these patients (36%), 13 of whom were women. The median age of the patients was 60 years (range, 29–85 years).

In general, two or three laparoscopic ports were placed along the left midabdomen, and a complete laparoscopic exploration was carried out to assess for metastatic disease when appropriate (Fig. 1). A hand-port incision, usually 6 to 7 cm long, was made in the midline midway between the umbilicus and the xiphoid process (Fig. 1). The surgeon's left hand was placed through the hand port and used for retraction, palpation of the tumor, blunt mobilization, and palpation of major vascular structures. At times, the assistant placed his hand through the hand port to enable the surgeon to operate with two laparoscopic instruments. The surgeon usually stood on the right-hand side of the patient or between the legs (Fig. 2).

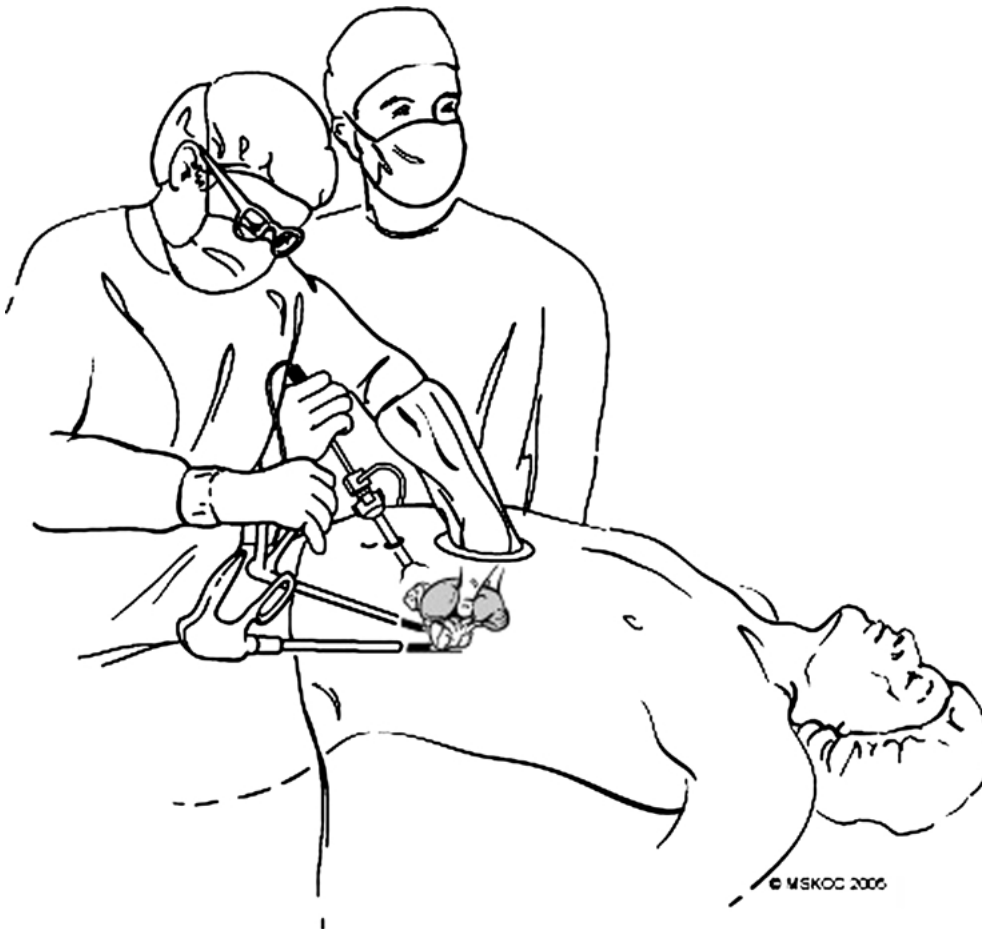
Laparoscopic instruments were used for countertraction, division of the gastrocolic ligament and short gastric vessels, division of the splenic and posterior pancreatic attachments, and dissection of the splenic vein and artery (Fig. 2). The short gastric vessels were divided with ultrasonic shears or with the Ligasure device (Valley Lab, Boulder, CO, USA). The splenic vein and artery were divided with vascular staplers, clips, or both. The pancreas was divided with staplers in all cases.

Once the spleen and tail of the pancreas had been mobilized, two techniques were used. The first technique accomplished dissection and division of the splenic vessels and pancreas intracorporeally. The second technique mobilized the spleen and distal pancreas, eviscerated them through the hand-port incision, and divided vessels, pancreas, or both extracorporeally. This latter strategy was particularly helpful when the transection line of the pancreas was at the level of the mesenteric vessels. The technique used depended on the individual patient, the patient's body habitus, and the mobility of the pancreas. The placement of a drain was determined according to the surgeon's preference. Drains were not routinely placed.

## Results

### *Preoperative workup*

Seven of the total group of 17 patients (41%) were thought to have cystic neoplasms, and three patients were believed to have low-grade primary pancreatic neuroendocrine tumors. One of these patients had known liver metastases and underwent resection for palliation of a symptomatic tumor. One patient had chronic pancreatitis and a dominant pancreatic duct stricture in the body of the pancreas. The remaining six patients had solid tumors: three thought to be adenocarcinomas (2 documented by fine-needle aspiration), one solid pseudopapillary tumor documented by fine-needle aspiration, one metastatic sarcoma, and one solid tumor of unclear etiology. The



**Fig. 2.** Combined dissection with laparoscopic instrument and hand.

median size of these tumors according to cross-sectional imaging was 3.5 cm (range, 1–6 cm).

#### *Intraoperative outcome*

The intraoperative outcome data are presented in Table 1. Of the 17 patients, 1 was found to be locally unresectable because of celiac artery involvement. Two of the 16 resections involved attempts at splenic preservation in patients with low-grade neuroendocrine tumors, one of which was successful. These 16 resections included 2 conversions to laparotomy, which required extension of the hand port to a lengthened midline incision. One conversion was because of bleeding at the splenic hilum during an attempt at splenic preservation, and the other one was because of poor exposure. The splenic vein was dissected off of the pancreas and divided separately in all but one case, in which it was taken with the pancreas in a single firing of the stapler. The splenic artery was divided intracorporeally in 10 cases and extracorporeally in 5 cases, with preservation used in 1 case. The pancreas was divided intracorporeally in 8 cases and extracorporeally in 8 cases. The median blood loss was 125 ml (range, 50–1,250 ml). A minimal blood loss of 50 ml was recorded for 5 of the 16 resections (31%). The blood loss in the two cases converted to laparotomy was, respectively, 500 and 250 ml. The median operative time was 196 min (range, 128–235 min).

#### *Postoperative outcome*

The postoperative outcome data also are presented in Table 1. The median length of stay was 5.5 days (range, 4–18 days). There was no incentive to send patients home early, but all were discharged when medically ready. For the three patients with significant postoperative complications, the lengths of hospital stay were 9, 12, and 18 days, respectively. The mean length of stay for the 13 patients without complications was 5.5 days (median, 5 days). The two patients who underwent conversion to laparotomy had postoperative hospital stays of 6 and 12 days, respectively. Most of the patients had mild incisional pain and a brief ileus, resulting in a median time of 3.5 days (range, 2–9 days) to a regular diet, and a median time of 3 days (range, 2–9 days) to oral analgesics. Of the 16 resected patients, 11 (69%) were discharged in 6 days or less.

No postoperative deaths occurred. The overall postoperative morbidity rate was 25% (4/16). One patient had a minor unexplained postoperative fever with no sequelae. Three patients (19%) experienced pancreatic leaks requiring drainage. One of these patients had successful percutaneous drainage; one had an initially successful percutaneous drainage but ultimately required reoperation for complete drainage, and one patient who presented in a delayed fashion was managed with endoscopic internal drainage. Two of the fistulae occurred in patients whose surgery was completed la-

**Table 1.** Perioperative outcome for 16 patients undergoing laparoscopic distal pancreatectomy

Patient	Conversion	EBL (ml)	Operative time (min)	LOS (days)	Regular diet (days)	Morbidity
1	No	50	210	4	4	None
2	No	200	222	6	3	None
3	No	50	185	6	2	None
4	No	200	200	4	3	None
5	No	250	230	9	5	Leak/fistula
6	No	50	175	7	4	None
7	No	1,250	224	4	3	None
8	Yes	500	192	6	4	None
9	No	100	156	5	4	None
10	No	150	175	5	3	None
11	No	100	155	18	9	Leak/fistula
12	No	200	202	5	3	None
13	No	50	128	5	3	None
14	Yes	250	235	12	6	Leak/fistula, CHF, wound infection
15	No	100	226	9	7	None
16	No	50	150	5	3	Fever

EBL, estimated blood loss; LOS, length of hospital stay; CHF, congestive heart failure

**Table 2.** Preoperative diagnosis and pathology for the 16 resected patients

Patient	Preoperative diagnosis	Pathologic size (cm)	Histology
1	3.5-cm cystic neoplasm	3.5	Mucinous cystadenoma
2	chronic pancreatitis	NA	Chronic pancreatitis
3	6-cm cystic neoplasm	7	Mucinous cystadenoma with atypia
4	4.5-cm LG neuroendocrine tumor <sup>a</sup>	5	Low-grade neuroendocrine
5	1- and 6-mm cystic neoplasms <sup>a</sup>	NA	IPMN with adenoma
6	3.5-cm adenocarcinoma	NA	Chronic pancreatitis
7	4.5-cm adenocarcinoma <sup>a</sup>	4	Adenosquamous carcinoma
8	2.8-cm LG neuroendocrine tumor	2.7	Accessory spleen
9	1.8-cm malignant cystic neoplasm <sup>a</sup>	2.5	Mucinous cystadenoma
10	3.7-cm metastatic sarcoma	5	Metastatic sarcoma
11	3.8-cm solid_pseudopapillary tumor <sup>a</sup>	4.7	Solid_pseudopapillary
12	3.2-cm cystic neoplasm	4	Serous cystadenoma
13	2.2-cm IPMN	2	Low-grade neuroendocrine
14	2.3-cm cystic neoplasm	NA	Lymphoplasmacytic sclerosing pancreatitis
15	4-cm solid mass	5.3	Solid pseudopapillary
16	3.1-cm LG neuroendocrine tumor	3	Low-grade neuroendocrine

NA, not applicable; LG, low grade; IPMN, intraductal papillary mucinous neoplasm

<sup>a</sup> Preoperative histology via fine-needle aspiration

paroscopically (fistula rate, 14%; 2/14). There was no long-term morbidity such as a chronic fistula, diabetes, or pancreatic exocrine insufficiency.

### Pathology and outcome

Table 2 details the preoperative impression and the final pathologic diagnosis for the 16 resected patients. The median pathologic size of the 12 measurable tumors was 4 cm (range, 2–7 cm). Margins were involved in 3 of the 13 applicable cases. One of these cases involved peri-pancreatic soft tissue in a low-grade neuroendocrine tumor representing extracapsular extension. Another case involved the proximal pancreatic margin in a patient with metastatic low-grade neuroendocrine tumor resected for palliation of local symptoms, and still another case involved the proximal pancreatic margin in a solid pseudopapillary tumor. The median number of

lymph nodes identified in the specimen was 5.5 (range, 2–19). No lymph node metastases were identified.

During a median follow-up period of 4 months, there were no local recurrences. At this writing, the three patients with chronic pancreatitis are free of symptoms and recurrent pancreatitis. Two of the patients have had recurrence of malignant disease at distant sites. One patient with adenocarcinoma of the pancreas experienced recurrence involving the liver 6 months postoperatively, and one patient with metastatic sarcoma experienced recurrence involving the lung 4 months postoperatively.

### Discussion

Standard open distal pancreatectomy has been performed safely with low mortality and acceptable morbidity over the past two decades [2, 4, 10, 18, 22, 29].

**Table 3.** Results of open distal pancreatectomy (selected series)<sup>a</sup>

Author/yr	<i>n</i>	Diagnosis	OR time (h)	Morbidity (%)	Mortality (%)	LOS
Brennan/96	34	Adenocarcinoma	—	23	0	13.5
Lillemoe/99	235	All	4.3	31	1	10
Balcom/01	190	All	—	24	2	9,7,6 <sup>b</sup>
Fahy/02	51	All	—	47	4	—
Hutchins/02	90	Pancreatitis	3.5	28	1	—

<sup>a</sup> All numbers are medians except where indicated

<sup>b</sup> Sequential medians over periods through the 1990s

**Table 4.** Results of largest published series on laparoscopic distal pancreatectomy

Author/yr	<i>n</i>	Procedures	Hand port ( <i>n</i> )	Conversion	Splenic preservation <sup>a</sup>	Morbidity <i>n</i> (%)	EBL <sup>b</sup> (ml)	LOS <sup>b</sup> (days)
Patterson/01	19	15 res/4 enuc	1	2	3/15	5 (26)	200	6
Gramatica/02	9	5 res/4 enuc	0	0	4/5	3 (33)	—	5
Park/02	25	23 res/2 enuc	2	2	12/23	4 (16)	273	4
Fabre/02	13	All res	0	2	10/13	4 (30)	—	5–22 <sup>c</sup>
Edwin/04	29	17 res/7 enuc	1	4	5/17	9 (38)	400	5.5
Fernandez-Cruz/04	19	All res	0	0	6/19	3 (16)	—	5.7
Current	17	All res	17	2	1/16	4 (25)	125	5.5

EBL, estimated blood loss; LOS, length of hospital stay; res, resection; enuc, enucleation

<sup>a</sup> Splenic preservation reported for resections only

<sup>b</sup> EBL and LOS expressed as medians except in Park study

<sup>c</sup> Only range given

Table 3 summarizes the largest modern series of open distal pancreatectomies and demonstrates that morbidity ranges from 23% to 47%, and that mortality is less than 5%. Traditionally, the length of hospital stay has been approximately 10 to 13 days [4, 22]. However, with attention focused on decreasing hospital stays, this number has decreased in many centers and currently approaches 7 to 9 days [2]. The most serious complication after distal pancreatectomy is a pancreatic ductal leak with resultant abscess, fistula, or both. The reported rates for pancreatic leak/fistula range from 0% to 40% [2–4, 10, 18, 21, 22, 29]. This wide variation probably is related to different definitions and the inherent limitations of retrospective reviews.

Despite the rapid growth of laparoscopic surgery, surgeons have been slow to apply laparoscopic techniques to pancreatic surgery. This is likely related to the complex location of the organ in the retroperitoneum and its close proximity to many other organs and major vascular structures. Additionally, many surgeons do not have combined expertise in pancreatic and laparoscopic surgery. Laparoscopic pancreaticoduodenectomy has been performed by Gagner and colleagues [13], but this procedure is not recommended because morbidity rates and hospital stays are similar to those for the open technique. Because pancreaticoduodenectomy is an operation whose morbidity is not related to the incision, but rather to control of blood loss, precise dissection, and meticulous reconstruction of fine structures, an open operation is recommended until improved laparoscopic techniques are developed. Distal pancreatectomy, on the other hand, is a simpler dissection and does not require complex reconstruction. Therefore, it is more amenable to laparoscopic surgery.

There are numerous case reports and small case series reporting of laparoscopic distal pancreatectomy for trauma [7, 26], insulinomas (resection or enucleation) [14, 23], chronic pancreatitis [6, 12], metastases [17] and cystic neoplasms [31]. Many techniques have been described that use either a four- or five-port pure laparoscopic approach or a hand-assisted approach in which a hand port is placed to assist with retraction, palpation, and blunt dissection [5, 20, 28]. Over the past 3 years, larger series have been published, but experience still remains extremely limited.

Table 4 details the largest series reported to date [8, 9, 11, 16, 24, 25]. These series demonstrate that the technique is feasible in experienced hands, and that perioperative factors such as blood loss and fistula are not demonstrably different from those in the open approach. The length of hospital stay appears to be decreased, and generally ranges from 4 to 6 days in uncomplicated cases. Conclusions about comparisons with open distal pancreatectomy, however, must be interpreted with caution because these retrospective reviews are from different periods and often involve different diseases.

In our initial experience with a minimally invasive approach to distal pancreatectomy, we used a hand-assisted technique. The use of a hand provides a number of advantages while maintaining a minimally invasive approach. The incision for a hand port is very small and provides the ability to perform blunt dissection, palpate major structures, and provide complex retraction. We believe that this adds an extra level of safety to complex laparoscopic cases and is an excellent technique for initial experiences. Additionally, the small incision for the hand port lies at the level of the pancreas neck and can accommodate an eviscerated tail of the pancreas

with or without the spleen. This allows for dissection of the mesenteric vessels as well as division of the pancreas and splenic vessels through a minilaparotomy in difficult cases that require dissection at this level.

This report of our initial experience with hand-assisted laparoscopic distal pancreatectomy shows that this operation is feasible and safe. The morbidity rate was similar to that reported in series of open operations, and no specific complications could be attributed specifically to laparoscopy. Pancreatic leaks occurred in two laparoscopic cases and one case converted to laparotomy, similar to the results for other series of open and laparoscopic cases [2, 4, 9, 10, 16, 18, 22, 24, 25, 29]. Two cases required conversion to formal laparotomy, similar to reports for other case series (Table 4). Blood loss was relatively low, and significant only in one case, resulting in a perioperative transfusion.

A common criticism of laparoscopic surgery is the prolonged operative time often necessary. However, in this series, the operation generally required about 3 h. We anticipate that this will improve with further experience. The most consistent benefit of laparoscopic surgery is less pain, less ileus, and a shorter hospital stay. This series demonstrated that in uncomplicated cases, patients tolerated a regular diet and were taking oral analgesics in 3 or 4 days. Although the median length of stay was 5.5 days for the whole group, it is probable that if no major morbidity occurs, many patients can be discharged earlier.

Splenic preservation is an important topic related to the performance of a distal pancreatectomy. Whereas we and others have shown that preservation of the spleen is associated with decreased perioperative morbidity, specifically infectious morbidity, others have found no difference. Studies addressing this issue are retrospective, with inherent limitations, and no prospective trials addressing this issue have been performed [1, 3, 15, 18, 22, 29]. Splenic preservation adds another level of complexity to an already difficult laparoscopic procedure, but it has been performed and reported for small numbers [8, 9, 11, 16, 24, 25]. The current series had a low rate of splenic preservation, but many of these cases involved solid tumors of unclear etiology and malignant lesions not amenable to splenic preservation. Two attempts at splenic preservation were made, and one was successful. With improvements in technique and familiarity with this new procedure, we anticipate that splenic preservation will be performed more often in appropriate cases.

In summary, we report our initial experience with hand-assisted laparoscopic distal pancreatectomy in a large number of cases performed in a relatively short period. With good surgical judgment, this operation is feasible and safe. According to this early analysis, laparoscopic distal pancreatectomy appears to have a morbidity rate similar to that of the open procedure, and it seems to be associated with a modestly reduced hospital stay and postoperative ileus.

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