SCIENTIFIC PAPER JSLS

Distal Pancreatectomy and Splenectomy: A Robotic or LESS Approach

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ABSTRACT

Introduction: The role and application of robotic surgery are debated, particularly given the expansion of laparoscopy, especially laparoendoscopic single-site (LESS) surgery. This cohort study was undertaken to delineate differences in outcomes between LESS and robotic distal pancreatectomy and splenectomy.

Methods: With Institutional Review Board approval, patients undergoing LESS or robotic distal pancreatectomy and splenectomy from September 1, 2012, through December 31, 2014, were prospectively observed, and data were collected. The results are expressed as the median, with the mean ± SD.

Results: Thirty-four patients underwent a minimally invasive distal pancreatectomy and splenectomy: 18 with robotic and 16 with LESS surgery. The patients were similar in sex, age, and body mass index. Conversions to open surgery and estimated blood loss were similar. There were two intraoperative complications in the group that underwent the robotic approach. Time spent in the operating room was significantly longer with the robot (297 vs 254 minutes, $P = .03$), although operative duration (i.e., incision to closure) was not longer (225 vs 190 minutes; $P = .15$). Of the operations studied, 79% were undertaken for neoplastic processes. Tumor size was 3.5 cm for both approaches; R0 resections were achieved in all patients. Length of stay was similar in the two study groups (5 vs 4 days). There was one 30-day readmission after robotic surgery.

Conclusions: Patient outcomes are similar with LESS or robotic distal pancreatectomy and splenectomy. Robotic operations require more time in the operating room. Both are safe and efficacious minimally invasive operations that follow similar oncologic principles for similar tumors, and both should be in the surgeon's armamentarium for distal pancreatectomy and splenectomy.

Key Words: Laparoendoscopic single-site surgery, Laparoscopic distal pancreatectomy, Robotic distal pancreatectomy and splenectomy.

INTRODUCTION

Recent advancements in technology have furthered the use of minimally invasive surgery. When applicable, minimally invasive surgery is preferred over open surgery, especially because of the shorter length of stay and reduced blood loss.[1–6] The location of the pancreas, particularly its proximity to vascular structures, makes the open approach the choice of many surgeons for diseases of the pancreas.[7] However, distal pancreatectomy and splenectomy does not involve anastomoses or complex reconstruction and therefore has led the way in minimally invasive pancreatic surgery. The first laparoscopic distal pancreatectomy was described in 1996.[7] Laparoscopy has been our choice for distal pancreatectomy for more than a decade.

Recent literature claims that laparoscopic distal pancreatectomy is now the gold standard for benign and low-grade malignant tumors because of decreased length of stay and blood loss in comparison with the open procedure.[1–5,8] The laparoendoscopic single-site (LESS) technique is not used as often with distal pancreatectomy and splenectomy. The literature details fewer than 20 uses of LESS for the operation.[9] It is well established that LESS is a safe, efficacious technique and is applicable to a wide range of general operations.[10–13] Since 2007, we have adopted this approach in other operations, and we began performing LESS distal pancreatectomy and splenectomy in 2010. The literature also reflects the first reported use of the LESS technique for distal pancreatectomy in 2010.[14] Robotics has been applied to distal pancreatectomy and splenectomy since 2000.[15] The literature pertaining to the robotic approach to this procedure is burgeoning, with most reports concentrating on cost effectiveness and feasibility of splenic preservation.

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Disclosure: Dr Ross reported receiving a grant from Covidien for a Women in Surgery Career Symposium and an Education Grant. Dr Rosemurgy reported receiving an education grant from Covidien.

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DOI: 10.4293/JSLS.2014.00246

As more options for minimally invasive techniques become available, assessments should be made to decide which of the approaches is better and the factors that should be considered before their application. Given that we are still in the early days of using the LESS and robotic surgical techniques, it seemed fitting that we review our recent experience. This study was undertaken to compare several outcome measures of LESS with those of robotic distal pancreatectomy and splenectomy. We hypothesized that most of the measures would be similar between the 2 approaches, but that operative time would be longer for the robotic approach.

METHODS

With Internal Review Board approval, the surgical outcomes of all patients undergoing minimally invasive distal pancreatectomy with splenectomy at our institution from September 1, 2012, through December 31, 2014, were reviewed. LESS distal pancreatectomy and splenectomy was not a novel procedure for the surgeons who performed the operations in this series. Before moving to our current institution, we had undertaken 12 LESS operations, but we excluded those patients from this single-institution study. Patients were selected to undergo LESS versus robotic surgery according to the surgeon's preference or the patient's request, with the recognized selection bias that the heavier patients were directed toward robotic surgery.

Demographic data were collected on each patient: sex, age, and body mass index (BMI) at the time of the operation. Preoperative imaging was obtained before each operation (computed tomography [CT], magnetic resonance imaging [MRI], or both, with or without endoscopic ultrasonography).

Surgical Techniques

We have described our open distal pancreatectomy and splenectomy approach in another publication.[16] The minimally invasive operation is much the same. The patient undergoing LESS distal pancreatectomy and splenectomy is laid in a slight reverse Trendelenburg position. A 1.2-cm incision is made at the umbilicus, and a 5-mm deflectable-tip laparoscope is introduced, to visualize the surgical field. The liver is retracted ventrally with the Snowden Pencer Articulating Pretzel Retractor (CareFusion Corp., San Diego, California). The short gastric vessels are divided with an electrosurgery unit (ESU). The gastrocolic omentum is opened to mobilize the stomach, and the splenic flexure of the colon is mobilized. The ESU is used to divide the lienorenal ligament. Full mobilization of the body and tail of the pancreas is achieved after division of the retroperitoneal attachments. The splenic artery and vein are ligated simultaneously, generally with a stapling device. If the operation is being undertaken for a neoplasm, the lesion is identified with the assistance of intraoperative ultrasonography, to ensure that the area of transection does not include tumor. The pancreas is then divided with an Endo GIA Stapler (Covidien, Mansfield, Massachusetts) with black or purple loads. The stapler loads are determined by the thickness of the gland: black loads for an extra-thick pancreas and purple loads for a pancreas of medium thickness. The remnant edge is oversewn. The specimen, including both the tail of the pancreas and spleen, is placed in an extraction bag. Depending on the size of the specimen, an extraction incision is placed along the lateral axillary line or in the suprapubic region, within the pubic hair line. If possible, the specimen is removed through the umbilicus. Close attention is paid to conserving the umbilical ring, to prevent postoperative occurrence of an umbilical hernia and to promote a desirable cosmetic outcome. The specimen is sent for frozen sectioning, to ensure adequate microscopic margins. The incision at the umbilicus is closed by using a figure-of-eight technique with absorbable Maxon sutures (Covidien).

In the robotic operation, the patient is placed in a slight reverse Trendelenburg position. First, an incision is made at the umbilicus and a 12-mm balloon-tip trocar is inserted to establish pneumoperitoneum. A deflectable-tip laparoscope is used to evaluate for metastatic disease. Two 8-mm robotic ports are placed at the right and left midclavicular line, 6 cm caudal to the umbilicus and 10 cm from the umbilical trocar, respectively. One 5-mm port is placed at the right anterior axillary line in the subcostal position for ventral retraction of the liver. As in the LESS approach, retracting the liver is important for adequate exposure of the stomach and take-down of the short gastric vessels. Once the gastrocolic omentum is divided to expose the pancreas, we reposition the liver retractor well to the right of the tumor to retract the stomach and left lobe of the liver together. One 12-mm port is placed at the left anterior axillary line, cephalad to the umbilicus and 10 cm from the robotic trocar. Robotic arms 1 and 2 are docked at the two 8-mm robotic ports, with an energy device in the arm on the right side and fenestrated bipolar forceps in the left arm. A 30° scope is used at the umbilicus port site (**Figure 1**). Once the robot is docked, the technique for the distal pancreatectomy and splenectomy is the same as that used in the LESS approach.

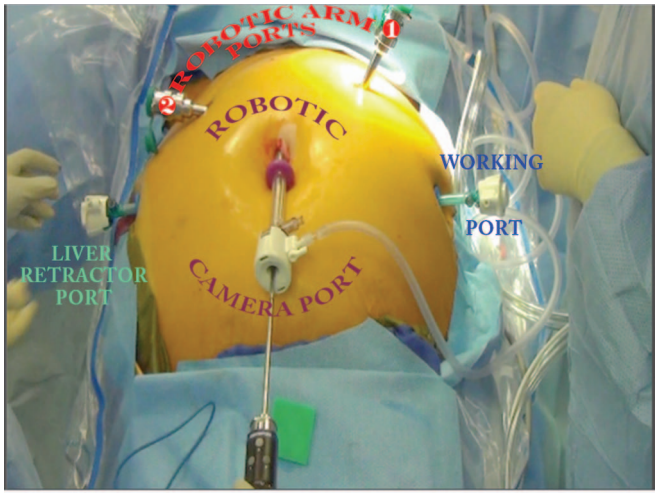

Figure 1. Placement of robotic and laparoscopic ports in a patient undergoing distal pancreatectomy and splenectomy.

After the operation, the patient is admitted for observation. Discharge criteria include adequate pain control and tolerance of oral intake. The patient is then seen in the outpatient clinic within 14 days of discharge. Short- and intermediate-term follow-up visits are arranged, and later follow-up is scheduled at 6-month intervals.

Operative time is defined as the time from skin incision to dressing application. Time in the operating room is defined as the moment the patient enters to when the patient is moved out of the operating room. Patients are considered to be readmissions if they were admitted to a hospital within 30 days of their discharge date. A postoperative complication was rigorously defined as any event occurring after the operation that led to morbidity of any type. Postoperative fistula was graded according to the International Study Group Pancreatic Fistula scale.[17] Postoperative complications were not limited to those that were iatrogenic.

Data were maintained on an Excel (Microsoft Corporation, Redmond, Washington) spreadsheet and analyzed by using the Wilcoxon matched-pairs test, the Mann-Whitney U test, or the Fisher exact test in GraphPad InStat, version 3.00 (GraphPad Software La Jolla, California). Significance was accepted at 95% probability. Where appropriate, for illustrative purposes, data are presented as the median (mean ± SD).

RESULTS

Thirty-four patients underwent a minimally invasive distal pancreatectomy and splenectomy from September 1, 2012, through December 31, 2014. The LESS approach was used in 16 patients (47%) and the robotic approach in 18 (53%). Forty-four percent of the patients were women, aged 66 (62 ± 15.3) years. BMI was 26 (27 ± 6.2) kg/m^2. Operating time was 221 (224 ± 66.1) minutes, whereas time spent in the operating room was 273 (296 ± 76.6) minutes. Estimated blood loss was 200 (476 ± 587.7) mL. Conversions to an open procedure occurred in 5 patients (15%). There were 2 intraoperative complications (6%) and 6 postoperative complications (18%) (**Table 1**). The operation was undertaken for neoplastic processes in 31 patients (91%) (**Table 2**). Tumor size was 3.5 (4.3 ± 2.4) cm. Length of stay was 4 (6 ± 3.8) days. One patient (3%) was readmitted.

Table 1.
Postoperative Complications

LESS (n = 13)	Robotic (n = 16)
1 Atrial fibrillation	1 Grade A pancreatic fistula
1 Colonic abscess	1 Stroke
1 Pneumonia	1 Left pleural effusion

Table 2.
Surgical Pathology

LESS (n = 16)	Robotic (n = 18)
3 Adenocarcinoma	4 Adenocarcinoma
3 Neuroendocrine	4 IPMN
2 IPMN	3 Neuroendocrine
2 Serous cyst adenoma	2 Mucinous cyst neoplasm
1 Mucinous cyst neoplasm	1 Adenosquamous
1 Splenic hemangioma	1 Pseudocyst
1 Splenule	1 Serous cyst adenoma
Converted to open:	Converted to open:
1 Adenocarcinoma	1 Mucinous cyst neoplasm
1 Mucinous cyst neoplasm	1 Serous cyst adenoma
1 Serous cyst adenoma	

IPMN = intraductal papillary mucinous neoplasm.

LESS Surgical Outcomes

Of the 16 patients undergoing LESS distal pancreatectomy and splenectomy, 6 were women (38%). The patients were 58 (60 ± 17.0) years of age and had a BMI of 25 (25 ± 4.5) kg/m^2 (range, 19–32 kg/m^2). Operative time was 190 (197 ± 40.7) minutes, and time spent in the operating room was 254 (259 ± 55.5) minutes. Estimated

blood loss was 150 (246 ± 263.9) mL. Three operations were converted to open because of the immense size of the tumor (11.7 cm), tumor invasion of the retroperitoneum, and difficulty achieving a dorsal plane for dissection of the distal pancreas. There were no intraoperative complications in patients who underwent LESS distal pancreatectomy and splenectomy. Three patients had postoperative complications (Table 1). Tumors were 3.5 (3.8 ± 2.99) cm but ranged from 0.8 to 11.7 cm. Eighty-eight percent (n = 14) of the patients underwent LESS distal pancreatectomy and splenectomy for a neoplastic process (Table 2). All patients had an R0 resection; however, 1 specimen had a margin positive for pancreatic intraepithelial neoplasms. Six (7 ± 6.6) lymph nodes were recorded in the pathology report. The length of stay was 4 (6 ± 3.8) days. No patients were readmitted after surgery. There were no differences in age, BMI, or tumor size in patients who underwent completed LESS procedures, when compared to those who had conversions to open.

Robotic Surgical Outcomes

Eighteen patients (9 women; 50%) underwent robotic distal pancreatectomy and splenectomy . The patients were 68 (67 ± 12.5) years of age and had a BMI of 28 (29 ± 7.1) kg/m^2 (range, 17–41 kg/m^2). The operating time was 225 (229 ± 57.8) minutes, and the time spent in the operating room was 297 (309 ± 46.4) minutes. Estimated blood loss was 175 (569 ± 757.4) mL. Two operations were converted to open: 1 for adequate visualization of a mass measuring 16 cm in its greatest dimension and 1 because the dissection was in proximity to the portal venous system. There were 2 intraoperative colotomies, but both were recognized during surgery and were repaired with no sequelae. Three patients had postoperative complications (Table 1), and 1 patient who had a conversion to open died. Overall tumor size was 3.5 (4.0 ± 2.6) cm (range, 0.7–16 cm); those in the operations completed robotically ranged from 0.7 to 10.5 cm. Ninety-four percent (n = 17) of the patients underwent the surgery for a neoplastic process (Table 2). Ten (9 ± 5.0) lymph nodes were recorded in the pathology reports. The length of stay was 5 (5 ± 2.8) days. One patient, who was readmitted (6%) for abdominal pain, fever, and fluid collection, had a grade A pancreatic fistula. Those whose operations were converted to open had a significantly larger tumor size (12.5 vs 3.5 cm). There was no difference in all other variables measured in the patients who underwent conversion to open.

The patients undergoing LESS versus robotic distal pancreatectomy and splenectomy were not significantly different, with the exception of time spent in the operating room. The time was significantly shorter with LESS (254 vs 297 minutes; $P = .03$).

DISCUSSION

In this detailed analysis of LESS and robotic distal pancreatectomy and splenectomy, we noted no clinical difference among the variables studied. The operations were undertaken safely and efficaciously.

Most of the procedures were for neoplastic processes. Tumor pathology was the sole reason for conversion to open procedures. Time in the operating room was significantly longer with the robotic approach, but the surgical time was shorter.

Most of the patients were middle-aged overweight men. In general, for patients who have a BMI within normal range, we prefer to offer the LESS approach, because the robotic arms may clash in a patient with a smaller body habitus, and because the technique provides a superior cosmetic outcome. BMI also guides our preference for robotic procedures in heavier patients. Furthermore, many thinner patients are focused on cosmesis with pancreatectomy—for example, a young lady with a pseudopapillary tumor. We initially thought that patients' concern about cosmetic effect would cause a selection bias, but there was no difference in BMI between those who underwent LESS and those who underwent robotic operations.

Prolonged time spent in the operating room for the robotic procedure is ascribed to the setup required for the robot. We recognize, however, that prolongation of the time spent in the operating room of more than 1 hour is costly, and we have worked to streamline the setup process by improving operating staff training and standardizing the setup procedures.

Given that this was a cohort study with unknown baseline risk for either treatment modality, we did not perform formal sample size calculations. However, for the observed results of the outcome of operative time with a sample size of 34, the study had 68% power to detect a considerable mean difference of 43 minutes, with a standard deviation of 9.1 minutes, between the treatment modalities.

In the case of the single postoperative death, the operation was initially robotic and was converted to open when it seemed that the dissection was too close to the portal venous system. Before surgery, we were aware of the presence of a replaced hepatic artery coming off the

superior mesenteric artery. Ultimately, an Appleby operation was performed. During surgery, a saphenous vein graft was undertaken, with good flow confirmed by Doppler ultrasonography. The patient died of liver failure 2 days after the operation.

In years past, the use of distal pancreatectomy and splenectomy has been reserved for benign and premalignant processes. The results in this study demonstrate that LESS distal pancreatectomy is safe and efficacious for cancer treatment and agree with findings in another study that looked at the feasibility of laparoscopic distal pancreatectomy and splenectomy for malignant tumors.[8] However, the latter study's recommendation was for the use of minimally invasive techniques for solitary metastasis to the pancreas. We believe that our data reflect that minimally invasive oncologic resections can be undertaken with salutary results. An adequate amount of lymphadenectomy was performed with these two approaches. Lymph nodes were harvested across the board, but the number documented in the pathology report depended on the diligence of the pathologist. This disparity continues to be a vexing problem for us. Intraoperative application of ultrasonography can be especially helpful in the evaluation of these pancreatic lesions and can further ensure a successful oncologic resection.

Most of the literature with regard to robotic distal pancreatectomy and splenectomy is limited to the study of cost and rate of preservation of the spleen. We do not practice splenic preservation, and we know of no results in a randomized control trial that support preservation versus resection. In our opinion, preservation increases risk (albeit low) and has a poorly documented benefit. Furthermore, the costs of splenic preservation in operating room time and blood loss do not justify general application. Recent studies have demonstrated that postsplenectomy vaccination for prophylaxis against postsplenectomy sepsis shows no significant decrease in risk after implementation of routine vaccination; furthermore, there is no randomized control trial to support postspelenctomy vaccination.[18] Therefore, our study is incongruous with others that reported a higher splenic preservation rate with robotic procedures.[19,20] A retrospective review comparing robotic with laparoscopic distal pancreatectomy found the robotic approach to be superior, because there were fewer conversions to open and the robotic approach could be applied to more malignant disease than the laparoscopic approach.[21]

In 2011, a study was published that reported that although length of stay is decreased in laparoscopic distal pancreatectomy, the readmission rate is significantly higher when compared to that of open distal pancreatectomy and splenectomy.[3] Our study demonstrates a lower readmission rate (6%) than the aforementioned study. Further a different study, reviewing the SEER (Surveillance, Epidemiology, and End Results) database, reported a 16% readmission rate after pancreatectomy in Medicare patients.[22] Our median patient age was 66 years, thus meeting Medicare requirements. Therefore, our readmission rates were again superior.

Overall, the conversion rate in our operations was 15%. Conversion to an open procedure should not be considered a failure, but rather good practice to ensure a safe and efficacious resection. Furthermore, operations that started as robotic and were converted to open involved excision of substantially larger masses than the median. Preoperative determination of tumor size should be undertaken when considering whether to use a robotic or an open approach. Although the evidence is anecdotal, we believe that an initial robotic approach allows for finer dissections with the assistance of 3-dimensional visualization; therefore, there are advantages to initial use of a minimally invasive approach.

CONCLUSIONS

This study demonstrates that the minimally invasive approach can be safely used for distal pancreatectomy and splenectomy for a variety of pancreatic diseases. Robotic and LESS operations can be used in the same extirpative operations that are undertaken with conventional laparoscopy, although long-term follow-up evidence is lacking. Furthermore, the data reflect that both approaches are safe and efficacious and that both should be in the surgeon's armamentarium. Careful patient selection may help to reduce the conversion-to-open rate, especially with preoperative determination of tumor size. The results of this study would be further supported by a randomized controlled trial to help elucidate whether there are in fact any differences between the two approaches; but, for many reasons, such a study will probably never be undertaken.

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