Surg Endosc (2001) 15: 1273–1276
DOI: 10.1007/s004640080054

Surgical Endoscopy
Ultrasound and
Interventional Techniques

Pancreatic complications following laparoscopic splenectomy

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Received: 8 June 2000/Accepted in final form: 15 November 2000/Online publication: 4 September 2001

Abstract
Background: Laparoscopic splenectomy (LS) has been widely accepted despite a paucity of outcome data. Therefore, we performed a review of LS to assess the pancreatic complications and outcomes associated with this procedure.
Methods: Ninety-four splenectomies were performed for a variety of hematologic disorders. The patient was placed in the lateral position, and three or four trocars were used.
Results: LS was completed successfully in 93 patients. One case was converted to an open splenectomy for suspected gastrotomy. Thirty of 32 patients with splenomegaly underwent successful LS. Fifteen patients (16%) had some evidence of pancreatic injury. Six patients had asymptomatic hyperamylasemia. An injury directly associated with an adverse outcome occurred in nine cases (9.5% overall); six patients had pancreatic collections, one had a pancreatic fistula, and two developed hyperamylasemia and pain altering the length of hospitalization. Four of these nine patients did not have elevated postoperative amylase levels and were readmitted with pancreatic complications.
Conclusions: LS can be performed for most pathologic conditions. Pancreatic injury is the most common morbidity associated with LS. The detection of hyperamylasemia can alert the surgeon to a pancreatic injury and alter postoperative management.

Key words: Pancreatic complications — Laparoscopic splenectomy — Pancreatitis — Morbidity

Elective splenectomy is typically performed for diagnostic and therapeutic purposes in hematological disorders. Due to advances in laparoscopic techniques and equipment, open splenectomy (OS) has now been superseded by laparoscopic splenectomy (LS) [9, 11, 16]. This rapid shift in operative approach has been facilitated by the use of stapling devices, ultrasonic shears, and lateral patient positioning [4, 7, 9, 10, 13]. Lateral positioning greatly improves visualization and allows atraumatic splenic retraction. However, regardless of operative approach, the attendant risks of splenectomy, including hemorrhage, overwhelming postsplenectomy infection, and pancreatic injury, remain.

Pancreatic injury is a potentially lethal complication known to occur at OS owing to the close anatomic proximity of the pancreatic tail and splenic hilum [1]. Given the known risk of pancreatic injury during OS, a similar occurrence may be anticipated with LS, and it is therefore rarely addressed independently in the laparoscopic literature. It is reasonable to assume that the incidence of pancreatic injury may be increased as a result of the same factors that have facilitated its success—lateral positioning and the use of stapling devices. The lateral position creates an altered orientation to both spleen and pancreatic tail, a situation that is initially unfamiliar to the surgeon accustomed to an anterior view. Additionally, although the use of the stapling device obviates the need for dissection in the splenic hilum, thus reducing inadvertent vascular injury, it may result in transection of the pancreatic tail. In contradistinction to OS, the early discharge allowed by LS may lead to the development of clinical symptoms in the outpatients. All of these considerations have impressed upon us the need to review our results with LS, focusing specifically on pancreatic injuries.

Methods

A retrospective review of all patients who underwent laparoscopic splenectomy (LS) between August 1995 and August 1999 was performed. A total of 94 patients underwent elective nontraumatic LS at the Cleveland Clinic. A staff general surgeon conducted the operation with the assistance of a laparoscopic fellow or senior level resident. Data collected prospectively included demographics, preoperative radiographic studies, operative time, length of hospital stay, postoperative serum amylase levels, complications, readmissions, and outcomes. Follow-up information was retrieved from the patient chart.

A pancreatic injury was deemed to occur in patients with either incidental hyperamylasemia or complications referable to the pancreas. The complications included peripancreatic fluid collections, pancreatic abscess, amylase-rich drain fluid, and atypical postoperative pain extending the length of hospitalization. Hyperamylasemia was defined as a serum amylase level greater than the reference range (0–137 IU/L).

Splenomegaly was defined as a cranio-caudal length >15 cm by preoperative radiographs, or a morcellated weight >600 g. Operative time was

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Table 1. Indications for splenectomy

Indication	*n* (%)
Hematologic	47 (50%)
ITP	39
TTP	3
Anemias	5
Malignancies	37 (40%)
Lymphoma	15
Leukemia	9
Splenomegaly	13
Other	10 (10%)
Total	94

defined as the length of time from incision to the reversal of anesthesia as noted in the operative report.

Our operative approach in the right lateral decubitus position has been previously described [13, 14]. Briefly, patients are placed in a complete lateral position and padded, with the operating table maximally flexed at the iliac crest. Dissection was done using sharp dissection or cautery and a Harmonic scalpel, and the splenic hilum was divided using the endoscopic stapler with vascular cartridge. Dissection at the splenic hilum included identifying both the vein and artery and firing the stapler across both these vessels. Individual skeletonizing of these vessels was not performed. The specimen was removed by placing the spleen in an impermeable bag and manually morcellating the spleen for removal. Routine drain placement was not done unless pancreatic injury was suspected.

Patients were placed on a regular nursing floor without nasogastric tubes. An oral diet was initiated on the day of surgery or 1st postoperative day and advanced as tolerated. Serum amylase and hemoglobin levels were checked on the 1st postoperative day. Patients were discharged once they were tolerating a regular diet and had adequate pain control with oral analgesics. Follow-up included an outpatient clinic visit with the attending surgeon within 3 weeks following discharge.

Results

Splenectomies were performed for a variety of pathologic conditions, as listed in Table 1. A total of 94 splenectomies were attempted. Ninety were done laparoscopically and three were done with hand assistance, achieving an operative success rate of 99%. One operation was started laparoscopically but converted to open surgery for a suspected gastrotomy (conversion rate of 1%). Forty-six patients (49%) had preoperative CT or ultrasound studies of the abdomen; splenomegaly was found in 25 of them (54%).

As seen in Table 1, the most common indication for splenectomy was a hematologic disorder, which was seen in 52 cases (55%). This included idiopatic immune trombocytopenic purpura (ITP) in 39 (41%) patients, trombotic thrombocytopenic purpurpa (TTP) in three patients (3%), and hemolytic anemia in 14 patients (5%). The other major group was composed of 37 patients (39%) treated for hematologic malignancy, including lymphoma in 15 cases (15%), leukemia in nine cases (9%), and splenomegaly suspected to harbor malignancy in 13 cases (14%). Splenomegaly was found in a total of 32 patients; 30 of these procedures (93%) were successfully completed laparoscopically.

The mortality and morbidity data are given in Table 2. Two patients (2%) died from nonpancreatic sepsis. Both patients were operated on for hematologic malignancy and succumbed to overwhelming postsplenectomy infection, one of fungemia.

Table 2. Complications

Complication	*n* (%)
Mortality	2 (2%)
Total morbidity	22 (23%)
Pancreatic injuries	15
Pneumonia	2
Atelectasis	2
DVT	1
Line sepsis	1
Relaparoscopy	1

The most common complication was pancreatic injury. Fifteen patients (16%) demonstrated either isolated hyperamylasemia or a pancreatic-associated complication, which altered expected recovery (Table 3). When patients with an uncomplicated recovery were compared with those who sustained a pancreatic injury, the mean operative time was longer (216 vs 157 min [$p = 0.015$]) and the relative proportion of patients with splenomegaly was higher (nine of 15 vs 23 of 79 [$p = 0.021$]). As expected, there was an increased length of hospital stay (6.8 vs 2.8 days [$p = 0.001$]) in patients with pancreatic injury. These data are presented in Table 3, which similarly shows that the presence of a minor pancreatic injury, defined as uncomplicated hyperamylasemia, did not alter the length of hospital stay when compared to the uncomplicated group. The differences in the presence of splenomegaly—increased operative time and length of stay—were totally accounted for by those patients with a major pancreatic injury who had persistent pain or pancreatic fluid collections.

An attempt was made to determine whether relative inexperience with the procedure increased the likelihood of a pancreatic injury. Issues regarding a learning curve bias are of interest with this operation since anatomic orientation is altered by lateral positioning In fact, there were more pancreatic injuries in the four procedures performed most recently as compared to the early half (Table 4).

Routine postoperative serum amylase values were obtained in 61 patients (64%). Eleven of these 61 patients (18%) had elevated values. None of these patients were known to have pancreatic disease; therefore, they were considered to have a pancreatic injury. Six of these 11 patients had hyperamylasemia without any change in their expected outcome; as previously noted, they were defined as having a minor injury. The remaining five patients with elevated postoperative amylase levels had complications referable to the pancreas.

One of these was suspected to have incurred a pancreatic injury intraoperatively, and a surgical drain was placed. This was the only patient with a postoperative drain, and amylase-rich pancreatic fluid was detected in the drain. The drain was removed on the day of discharge, day 4, when the output was <50 cc in the preceeding 24 hs.

Two patients had persistent pain in addition to the hyperamylasemia, which led to postoperative CT scans of the abdomen that confirmed the presence of intraabdominal fluid collections. In one of these patients, the abdominal pain resolved and the serum amylase eventually returned to normal. This patient was advanced slowly on his diet and discharged home without drain placement on postoperative day 4. The other patient was operated on for a fungal splenic

Table 3. Outcomes based on presence of pancreatic injury

	All patients (n = 94)	Splenomegaly (n = 32)	ITP (n = 39)	Mean operating time (min)	Mean hospital stay (days)
Uncomplicated	79	23^a	34	157^b	2.8^c
Pancreatic injury	15	9^a	5	216^b	6.8^c
Minor	6	3	2	227	2.3^c
Major	9	6	3	207	9.8

^{a} p = 0.021
^{b} p = 0.015
^{c} p = 0.001

Table 4. Learning curve

	Total pancreatic injuries (n = 15)	Minor injuries (n = 6)	Major injuries (n = 9)	Splenomegaly (n = 9)
First half	5	2	3	4
Second half	10	4	6	5

abscess in the setting of splenomegaly and acute lymphocytic leukemia (ALL). Persistent coagulopathy prohibited aspiration of a postoperative peripancreatic collection, and he succumbed to fungemia.

A fourth patient had persistent pain and hyperamylasemia, both of which gradually improved, allowing for discharge on the 3rd postoperative day. The final patient with hyperamylasemia was discharged on the 2nd postoperative day only to be readmitted 4 days later with an ileus. Management included nasogastric decompression and intravenous fluids for an additional 7 days.

In 34 patients, serum amylase levels were not obtained. Of these, four (12%) had pancreatic complications manifested by pancreatic fluid collections. Two of these patients were readmitted for abdominal pain and found to have normal serum amylase levels. Abdominal CT scans showed left upper abdominal fluid collections, which were drained percutaneously. The fluid was amylase-rich and only required a short period of outpatient drainage.

The third patient in this group presented with left upper abdominal pain and fever. Examination revealed incisional erythema and leukocytosis. The incision was opened and purulent fluid expressed. When a CT scan of the abdomen was obtained, it showed an intraabdominal abscess, which was also drained percutaneously. For the purposes of this study, it was presumed to be of pancreatic origin, although no amylase level was not obtained from the aspirated fluid. The patient remained in the hospital for 7 days and was discharged home after removal of the drain and the resolution of fever and leukocytosis.

The final patient in this group presented with generalized fatigue and fever 7 days following splenectomy for ALL and splenomegaly. A CT scan of the abdomen was obtained, a fluid collection was found, and a needle aspiration was performed. The fluid did not appear grossly infected and was high in amylase; however, a catheter was not placed. Despite negative cultures, the patient ultimately died from sepsis-associated heart failure.

Discussion

Laparoscopic splenectomy (LS) has supplanted conventional splenectomy for nearly all indications of elective splenectomy [2, 3, 4, 5, 6, 9, 11, 12, 13, 16]. This transition is similar to the one seen with laparoscopic cholecystectomy, although it has occurred at a rapid pace. Over a 3-year period at our institution, the number of LS has increased from 17% to 75% of all splenectomies. Factors that have combined to foster this transition include increased surgeon facility with laparoscopic techniques, patient acceptance, improved recovery, and improvements in operative technique. The operative adaptations that have led to the success of laparoscopic splenectomy are the result of a combination of laparoscopic innovations and product development. Lateral positioning [4, 9, 11, 13, 14], hand-assist devices [8], and endoscopic staplers [7] have greatly facilitated this change.

Our data confirm that pancreatic injury is the most common morbidity associated with LS. We purposely used the broadest definition of pancreatic injury to include uncomplicated hyperamylasemia. The inclusion of these patients is meant to alert the surgeon to the unsuspected pancreatic manipulation that occurs with the dissection or as a consequence of stapling the splenic hilum. In our series, only 64% of patients had serum amylase levels drawn because this was not routine in our postoperative management early on in our experience. Unfortunately, we do not know if any of these 33 patients had elevated postoperative levels.

Our review of this LS series indicates that 15% of patients will demonstrate some degree of pancreatic injury—half with simple hyperamylasemia, the others with a complicated course due to the pancreatic injury. This rate of pancreatic complications is higher than the one that has been typically reported for both open splenectomy [1, 2] and LS [3, 5, 12]. Pancreatic complications ranging from 0% to 6% are reported for both, although no prospective analysis has been performed for either operation. All of the asymptomatic patients with hyperamylasemia were detected by routine checks of postoperative amylase levels. Obtaining this value routinely may be more relevant in this new laparoscopic era owing to the expected rapid discharge of patients, typically on the 2nd postoperative day. In fact, half of the patients with a major injury required readmission to evaluate persistent abdominal pain. None of these patients had undergone routine tests of amylase levels, which might have alerted the surgeon to a potential problem and altered the postoperative routine, such as delaying oral intake. Of note, the patients with elevated postoperative amylase levels and persistent pain had a longer hospital stay due to slower diet advancement, but none of them developed fluid collections or required readmission.

The occurrence of a pancreatic injury must be due to patient disease and/or performance of the operation. The only contribution noted to be a factor of preexisting disease was the presence of splenomegaly. Patients with splenomegaly were significantly more likely to sustain a major pancreatic complication. Limited exposure to, or broad splenic hilum is the likely mechanism. Less than ideal placement of multiple staplers across the hilum in the setting of splenomegaly predisposes to injury of the pancreatic tail. Early use of a hand-assist device in the course of LS for splenomegaly may help to minimize this occurrence.

Technical factors that may influence the occurrence of pancreatic injury include surgeon experience and operative approach. Our data do not show any obvious improvement with greater experience. This unexpected finding is probably the result of the nonuniform and overlapping position along the learning curve that each of the five surgeons occupied during the study period. Experience with other advanced laparoscopic procedures would predict an improvement with time, but that has yet to be realized with LS. It is, however, plausible that the lateral positioning and the use of staplers, which greatly facilitate the performance of the operation, may result in an unalterable increase in pancreatic injuries. This may parallel the experience of bile duct injuries with laparoscopic cholecystectomy, which appear to occur at a slightly higher rate than is found in open cholecystectomy [15]. Once the surgeon becomes familiar with lateral exposure, the exposure of the pancreatic tail in LS is usually superior to that achieved with open splenectomy, but the use of bulky staplers across the hilum and incomplete dissection may predispose to pancreatic injury.

The two deaths in our series resulted from overwhelming postsplenectomy sepsis, not pancreatic injuries. Additional interventions were necessary in a few patients, an outcome that serves to underscore the importance of avoiding pancreatic injury whenever possible. It is important to reinforce the anatomic knowledge that the pancreatic tail is presumed to always be intimately associated with the splenic hilum. This knowledge should guide the surgeon to identify landmarks and always apply the stapler in close proximity to the hilum. Should a pancreatic injury be suspected at the conclusion of the operation, a closed-suction drain should be placed and exited through a trocar site. Following all LS, we recommend a routine check of amylase levels on postoperative day 1 to alert the surgeon to the possibility of a pancreatic injury. Postoperative management can then be better tailored to the patient's clinical course. If the patient's clinical picture suggests pancreatitis, there should be a slower advancement in diet and most likely further in-hospital observation.

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