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Single-incision laparoscopic splenectomy: preliminary experience in consecutive patients and comparison to standard laparoscopic splenectomy

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Abstract

Background—Since first being described in 2009, single-incision laparoscopic splenectomy has been described in a limited number of case reports and small case series. No studies have evaluated single-incision splenectomy in unselected patients, and outcomes of the procedure have not previously been compared to standard laparoscopy.

Methods—A retrospective review was conducted to evaluate all single-incision splenectomies performed by a single surgeon between June 2010 and June 2011. Additionally, patients who underwent standard laparoscopic splenectomy by surgeons in the same tertiary referral surgical oncology group were evaluated to serve as a control group. Demographic data, operative parameters, and postoperative outcomes were assessed.

Results—Eight patients underwent successful single-incision splenectomy during the study period without conversion to an open procedure or requiring additional ports. The median operative time was 92.5 min. There was 25 % morbidity and no mortality in the study group. Median length of stay was 4 days. Additionally, 18 patients who underwent standard laparoscopic splenectomy were evaluated for comparison. No significant differences were identified in the preoperative patient characteristics between the two groups. Single-incision splenectomy was associated with a shorter operative time (92.5 vs. 172 min,p= 0.003), lower conversion rate, equivalent length of stay, reduced mortality, similar morbidity, and comparable postoperative narcotic requirements.

Conclusions—Single-incision splenectomy is feasible, safe, and efficient in an unselected patient population in the hands of an experienced laparoscopic surgeon. The singleincision technique is comparable to standard laparoscopic splenectomy in terms of operative time and perioperative outcomes.

Keywords

Single-incision laparoscopy; Splenectomy

Laparoscopic splenectomy has emerged as an accepted alternative to conventional open splenectomy in selected cases of splenic disease [2, 12, 16]. When compared with open

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Disclosures

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splenectomy, laparoscopic splenectomy has been shown to be as safe and effective, with the added benefits of fewer complications, shorter postoperative stay, and faster recovery [15, 26]. More recently, the interest in increasingly minimally invasive surgery has led to the development of single-incision laparoscopic surgery or single-port access surgery. These techniques utilize a single incision through which the camera and working ports are placed to carry out dissection. The technique is gaining popularity in an array of procedures, including appendectomy [3], cholecystectomy [11], nephrectomy [20], partial and sleeve gastrectomy [14, 19], colectomy [6, 17], proctectomy [7], and inguinal hernia repair [4]. Since first being described in 2009 [1, 10, 24, 25], single-incision laparoscopic splenectomy has been described in a limited number of case reports [8–10, 18, 21] and small case series [13, 23,27]. These initial studies have evaluated single-incision splenectomy in highly selected patients [10, 23, 24], including only patients who were thin, without prior surgery, and with smaller spleens. Despite this preliminary data, several questions remain regarding the safety and efficacy of this approach, the optimal surgical technique, and whether there are benefits over standard laparoscopy [22]. Additionally, no comparison to standard laparoscopic splenectomy has been made in the literature to date.

This study seeks to evaluate single-incision laparoscopic splenectomy as a safe and feasible technique in an unselected patient population. Additionally, we compare pre- operative patient characteristics and outcomes to those of all patients who underwent standard laparoscopic surgery within our group in the past 3 years.

Methods

Patient selection and data collection

All patients who presented to a single surgeon between June 2010 and June 2011 with an indication for splenectomy underwent single-incision laparoscopic splenectomy after signing an informed consent form. All patients agreed to the single-incision technique. This was the operating surgeon's initial experience with single-incision splenectomy. In addition, patients who underwent standard laparoscopic splenectomy performed by five surgeons in the same tertiary referral surgical oncology group from June 2008 to June 2011 were evaluated to serve as a control group. All surgeons are from a single institution. Surgical residents were present for all cases but served only as assistants rather than as the primary operating surgeon. Patients were retrospectively identified by searching an electronic database. Medical records were reviewed to collect relevant information from the perioperative period. Operative reports were examined to obtain indications, operative time, incision length, need for conversion to open procedure or additional ports, estimated blood loss, and intraoperative complications. Pathology reports were reviewed to obtain spleen weight and final diagnosis. Daily progress notes were reviewed to document perioperative complications within 30 days and length of stay. Medication records were reviewed to determine narcotic use during the hospital stay. Complications were graded according to the Clavien-Dindo classification scheme of surgical complications [5], which grades complications on the basis of the intervention required to correct them. Grade I is any deviation from the normal postoperative course. Grade II is a complication that requires pharmacologic treatment. Grade III is a complication that requires surgical, endoscopic, or radiologic intervention. Grade IV complications are life threatening and require the patient to be in the intensive care unit. Grade V complications include mortality. This study was approved by the Institutional Review Board at the University of Pittsburgh and the University of Pittsburgh Medical Center (PRO11050618).

Surgical technique

Our single-incision laparoscopic splenectomy is performed with the patient's left side elevated at 90° on a beanbag. A 4 cm incision is created in the midclavicular line at the level of the umbilicus. The wound protector/sleeve of the Gelpoint device (Applied Medical, Rancho Santa Margarita, CA, USA) is placed through the wound and tightened. Three 10 mm trocars are placed through the Gelpoint and then attached to the wound protector (Fig. 1). A 45° 10 mm extra long laparoscope (Stryker, San Jose, CA, USA) is used for visualization. The patient is placed in a reverse Trendelenburg position. The splenic flexure of the colon is fully mobilized allowing access to the lesser sac. Using the LigaSure device (Covidien, Boulder, CO, USA), the gastrosplenic ligament is ligated, including the short gastric vessels. The splenorenal ligament is then ligated leaving intact only the superior-most portion of the splenophrenic ligament. Next, the hilum of the spleen is ligated with a vascular stapler. The spleen is placed into a laparoscopic bag and brought out through the wound protector. The spleen is morcellated, removed, and sent for pathology. The Gelpoint is replaced and the abdomen is reinsufflated. We inspect the surgical field for hemostasis. The wound protector and Gelpoint are then removed and the abdomen is deinsufflated. The fascia is reapproximated with simple interrupted sutures. Skin is closed with absorbable suture and skin glue.

Statistical analysis

Continuous data are presented as the mean ± standard deviation, median, and the range. Categorical variables are expressed as numbers and percentages for the group from which they were derived. Continuous variables were compared between the single-incision and standard laparoscopic splenectomy groups using an unpaired-sample Student *t* test and Mann–Whitney test. Results were considered statistically significant for $p < 0.05$.

Results

Eight patients underwent single-incision laparoscopic splenectomy between June 2010 and June 2011. Patient characteristics are listed in Table 1. Seventy-five percent of the patients who underwent single-incision splenectomy were female. The most common diagnoses requiring splenectomy were myeloproliferative disorders, but also included immune thrombocytopenic purpura (ITP), hemolytic anemia, and splenic cyst. ASA class ranged from 1 to 4, with a mean of 2.8. Fifty percent of the patients had prior abdominal surgery. The mean age was 51 years, the mean preoperative platelet count was 148, and the mean spleen weight was 423 g.

Operative data are given in Table 2. All patients were successfully completed with a single incision without conversion to open procedures or placement of additional ports. The median operative time was 92.5 min, with all procedures finished in <175 min. The median estimated blood loss for the group was 50 cc, with two patients requiring perioperative transfusion of red blood cells. The median length of stay was 4 days. There was no mortality. The complication rate was 25 %, with one patient developing a postoperative deep vein thrombosis (DVT) (Grade 2) and one patient requiring reintubation and ICU care for severe epistaxis related to thrombocytopenia (Grade 4).

To put our data into perspective, we also identified 18 patients who underwent standard laparoscopic splenectomy performed by surgeons within our tertiary referral surgical oncology group from June 2008 to June 2011. All preoperative patient characteristics of the single-incision patients were compared with those of the patients who underwent standard laparoscopic splenectomy and there were no statistically significant differences between the groups (Table 1). Operative outcomes were also evaluated(Table 2). The median operative

time was significantly higher in the standard laparoscopic group (172 vs. 92.5 min, $p = 0.003$). Median estimated blood loss did not significantly differ between the two groups (150 vs. 50 ml, $p = 0.25$). The percentages of patients requiring blood transfusions were similar between the groups. The median length of stay was 4 days in each group. Standard laparoscopic splenectomy was associated with a higher rate of conversion to open (33 vs. 0 %). There were two deaths (10 %) in the standard laparoscopic group compared with no mortality in the single-incision group. One patient died from postoperative hemorrhage on postoperative day 7. Another patient died on postoperative day 27 due to sepsis related to underlying hemophagocytic lymphohistiocytosis, or macrophage activation syndrome. The complication rates were similar in both groups, 25 % in the singleincision patients versus 28 % in the standard laparoscopic group. The use of in-hospital postoperative narcotics was evaluated in both groups of patients (Table 3). While single-incision patients used a lower total dose of narcotic medication, this did not reach statistical significance. A similar number of patients in both groups were treated with paravertebral lidocaine nerve blocks and ketorolac.

Discussion

This series demonstrates single-incision splenectomy to be safe in eight consecutive unselected patients with no intraoperative complications and no conversions to open splenectomy or placement of additional ports. Standard laparoscopic splenectomy is associated with a conversion to open rate of <10 %, with conversion most commonly required due to excessive blood loss [2, 12, 16]. The initial reports on single-incision laparoscopic splenectomy demonstrated a conversion rate from 10 [13] to 25 % [23]. We also demonstrated that single-incision laparoscopic splenectomy is efficient. Our mean operative time of 102 min is lower than the times published for standard laparoscopic splenectomy [2, 12, 16] and is comparable to the operative times in case series on single-incision splenectomy [13, 23,27].

Previous literature has described the use of single-incision splenectomy in a selected patient population. This is an understandable and necessary precaution while the safety of single-incision techniques is established. However, prior to the widespread application of single-incision procedures, further studies are required to demonstrate thatthis technique can be applied to patients who present in a typical practice. Our series demonstrates that single-incision splenectomy is safe and feasible in an unselected patient population. Our data demonstrate that the technique can be applied to a diverse patient population, including patients with prior surgery (50 % of patients in this study), who are obese (BMI up to 41), have medical comorbidities (ASA up to 4), have larger spleens (up to 1,400 g), and have severe thrombocytopenia (preoperative platelet count as low as 3). While these examples represented the extremes in our population, these types of patients are seen in everyday practice.

The use of a single incision for laparoscopic surgery minimizes abdominal trauma and has the theoretical advantages of shorter postoperative stay, reduced postoperative pain, and fewer complications. No prior studies have compared single-incision laparoscopic splenectomy to standard laparoscopy. In this series we compared the initial one-year experience of a single surgeon performing singleincision laparoscopic splenectomy to a surgical oncology group’s experience over 3 years. The 3-year period was chosen to allow for an adequate number of standard laparoscopic splenectomy cases for comparison. All surgeons in the group are highly experienced laparoscopic and robotic surgeons and routinely perform standard laparoscopic splenectomy. There were no differences in preoperative patient characteristics between the two groups. Single-incision laparoscopic splenectomy was associated with a significantly lower conversion to open rate, shorter

operative time, and similar median estimated blood loss. Morbidity and mortality were statistically equivalent for the two groups. The shorter operative time in the singleincision group is difficult to interpret and may reflect different operative speeds among individual surgeons performing standard laparoscopic splenectomy. All cases in the single-incision group were performed by one surgeon, while the laparoscopic splenectomies were performed by five different surgeons. Analysis of postoperative pain medication requirement revealed that the single-incision patients required fewer narcotics, but this did not reach statistical significance, likely due to the small numbers of patients included in this study. Overall, our series demonstrates that single-incision splenectomy is at least equivalent to standard laparoscopic splenectomy.

One of the greatest challenges to more widespread use of single-incision splenectomy is the greater technical demands of the operation. For single-incision techniques in general, dissection and exposure are more difficult to perform due to loss of triangulation and decreased range of motion to maneuver instruments. Single-incision splenectomy has even greater technical demands because solid organs such as the spleen cannot be grasped and retracted. Several authors have shared their techniques to circumvent this problem. Srikanth et al. [21] describe the use of a gastric traction suture to aid in exposure. In the largest series in the literature on single-incision splenectomy, Misawa et al. [13] describe the use of the “tug-exposure technique” in which a cloth tape is introduced intraperitoneally to encircle and provide traction around the splenic hilum in ten patients. In addition to the challenges encountered with a normal spleen, patients with splenomegaly present even greater difficulty to completing the splenectomy as a single-incision technique. The largest spleen removed with a single incision in this series weighed 1,400 g. Further study is required to establish what the upper limit for spleen weight should be to complete the operation safely and to establish the optimal surgical approach.

This study has several limitations. It is a retrospective study with a small number of patients. It also compares only a single-surgeon’s experience with single-incision splenectomy to that of a group of surgical oncologists. This analysis was intended to serve as a global control of patients undergoing laparoscopic splenectomy rather than a direct case-controlled comparison. Because this study examines the results of a surgeon with advanced training and experience in minimally invasive surgical oncology, the outcomes may not be representative of those obtained by the general surgeon population. Nevertheless, the study does demonstrate that the procedure is feasible in treating unselected patients meeting indications for splenectomy in the hands of experienced surgeons.

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Fig. 1.
Gelpoint device (Applied Medical, Rancho Santa Margarita, CA, USA) utilized for single-incision splenectomy in our series

Table 1

Characteristics of patients who underwent single-incision and standard laparoscopic splenectomy

	Single incision (*n* = 8)	Standard lap (*n* = 18)	*P*
Gender [*n* (%)]			
Male	2(25)	7 (39)	
Female	6(75)	11 (61)	
Diagnosis [*n* (%)]			
Myeloproliferative disorder	3 (38)	8 (44)	
ITP	2 (25)	6 (33)	
Hemolytic anemia	2 (25)	2(11)	
Splenic cyst	1 (12)	1 (6)	
Splenic infarction	0(0)	1 (6)	
ASA [*n* (%)]			
1	1 (12)	0 (0)	
2	2 (25)	6 (33)	
3	3 (38)	8 (44)	
4	2 (25)	4 (22)	
Prior abdominal surgery [*n* (%)]	4 (50)	9 (50)	
Age			
Mean ± SD	51.4 ± 21.6	49.3 ± 16.6	0.81
Median (range)	56 (17–75)	47 (25–77)	
Body mass index			
Mean ± SD	27 ± 8.1	26.9 ± 5.5	0.98
Median (range)	26.9 (14.7–41.4)	25.4 (19.7–34.1)	
ASA			
Mean ± SD	2.8 ± 1.0	2.9 ± 0.8	0.74
Median (range)	3 (1–4)	3 (2–4)	
Platelet count			
Mean ± SD	148.1 ± 118.4	157.9 ± 123.4	0.85
Median (range)	135 (3–355)	121.5 (20–497)	
Spleen weight			
Mean ± SD	422.9 ± 443.6	473.8 ± 331.8	0.77
Median (range)	268.5 (131–1,442)	422 (60–1,126)	

ITP immune thrombocytopenia, *ASA* American Society of Anesthesiologists

Table 2

Operative outcomes for single-incision and standard laparoscopic splenectomy

	Single incision (*n* = 8)	Standard lap (*n* = 18)	*P*
Operative time			
Median (range)	92.5 (79–175)	172 (83–364)	0.003
Mean ± SD	101.6 ± 31.2	185.9 ± 76.6	
Estimated blood loss			
Median (range)	50 (25–200)	150 (0–1,700)	0.25
Mean ± SD	78.9 ± 68.2	398.1 ± 494.3	
Length of stay			
Median (range)	4 (2–11)	4 (3–10)	0.51
Mean ± SD	4.4 ± 2.8	5.1 ± 2.5	
PRBC transfusion [*n* (%)]	2 (30)	6 (33)	
Conversion to open [*n* (%)]	0 (0)	5 (28)	
Mortality [*n* (%)]	0 (0)	2 (33)	
Morbidity [*n* (%)]	2 (25)	5 (28)	
Complications (Clavien–Dindo classification)			
Grade 1	0 (0)	0 (0)	
Grade 2	1 (50)	3 (50)	
Grade 3	0 (0)	0 (0)	
Grade 4	1 (50)	0 (0)	
Grade 5	0 (0)	2 (33)	

PRBC = packed red blood cells

Table 3

Narcotic requirements for patients who underwent single-incision and standard laparoscopic splenectomy

Postoperative pain control	**Single incision (*n* = 8)**	**Standard lap (*n* = 18)**	***p***
Dilaudid equivalents			
Mean ± SD	12.7 ± 9.7	17.2 ± 12.7 0.42	0.42
Median	10.6	15.8	
Toradol [*n* (%)]	2 (30)	3 (20)	
Paravertebral nerve blocks [*n* (%)]	4 (60)	6 (40)	