Surgical Endoscopy (2019) 33:1298–1303
https://doi.org/10.1007/s00464-018-6394-7

2018 SAGES ORAL

Laparoscopic versus open splenectomy for splenomegaly: the verdict is unclear

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Received: 24 April 2018 / Accepted: 20 August 2018 / Published online: 27 August 2018

Abstract

Background The benefits of laparoscopic splenectomy (LS) over open splenectomy (OS) for normal-sized spleens have been well documented. However, the role of laparoscopy for moderate and massive splenomegaly is debated.

Methods A retrospective review of patients undergoing elective splenectomy at one institution from 1997 to 2017 was conducted. Moderate and massive splenomegaly was defined as splenic weight of 500–1000 g and greater than 1000 g, respectively. We performed a 1:2 matching of laparoscopic to open splenectomy to control for differences in splenic weight. Differences in perioperative morbidity (infection, thromboembolism, reoperation, readmission), intraoperative factors (blood loss, operative time), length of stay, and mortality were examined.

Results A total of 491 elective splenectomies were identified. 268 cases were for splenic weights greater than 500 g. After a 1:2 matching of LS:OS, we identified 22 LS and 44 matched OS for moderate splenomegaly. The LS group had longer mean operative times (178 vs. 107 min, $p < 0.01$), with similar length of stay and blood loss. For massive splenomegaly, 26 LS were identified and matched to 52 OS. LS had longer mean operative times (171 vs. 112 min, $p < 0.01$) and higher readmission rates (27% vs. 6%, $p < 0.05$). Other factors and outcomes did not differ between LS and OS for moderate or massive splenomegaly. The conversion rate for LS was higher for massive versus moderate splenomegaly, but was not statistically significant (35% vs. 14%, $p = 0.09$).

Conclusions LS for moderate and massive splenomegaly is associated with longer operative times. Other perioperative outcomes were comparable to OS, with no demonstrated benefits for LS. Although LS may be a feasible approach to moderate and massive splenomegaly, its benefits require further clarification in this patient population.

Keywords Splenectomy · Splenomegaly · Laparoscopic splenectomy · Massive splenomegaly · Moderate splenomegaly

Laparoscopic splenectomy has become the standard approach for surgical resection of the spleen for a variety of indications since it was first introduced in the early 1990s [1–3]. When compared to open splenectomy (OS), laparoscopic splenectomy (LS) has been associated with less postoperative pain, shorter length of hospital stay, less intraoperative blood loss, and less overall morbidity [4–6]. The advances in technology have increased the applicability of the laparoscopic technique to a variety of indications including splenomegaly, which was once considered a contraindication for the laparoscopic approach.

Several groups have proposed that the laparoscopic approach for splenomegaly is comparable and if not, superior to the open approach when measuring perioperative outcomes [7–9]. Others have shown that the laparoscopic approach for smaller degrees of splenomegaly is safe, but is associated with increased morbidity and conversion rates for massive splenomegaly, suggesting that the benefits of laparoscopy become limited with increasing size of the spleen [10–14]. This is due to the technical challenges involved with a large spleen such as difficulty manipulating the organ, decreased visualization of the operative field, and difficulty with extraction of the larger specimen [8, 15]. However, some groups have advocated for the safety and superior outcomes of LS even for massive splenomegaly with shorter lengths of stay and reduced blood transfusion requirements compared to the open approach, although operative times were longer [8, 13, 15, 16]. In contrast, others have advised

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caution with the laparoscopic technique for massive splenomegaly due to findings of higher morbidity, higher conversion rates, and longer hospital stay [10–12].

The results of these studies have made the role of laparoscopy in the setting of different degrees of splenomegaly unclear and currently no consensus exists. We therefore analyzed our institution's 20-year data on splenectomy for moderate and massive splenomegaly, comparing the perioperative outcomes of the laparoscopic and open approach.

Materials and methods

A retrospective analysis was performed on patients undergoing elective splenectomy for a variety of benign and malignant diagnoses at one institution from January 1997 to October 2017. The study was approved by the Partners HealthCare Systems Institutional Review Board. Laparoscopic cases were defined as those cases during which the spleen was fully mobilized and the vascular pedicle divided laparoscopically. Cases that required a subsequent extension of the incision for specimen removal were still included into the LS group; however, cases in which a hand had to be introduced to the abdominal cavity to help with mobilization were classified as Hand-Assisted Laparoscopic Splenectomy (HALS), and were excluded.

A total of 491 elective splenectomies were initially identified and their medical records were reviewed. Moderate and massive splenomegaly was defined as splenic weight of 500–1000 g and greater than 1000 g, respectively at final pathology [17]. Patients undergoing splenectomy for trauma were excluded. Two hundred and sixty-eight patients had undergone elective splenectomy with recorded splenic weights greater than 500 g. Fifty-two patients with moderate or massive splenomegaly had been treated with LS and 220 patients with OS. After analysis of the overall cohort, we found that there were more patients with large spleens and outliers with very large spleens in the OS group. Therefore, to control for the differences, we performed a 1:2 matching of laparoscopic to open splenectomy based on splenic weight. This resulted in 22 patients in the LS group and 44 patients in the OS group for moderate splenomegaly and 26 patients in the LS group and 52 patients in the OS group for massive splenomegaly. Perioperative outcomes such as morbidity (infection, thromboembolism, reoperation, readmission), intraoperative factors (blood loss, operative time), length of hospital stay, and mortality between LS and OS groups were examined and compared for moderate and massive splenomegaly. Infection was defined as any postoperative infectious process including surgical site infections, pneumonia, intra-abdominal abscesses, and sepsis. Thromboembolism included deep venous thrombosis of lower extremities, pulmonary embolism, and portal vein thrombosis.

Descriptive statistics were reported as means with ranges and percentages. Statistical analysis was performed using t test for continuous data and Fisher's exact or χ^2 test for categorical data with $p < 0.05$ to determine statistical significance.

Results

Moderate splenomegaly

A total of 66 patients undergoing splenectomy for moderate splenomegaly (splenic weight of 500–1000 g) were matched and included, 22 in the LS group and 44 in the OS group (Table 1). Patients undergoing LS were older with a mean age of 60.8 years (37–82 years) compared to 52.2 years (25–77 years) in the OS group. The mean splenic size was 677.6 g (570–984 g) and 689.5 g (508–1000 g) for the LS

Table 1 Patient characteristics

	Laparoscopic splenectomy (LS)	Open splenectomy (OS)	p
Moderate splenomegaly (splenic weight of 500–1000 g)			
Number of patients	22	44	
Age, years	60.8 (37–82)	52.2 (25–77)	0.02*
Gender, F:M	11:11	21:23	NS
BMI, kg/m^2	27.1 (14.8–39.7)	26.4 (17.9–36.9)	NS
Splenic size, g	677.6 (570–984)	689.5 (508–1000)	NS
Massive splenomegaly (splenic weight > 1000 g)			
Number of patients	26	52	
Age, years	58.5 (25–87)	60.6 (29.3–83)	NS
Gender, F:M	17:9	38:14	NS
BMI, kg/m^2	27.9 (20.4–39.3)	25.4 (18.8–39.9)	NS
Splenic size, g	1754.9 (1032–3800)	1755.6 (1034–3850)	NS

*Indicates statistical significance ($p < 0.05$)

and OS group, respectively ($p = 0.73$). The mean operative time was significantly longer for LS than for OS (178.4 min vs. 107.2 min, $p < 0.01$). The intraoperative blood loss was greater in the LS group (720.5 ml vs. 367.1 ml), but this did not reach statistical significance ($p = 0.06$). There was no difference in hospital length of stay (5.5 days for LS vs. 6.5 days for OS, $p = 0.54$), perioperative morbidity (41% for LS vs. 23% for OS, $p > 0.05$), or mortality (5% for LS vs. 5% for OS, $p > 0.05$) (Table 2). The conversion rate for LS in this cohort was 14%.

Massive splenomegaly

A total of 78 patients undergoing splenectomy for massive splenomegaly (splenic weight > 1000 g) were matched and included, 26 in the LS group and 52 in the OS group (Table 1). There were no differences in preoperative patient factors between the two groups. The mean splenic size was 1754.9 g (1032–3800 g) for LS and 1755.6 g (1034–3850 g) for OS ($p = 0.99$). The mean operative time was significantly longer for LS than for OS (170.8 min vs. 112.1 min, $p < 0.01$). There was no statistically significantly difference between groups for intraoperative blood loss (606.6 ml for LS vs. 588.5 ml for OS, $p = 0.94$) or length of hospital stay (4.6 days for LS vs. 5.7 days for OS, $p = 0.12$). Comparison of postoperative complications demonstrated a significantly higher readmission rate for patients undergoing LS than OS (27% vs. 6%, $p < 0.05$). There was no difference between groups in other measured postoperative factors (Table 3). The conversion rate for LS was 35%.

Laparoscopic splenectomy for moderate versus massive splenomegaly

A further analysis comparing LS for moderate and massive splenomegaly was performed (Fig. 1). There were no significant differences in preoperative factors between the two groups except for splenic size as expected (Moderate splenomegaly, $n = 22$: 677.6 g vs. Massive splenomegaly, $n = 26$: 1754.9 g, $p < 0.05$). Comparison between the two groups did not demonstrate any difference in intraoperative blood loss, operative time, length of hospital stay, or postoperative outcomes. The conversion rate was lower in the moderate splenomegaly group compared to the massive splenomegaly group, but this did not reach statistical significance (14% vs. 35%, $p = 0.09$).

Table 2 Operative characteristics for moderate splenomegaly

Results	Laparoscopic splenectomy ($n = 22$)	Open splenectomy ($n = 44$)	p
Operative time, min	178.4 (114–296)	107.21 (38–288)	< 0.01*
Intraoperative blood loss, ml	720.5 (100–3000)	367.1 (50-2200)	0.06
Length of hospital stay, days	5.5 (2–25)	6.5 (3–48)	NS
Postoperative morbidity	9 (41%)	10 (23%)	NS
Infection	3 (14%)	1 (2%)	NS
Thromboembolism	3 (14%)	5 (11%)	NS
Reoperation	0 (0%)	0 (0%)	NS
Readmission	2 (10%)	2 (5%)	NS
Death	1 (5%)	2 (5%)	NS

*Indicates statistical significance ($p < 0.05$)

Table 3 Operative characteristics for massive splenomegaly

Results	Laparoscopic splenectomy ($n = 26$)	Open splenectomy ($n = 52$)	p
Operative time, min	170.8 (70–291)	112.1 (45–322)	< 0.01*
Intraoperative blood loss, ml	606.6 (5–2400)	588.5 (5–9500)	NS
Length of hospital stay, days	4.6 (2–12)	5.7 (3–27)	NS
Postoperative morbidity	11 (42%)	14 (27%)	NS
Infection	7 (27%)	6 (12%)	NS
Thromboembolism	5 (19%)	4 (8%)	NS
Reoperation	0 (0%)	1 (2%)	NS
Readmission	7 (27%)	3 (6%)	NS
Death	0 (0%)	1 (2%)	NS

*Indicates statistical significance ($p < 0.05$)

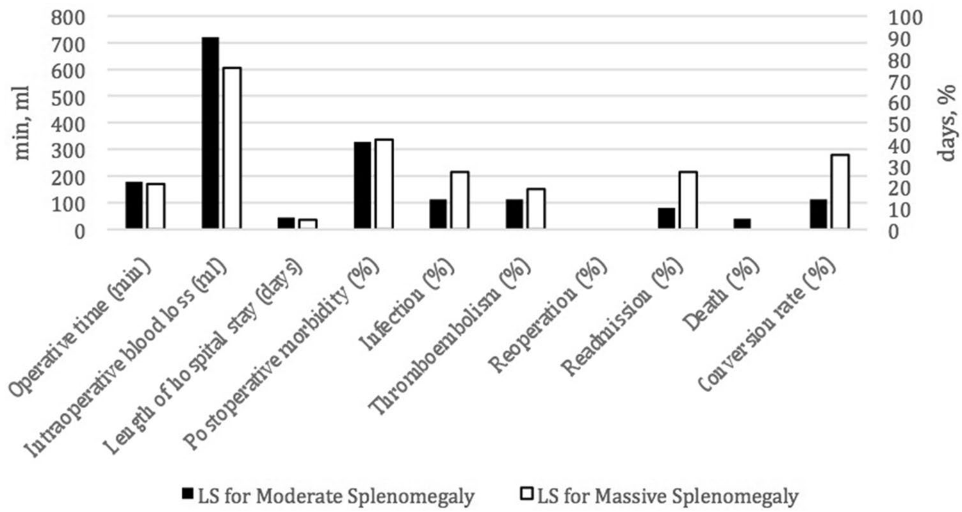

Fig. 1 Comparison of laparoscopic splenectomy for moderate and massive splenomegaly

Discussion

Our study comparing open and laparoscopic splenectomy for moderate and massive splenomegaly did not show a clear advantage of the laparoscopic approach over the open technique. The analysis of our data demonstrated that operative times for LS was significantly longer than OS for both moderate and massive splenectomy, LS for massive splenomegaly was associated with significantly higher readmission rates compared to OS, and overall morbidity rates showed a trend towards a higher rate for LS in both splenic size groups, although this did not reach statistical significance. There were no other significant differences in regards to intraoperative blood loss, length of hospital stay, postoperative morbidity, or mortality when comparing LS to OS.

Laparoscopic splenectomy has become the recommended approach for normal-sized spleens with a high penetration of its use in this population over the years [18, 19]. However, LS in conditions associated with splenomegaly has been less wide spread. In part, this is due to contrasting outcomes data on the role of LS in splenomegaly, which has led to a lack of consensus on the standard operative technique. Targarona and colleagues have been proponents of the use of LS for all splenectomies regardless of size [7, 8]. They categorized patients into three different groups according to splenic weight (group 1 = < 400 g, group 2 = 400–1000 g, group 3 = > 1000 g) and found that although operative time for LS was significantly longer with larger spleens, there was no difference in transfusion rate, length of stay, severe morbidity, or conversion rate between the groups [7]. They also conducted another study and found that for spleen weights of 400–1000 g and > 1000 g, LS had similar transfusion rates, morbidity, and analgesic requirements as OS with significantly shorter length of hospital stay [8]. Other proponents of LS for splenomegaly have demonstrated similar results with LS associated with less perioperative morbidity, quicker recovery, and less intraoperative blood loss in exchange for longer operative times [7–9, 13–16]. Investigators of these studies suggest that splenomegaly should not be a contraindication for LS.

However, other groups have advised caution in the utilization of LS for splenomegaly based on their results showing increased perioperative morbidity in this population [10–14]. Patel and colleagues found that patients with spleens > 1000 g, compared to patients with spleens < 1000 g, had significantly increased postoperative morbidity and length of stay [11]. Splenic weight was reported to be the most powerful predictor of morbidity and patients with spleen weight > 1000 g had a 14 times greater likelihood of a postoperative complication compared to the < 1000 g group. Based on these results, Boddy and colleagues compared LS and OS for spleens greater than 1000 g and showed that the OS group had shorter operative time, less intraoperative blood loss without an increase in perioperative morbidity or hospital length of stay [12]. Of note, their average spleen weight was 2,000 g and 2,447 g for the LS and OS group, respectively, which is larger than most other studies. However, they concluded that when splenic weight is expected to be greater than 1000 g, LS should be used with caution and suggested the open approach be used in this population routinely.

Given these differing findings, some guidelines such as the European Association for Endoscopic Surgery (EAES) support the use of LS for splenomegaly, defined as spleen size of up to 15 cm in maximal diameter or spleen weight of up to 1000 g, but do not recommend its use in larger spleens due to higher complication, morbidity, and conversion rates [19, 20]. However, in our sub-analysis comparing LS for moderate and massive splenomegaly, we did not identify any significant difference in intra or postoperative morbidity or mortality between the two groups. The conversion rate was higher in the moderate splenomegaly group, but this was not statistically significant. These findings suggest that LS in patients with spleens greater than 1000 g is not associated with higher complication rates or morbidity when compared to moderate splenomegaly and therefore, can be considered in these patients (Fig. 1).

Our study demonstrated that with the exception of longer operative times, there were no significant differences in outcomes for LS in patients with moderate splenomegaly. This supports the findings of other investigators advocating for the safety of LS in this population. However, we were not able to reproduce the advantages of LS such as shorter length of hospital stay and decreased intraoperative blood loss. In the massive splenomegaly group, although operative time and readmission rates were higher for LS compared to OS, other intraoperative and postoperative outcomes were similar as well. This finding supports the feasibility and safety of LS in patients with spleens greater than 1000 g, but does not suggest its superiority or advantage over OS.

The conversion rate for LS in our study was 14% and 35% for moderate and massive splenomegaly, respectively. These conversion rates are slightly higher than others; however, it is difficult to directly compare the reported rates due to widely differing classifications of splenic weight groups in the various studies [7–9, 11, 12, 15, 21]. The mean splenic weights in our LS groups for moderate and massive splenomegaly groups were 677.6 g and 1754.9 g, respectively, which is higher than some of the other reports and may account for the higher conversion rate.

The limitations of our study are attributable to the traditional flaws of a retrospective review. Selection bias and other confounders were unavoidable due to the study design. For example, we were unable to capture the impact of certain diagnoses that may have influenced the postoperative outcomes as well as the effect of the surgical approach on other factors such as postoperative pain management, return to normal activity, and quality of life. Also, although our data were collected over a 20-year period, the included sample size was small. This reflects the scarcity of the disease process eligible for elective operative intervention. However, our sample size is comparable and if not, larger than many other reports. Another limitation to our study and other studies comparing OS and LS is the inaccuracy and method of splenic size measurement. In most cases of LS, the spleen is morcellated to remove the specimen through a smaller incision. It has been suggested that morcellation of the spleen underestimates the weight of the spleen at pathology [22]. The variability in splenic weight measurements has led some investigators to recommend that splenic size be determined and categorized by computed tomography (CT) or ultrasound (US) [11, 15, 19]. The EAES defines splenomegaly as a maximum splenic diameter exceeding 15 cm and massive splenomegaly as maximum splenic diameter exceeding 20 cm [19]. Unfortunately, we did not have imaging data available for all of our cases and were unable to use splenic size to categorize our patients. Preoperative measurement of the spleen with imaging may be a more practical method to determine the appropriate operative approach and should be performed routinely in patients undergoing surgical planning for splenomegaly. Another factor to be considered, is that intraoperative blood loss may be artificially higher in LS, as during morcellation of the spleen there is release of intra-splenic blood which is often suctioned out and may be counted as intraoperative blood loss, while in OS, this volume is often removed with the specimen.

Our study analyzed data over a 20-year period and our findings suggest that although LS has comparable perioperative outcomes to OS for moderate and massive splenomegaly, there was no demonstrable advantage of LS over OS. However, much has changed over time in the field of laparoscopic and minimally invasive surgery. Laparoscopic surgery has gained more widespread use with increasing utilization of its technique by surgeons and application to more complex procedures and there have been significant advancements in technology with staplers and coagulation devices. Cases that were once considered contraindications for laparoscopic surgery have adopted the technique as the standard approach such as for mild splenomegaly. Over time, surgeons have gained more experience and familiarity with the laparoscopic technique and have demonstrated its benefits in a variety of fields. We anticipate that the outcomes for LS in patients with splenomegaly will continue to improve with increased experience and advancements in devices for handling and retrieving large specimens. Further investigation and analysis of current experiences to clarify the benefits of its approach in this population is encouraged.

Acknowledgements This study was possible by grant support from the Foundation for Surgical Fellowships (FSF) (for RDS).

Compliance with ethical standards

Disclosures Ali Tavakkoli receives a grant from Siemens and is a paid consultant for Medtronic. Reuben Shin, Roger Lis, Nicholas Levergood, Brent Shoji, and David Brooks have no conflict of interest or financial ties to disclose.

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