

Splenomegaly as A Complication Factor in Laparoscopic Splenectomy: Outcomes from 100 Cases by A Single Surgeon

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1. Abstract

1.1. Introduction: Laparoscopic Splenectomy (LS) is believed to be the gold standard in spleen surgery and is considered to be relatively safe with minimal complications, depending on the technology at hand, and the experience of the surgeon.

1.2. Methods: This paper presents data from 100 LS procedures under a single general surgeon over the last 17 years performed in a regional hospital.

1.3. Results: Of these 100 patients, female to male ratio was 1.5:1. Median age was 57.5 (15- 91) years. Most common indications for splenectomy were Benign Haematological Diseases (BHD), Group 1: (88%) largely idiopathic thrombocytopenic purpura (66); Group 2 had Malignant Haematological Disease (MHD) (7%); Group 3 sarcoidosis (5%). The average operation time was 107 (30-210) min. Splenunculi were found during LS in 4%. Only one LS was converted to open. Mean weight of spleen was 237 grams. There were seven cases of moderate splenomegaly (weight \geq 500g). There were significant differences between the three groups in spleen weights ($p < 0.0001$) and this appeared to be linked with certain complications. Early complications were haemorrhage from the short gastric artery (2%), pneumonia, upper gastrointestinal haemorrhage and portal vein thrombosis. The MHD group had more severe complications than the BHD group. The average LOS was 3.28 days.

1.4. Conclusions: We found that large spleens were related to se-

vere complications. Our results were comparable with the literature, although the rate of complications in our study was lower. The latter could be due to the fact that we did not have any cases of supramassive splenomegaly.

2. Introduction

Laparoscopic Splenectomy (LS) is considered the gold standard in spleen surgery and technological advancement has ensured this type of surgery confers relatively less complications when compared with open splenectomy. The rate of complications is purported to depend on the institution and the experience and exposure of the surgeon in relation to LS [1].

Although the spleen has essential haematological and immunological functions, including storage, maturation, and destruction of red blood cells and, immunologically, the generation of peptides (which is elementary for the phagocytosis of encapsulated bacteria and facilitate antibody synthesis), the spleen is commonly involved in a large variety of systemic diseases [2]. In almost all cases the spleen responds by enlarging. A chronically enlarged spleen often causes increased sequestration and premature destruction of excessive numbers of one or more of the formed elements of blood, causing anaemia, leukopenia, or thrombocytopenia. Platelets are more susceptible to sequestration in the red pulp resulting in severe thrombocytopenia followed by anaemia or neutropenia in the conditions causing splenomegaly [3]. In these situations, splenectomy is considered a potentially curative option where the primary

site of blood cells destruction would be eliminated.

Today, LS is widely accepted as a safe and feasible procedure. The laparoscopic approach offers better visualisation of the operating field, which has particular importance during splenectomy due to the complex, numerous vascular relationships of surrounding structures [4]. With the evolution of technology, the availability of advanced laparoscopic tools for ligation has resulted in less intra-operative complications [5]. Moreover, LS patients benefit from better cosmetic outcome with smaller incisions, minimal postoperative pain and early discharge.

The completion of the 100th procedure under a single general surgeon at a regional hospital in NSW, Australia, has motivated us to present our outcomes and experience with LS over last 17 years.

3. Methods

This study retrospectively reviewed 100 consecutive patients who underwent splenectomy under a single general surgeon (AM) during 2002- 2019 at a regional 500-bed hospital in New South Wales, Australia. We analysed patients' demography, indication, operative time, presence of splenunculus, conversion to open surgery, re-operation, unplanned return to theatre, size of spleen, length of stay and complications, and we compared our results with available literature in this area.

All the patients were identified through an electronic hospital patient administration system using ICD- 10 and the procedure; splenectomy was the search term used for the DRG code 31470-00. These patients were divided into three groups as per the indication for splenectomy. These three groups were Group 1 Benign Haematological Disease (Group 1, n = 88), Malignant Haematological Disease (Group 2, n = 7) and sarcoidosis (Group 3, n=5)

The operative time was measured from incision to skin-to-skin closure. Postoperative complications were explained as per the Clavien-Dindo Classification of surgical complications [6]. Length of Hospital Stay (LOS) was measured from the day of admission to the day of discharge.

For all patients, the haematological diagnosis and primary treatment were provided by the haematologists; all patients were initially managed with medications. In Idiopathic Thrombocytopenia (ITP), splenectomy was considered when ITP was refractory to medical treatment, relapse after initial response to steroids, the requirement for larger dose of corticosteroid to maintain remission and the presence of contraindications to medical therapy.

The reference weight and craniocaudal length of a normal spleen are 150 to 200 g and less than 12 cm, respectively [7]. When the spleen weighs more than 500gm and craniocaudal length is more than 17cm, it defines a massive spleen; if a spleen weighs more than 1600g or the craniocaudal length is more than 22 cm, it is considered as a supramassive spleen [7].

Postoperative complications were explained as per the Clavien-Dindo Classification of surgical complications where the complications were categorised from Grade I to Grade V6. Grade I complications are like any deviation from the normal postoperative course without the requirement of pharmacological treatment or surgical, endoscopic, and radiological interventions; Grade II complications needed pharmacological treatment with drugs other than such allowed for Grade I complications. Grade I and II were considered minor complications. The requirement of blood transfusion and total parenteral nutrition were included in this minor complication group. Grade III to V expressed severe complications where the complication required surgical, endoscopic, or radiological intervention with or without general anaesthesia, life-threatening complications needing intensive care unit (ICU) admission (Grade IV) and death (Grade V).

3.1. Ethical Approval

Records of the patients have been retrieved after obtaining institutional review board approval for this retrospective study.

3.2. Statistical Analysis

Non-parametric tests were used to apply statistical analysis to the following variables: age, operation duration time, spleen weight, and length of stay due to skewed data and non-normality. Kruskal-Wallis was used to test the difference about the medians in all three groups. When two groups were compared, the Mann-Whiney U test was applied. Medians were reported alongside means when non-parametric tests were utilized.

Past statistical package was used for the above non-parametric calculations.

3.3. Preoperative Measures

To reduce the risk of post-splenectomy sepsis, all our patients were immunised against pneumococcal infection, Haemophylus influenza type b and meningococcus group C infections.

One of our patients had preoperative percutaneous splenic artery embolisation. All of the cohort patients received the first-generation cephalosporin perioperatively. Anaemia, thrombocytopenia and coagulopathies were corrected preoperatively. Packed red cells were reserved for all patients and platelets for thrombocytopenic patients. Patients had transfused platelets intraoperatively after ligation of the splenic artery when their platelet count was below 40x10⁹/L.

3.4. Surgical Procedure

Patient placed in right lateral position; bed flexed at the level of the costal margin. Hasson cannula inserted to left of umbilicus to create pneumoperitoneum; two to three 10- and 15-mm operating ports used in the epigastrium and left loin. Retraction of stomach to expose spleen; systematic exploration to search for splenunculi commonly at the hilum of spleen and adjacent to tail of the

pancreas [4]. Upon mobilisation of splenic flexure of colon, the lienocolic and lienorenal ligaments were divided using LigaSure (electrothermal bipolar-activated device) or Harmonic scalpel (ultrasonic endoshear). Lesser sac entered at medial border of spleen. Upon spleen elevation, short gastric vessels, and main vascular pedicle evident; tail of pancreas located and protected. Serial transection of splenic hilar vessels by Endovascular Gastrointestinal Anastomosis (Endo-GIA) stapler. Serial ligation of short gastric vessels by Endo-GIA stapler. Spleen detached from diaphragm by LigaSure. Spleen crushed through Endo-Bag using finger fracture technique. Spleen delivered piecemeal through skin incision whilst still in Endobag. Bellovac drain (size 10) inserted into splenic bed; pneumoperitoneum released. Wounds closed in layers 1 nylon to sheath, skin closed with 3/0 subcuticular Monocryl. Bellovac drain is usually removed withing 1st 48hour post-operative period.

4. Results

Off these 100 patients, female to male ratio was 1.5: 1. The median age was 57.5 (15- 91) years. Group 1 constituted patients with benign haematological diseases (BHD) such as idiopathic thrombocytopenic purpura (66), autoimmune haemolytic anaemia (18), hereditary spherocytosis (4) and made up 88% of the cohort. Group

2 had patients with malignant haematological disease (MHD) and included lymphoma (7) making up 7% of the cohort. Group 3 constituted patients with sarcoidosis (5) and completed the cohort (5%).

Patient demographics in these groups, and significance between groups in given variables, are presented in (Table 1).

As shown in Table 1, female participants dominated Groups 1 and 3. The mean and median weight of spleen was significantly greater in Group 2.

Table 2 shows the larger spleen weight associated with lymphoma compared with other conditions, and the ages of those afflicted with the different presentations requiring splenectomy. Table 3 outlines the perioperative outcomes for all three groups. The greater length of stay is seen for Group 2, although Table 1 shows that this is not significant. Average operation time was 101.6 (30-190) minutes. In group 2, the average operation time was 142.5 (75-210) minutes. For group 3, the average duration was 100 (60-180) minutes. Overall, our mean duration for laparoscopic splenectomy was 104 minutes.

During a concomitant cholecystectomy, the duration of total laparoscopic splenectomy and cholecystectomy was 60-105 minutes.

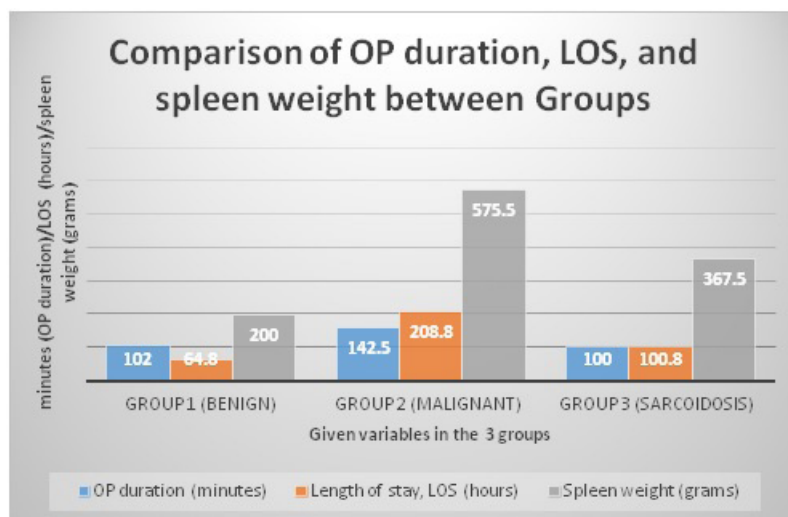


Figure 1: Difference between the 3 Groups in duration of operation [OP] (minutes), length of stay [LOS] (hours), and weight of spleen (grams).

Table 1: Patient demographics and significance of certain variables

	All cases	Group 1	Group 2	Group 3	P value*
N	100	88	7	5	
Gender distribution					
Male		33	4	2	
Female		55	3	3	
Pregnant	2	2	0	0	
Non pregnant		53	2	3	
Age Range (years)		15-91	43-77	32- 58	
Mean age (years)		52.9	60.1	4.2	
Median age (years)		58	63	3	NS
Operation duration Mean(Minutes)		101.6	142.5	100	NS
Length of hospital stay					NS (p=0.09)
Mean(Days) Median(Days)		2.7 2	8.7 3	4.2 3	P=0.079** between Group 1 & Group 2

Weight of spleen Mean (g)		200	575.5	367.5	p<0.0001 p<0.0001**between Group1 & Group 2, and p<0.01** between Group 1 and Group 3
Contemporary cholecystectomy performed	4	3		1	

As shown in Table 1, female participants dominated Groups 1 and 3. The mean and median weight of spleen was significantly greater in Group 2.

*Using Kruskal-Wallis non-parametric test, significant at p<0.05.

** using Mann Whitney U non-parametric test, significant at p<0.05

NS= not significant

Table 2: Indication for splenectomy and associated factors.

	Number	Mean weight of spleen (gm)	Mean age
Benign haematological disease			
ITP (Idiopathic thrombocytopenic purpura)	66	165.66 (47- 440)	51.69 (15-91)
Autoimmune Haemolytic Anaemia (AHA)	18	262 (104- 500)	64 (32- 82)
Hereditary spherocytosis (HS)	4	403 (355- 475)	19.5 (16- 22)
Malignant Haematological disease		7	
Non-Hodgkin lymphoma (NHL)	6		
Diffuse Large B cell lymphoma	3	702 (580-825)	64 (62- 66)
Chronic lymphocytic lymphoma	2	400 (300- 500)	61 (45- 77)
Marginal zone lymphoma	1	485	63
Stage IV Hodgkin lymphoma	1	762	43
Others			
Sarcoidosis	5	367.5 (200- 590)	42 (32- 45)

Table 2 shows the larger spleen weight associated with lymphoma compared with other conditions, and the ages of those afflicted with the different presentations requiring splenectomy.

Table 3: Perioperative outcomes

	All case	Group 1	Group 2	Group 3
Number	100	88	7	5
Operative duration (min)	104 (30- 210)	102 (30-190)	142.5 (75- 210)	100 (60- 180)
Intraoperative transfusion	3	2	0	1
Conversion	1	0	1	0
Unplanned return to theatre (UPRT)	2	1	0	1
Accessory spleen	4	3	1	0
Spleen weight	233	199 (47-500)	575 (300- 825)	367.5 (200- 590)
Mean length of stay, days (LOS)	3.13	2.6 (1-8)	8 (2-28)	4.2 (2-7)
Mortality	1	0	1	0

Table 3 outlines the perioperative outcomes for all three groups. The greater length of stay is seen for Group 2, although Table 1 shows that this is not significant.

Table 4: Indication for splenectomy, Intra/ Post-operative event, Action and Result

Indication for splenectomy	Weight of spleen (gm)	Intra/Post-operative event	Action	Result
NHL	825	Intraoperative Concern of gastric injury	Converted to open	- Prolong LOS - Pancreatic Fistula - Atelectasis - Subphrenic Collection
Sarcoidosis	590	Bleeding from Short gastric artery (SGA)	Unplanned return theatre (UPRT) Open approach Blood transfusion 4 unit	LOS 7
AHA	163	Bleeding from SGA	UPRT Converted to open transfusion 4 units	LOS 6
ITP	170	Missed splenunculus x 2	1.Laparotomy and splenunculectomy 2. Laparoscopic splenunculectomy	LOS 2- 4

Table 5: Postoperative complications within 30 days of operation according to Clavien-Dindo grading

Grades	Group 1	N=88	Group 2	N= 7	Group 3	N=5
Grade I	Atelectasis	1	Fever with atelectasis	2		
Grade II	Portal venous thrombosis	1	Pneumonia	1		
	Intra-operative transfusion (x)	1	Post operative transfusion	3(1, Y)	Post operative transfusion (Z)	1
			Total parental nutrition (Y)	1		
			Ileus (Y)	1		
Grade III-a			Subdiaphragmatic collection (Y)	1		
Grade III-b	Post operative haemorrhage- UPRT (x)	1	Pancreatic fistula (Y)	1	Post operative haemorrhage- UPRT (Z)	1
Grade IV	Post operative ICU admission (X)	1				
Grade v			Death from upper gastrointestinal bleeding	1		

X= A patient who had UPRT, intraoperative transfusion and postoperative ICU admission.

Y= A patient who required postoperative transfusion, TPN, pancreatic fistula, subdiaphragmatic collection, ileus, and ICU admission for respiratory failure with other comorbidities.

Z = A patient who had UPRT for bleeding from SGA and required postoperative transfusion

Table 6: Complications related to spleen weight

Complication	Spleen weight in gm
Atelectasis	485
Pneumonia	177
Portal venous thrombosis	197
UPRT- SGA bleeding and ICU admission	163
UPRT- SGA bleeding	590
Pancreatic fistula, subdiaphragmatic collection, ileus,	825
Upper gastrointestinal bleeding	762

4.1. Unplanned Return to Theatre (UPRT)

Two of our patients needed re-operation due to bleeding from the short gastric artery (SGA).

The rate of our UPRT was 2%.

4.2. Presence of Splenunculi

We found splenunculi in three cases intraoperatively. Two of our patients re-presented nearly 2 years after their elective splenectomy due to persistent thrombocytopenia. Single-Photon Emission Computerised Tomography (SPECT) was used to locate these splenunculi. Laparoscopically, one of these patient's splenunculi were removed where the splenunculi were located below the left hemidiaphragm (duration 45min). However, for the second patient, the laparoscopic procedure was converted to open with a left subcostal incision due to difficult access to the splenunculus. The splenunculus was located posteriorly just above the left kidney (duration of the procedure was 180 min).

In both situations, the accessory spleen also noted adjacent to the staple line across the splenic hilum. Laparoscopic versus open ratio for accessory splenectomy was 0.50.

4.3. Conversion

Only one case was converted during laparoscopic procedure for splenectomy due to concern of injury to the gastro-oesophageal junction.

5. Discussion

In splenic surgery, splenectomy is preferentially performed through laparoscopy unless there are convincing contraindications. LS is the standard procedure for surgical treatment for benign haematological disorders [8]. Our study showed reasonable outcomes with LS, many of which were better than the reported literature.

Our cohort was divided into 3 groups which complied with the commonest indications for splenectomy and aligned with published literature [1, 4, 9]. ITP was the most common reason for splenectomy in the current study and is consistent with other studies [1, 4, 9]. ITP belonged to the benign haematological group (Group 1) which constituted 88% of the cohort.

As expected, spleen weight was significantly heavier in the malignant group which was dominated by lymphoma (significant differences between the three groups $p < 0.0001$; difference between

Group 1: the benign group and Group 2: the malignant group: 161.5g vs 540g, $p < 0.0001$; and Group 2: the benign group and Group 3: sarcoidosis: 161.5g vs 367.5, $p < 0.01$: Table 1). These findings are similar to the findings of Wang et al. (2013) who found the malignant haematological group had patients with massive splenomegaly.

Wang et al. (2013) report benign spleen-related disease group in their study had fewer complications compared with the malignant group. In our study, we found that large spleens were related to severe complications [9]. Increased size of spleen was directly proportionate to the severity of complications (Table 6) and other variables (Figure 1). As per Casaccia and Patel et al., splenic size and craniocaudal length were the independent predictors for the occurrence of postoperative complications [10, 11].

Marte et al. (2013) studied 48 consecutive patients having undergone LS over five years [12]. They found splenomegaly in 31% of their cohort. In our study, for one patient, the procedure was converted to laparotomy due to the concern of stomach injury. This patient had splenomegaly amongst a total of 7% of our cohort with splenomegaly. Here the spleen weighed 825gm. According to Marte et al., massive splenomegaly (spleen weight > 1000 gm and craniocaudal length > 20 cm) should be considered a relative contraindication to LS [12].

The reported rate of conversion in the available literature was 3 to 4.1% [1, 12] which was considerably more than our conversion rate of 1%. The commonly found causes for conversion were bleeding (1%), technical problems (0.8%), infiltration of surrounding structures (0.8%), splenic friability (0.2%) and size of the spleen (0.2%) [1]. Our only case did not fit into these categories but was a precautionary move.

To minimise complications with massive spleens during LS, a few different approaches were suggested in the literature: Splenic Artery Embolization (SAE) [13], hand-assisted laparoscopic splenectomy [14], and adrenaline injected into the splenic artery before splenic mobilisation to reduce splenic volume [15]. Shaw et al. (1989) reported 40% splenic volume was reduced by the latter method [15]. However, one of our patients who had SAE, developed sepsis from splenic abscess due to SAE complications.

Even though the electromechanical morcellator removed tissue masses faster than finger morcellation, we morcellated the spleen by finger dissection to avoid splenic tissue spillage [16, 17].

Another two of our patients had unplanned returned to theatre due to bleeding from SGA. Thus, the rate of our UPRT was 2% and was less than half of the 4.4% reported in the literature [1]. In one of these cases the spleen weighed 590gm (Table 6). Both of these patients' LOS was more than average LOS: the patient with splenomegaly was in hospital for 7 days in total (Table 4), 4 days longer than the average LOS of approx. 3 days.

It is worth noting that the difference in average LOS between Group 1 and Group 2 was marked, although it did not reach statistical significance. Nonetheless, a LOS of 28 in Group 2 (mean 8 days) compared with a mean of 2.6 for Group 1 (Table 3) confers clinical significance. Despite this, our mean length of stay was 3.2 days shorter than reported LOS (4 days) in the literature [1].

The mean operation time for our cohort ranged from 30 to 210 minutes which is less than reported in other studies. The range documented in the available literature is 117- 261 minutes [18].

Postoperative complication rates in the benign group (Group 1) with 3.4% (3/88) suffering mild complications and 2.3% (2/88) severe complications, were lower than published studies. Wang et al. (2013) and Rosen et al. (2002) report 4% - 11 % minor complications and 4- 12% severe complications [9, 14]. In our study, in the malignant group (Group 2), five out of seven patients had mild complications and 1 (14%) had a severe complication. In Group 3 (sarcoidosis), one out of five patients had a severe complication (20%). Wang et al. had 17% of patients in their malignant group experiencing severe complications, which was higher than our cohort [9].

In 3% of cases, we found splenunculi during LS. Apart from the pancreatic tail, other reported locations of splenunculi were the splenic bed (27%), greater omentum (22%), gastrocolic ligament (7%), transverse mesocolon (5%), retro colic fat, and retroperitoneum (2.5%) [19]. Our laparoscopic versus open ratio for accessory splenectomy was 0.50, which is close to the rate reported in the available literature. 0.56 (31/55) [18].

Marchese et al. (2019) explained three etiologic mechanisms to explain the finding of splenunculi in refractory ITP: missed functioning splenunculus at splenectomy which is why a thorough laparoscopic exploration is touted; spread of splenic tissue due to the surgery itself; splenunculi caused from hypertrophy of extremely small splenic tissue areas to compensate for surgical imposition, which would not have been visible in surgery. Splenunclectomy are of benefit in ITP patients with minimal or short-term response post LS as they require lower doses of immunosuppressive drugs [19].

In only one case, the spleen was delivered intact with an accessory incision at left iliac fossa. Here the spleen was 27 cm long, and spleen weight was 762gm. The indication of splenectomy, in this case, was symptomatic splenomegaly secondary to Hodgkin's lymphoma. We avoided Pfannenstiel incision due to reported bladder injury (0.2%) from this incision [1].

The discrepancy in outcomes in our study may have been due to a number of factors. As Radkwiak et al. (2018) point out, complications and outcomes are dependent on the institution in question, the level of technological tools at hand, and the surgeon's ability and experience. The most plausible reason for the better outcome

in our study was likely the fact that we did not have any supra-massive spleens.

LS remains the best and safest approach to splenectomy. Apart from reduction in complications and better outcomes as compared with open splenectomy, LS has been shown to reduce hospital cost by shortening hospital stay even with high operating room costs resulting from increased operation time and disposable resources [20].

5.1. Limitations

Only elective splenectomy cases were included in this study. The retrospective nature of the study limited data collection, and established missing data. The cohort was relatively small.

6. Conclusion

Our study showed reduced perioperative morbidity rates, reduced complication rates, shorter hospital stay, shorter mean operative time, reduced and re-operation rate, and reduced spleen weight when compared with the available literature. The spleen weight could be the link to complications during LS.

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