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Laparoscopic splenectomy: experience of a single center in a series of 300 cases

Francesco Corcione · Felice Pirozzi · Giuseppe Aragiusto · Francesco Galante · Antonio Sciuto

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Abstract
Background Laparoscopic splenectomy (LS) has gradually become the technique of choice for surgical removal of the spleen. The aim of this study was to evaluate the efficacy of LS in a large cohort of patients from a single center.
Methods From March 1992 to June 2010, 300 patients underwent LS at our hospital for predominantly hematologic disorders. The first 92 cases were performed using an anterior approach, whereas in the remaining 208 cases a lateral approach with a four-trocar technique was used. Patient demographics, diagnosis, and outcomes were reviewed.
Results Spleen volume was similar between the anterior (350 ml) and the lateral (370 ml) approaches. The lateral approach was associated with shorter operative time (60 vs. 80 min), less blood loss (30 vs. 110 ml), and no conversion (0 vs. 2.2 %) compared to the anterior approach. Reoperations were required in three patients (1.0 %) because of bleeding, subphrenic abscess, and intestinal ischemia. Postoperative complications were significantly fewer for the lateral (4.8 %) than for the anterior (31.5 %) approach and the hospital stay was shorter (3.1 vs. 5.2 days) and there was less postoperative pain. Splenectomy for hematologic malignancies resulted in a higher morbidity rate, more postoperative pain, and longer hospital stay. Overall mortality rate was 0.3 %. No late complications were observed during the 1–5-year follow-up.
Conclusions LS using the lateral approach with the placement of four trocars can be considered the procedure of choice for both benign and malignant diseases affecting the spleen. Extensive experience and technical standardization help to avoid surgical pitfalls, providing an adequate control of hemostasis, the excision of accessory spleens (AS), and the avoidance of parenchymal rupture.

Keywords Laparoscopic splenectomy · Splenectomy · Laparoscopy · Technique · Standardization · Splenomegaly

Laparoscopic splenectomy (LS) has become the technique of choice for surgical removal of the spleen since its first description in 1991 [1]. Indications for LS have rapidly increased and LS is now considered the standard approach for almost all diseases requiring splenectomy, including benign and malignant hematologic disorders and also nonhematologic malignancies [2]. Moreover, cases of spleen injury managed laparoscopically have been recently described in literature [3, 4], so spleen injury should not be considered a contraindication for LS.

The aim of this study was to evaluate the efficacy of LS in a large cohort of patients from a single center. A total of 300 laparoscopic splenectomies were performed from March 1992 to June 2010 at the Department of Laparoscopic and Robotic Surgery of Monaldi Hospital in Naples.

Materials and methods

From March 1992 to June 2010, 300 patients underwent LS in our institution for predominantly hematologic disorders.

F. Corcione (✉) · F. Pirozzi · F. Galante · A. Sciuto
Department of Laparoscopic and Robotic Surgery, "Azienda Ospedaliera dei Colli"—Monaldi Hospital, Via Leonardo Bianchi, 80131 Naples, NA, Italy
e-mail: francesco.corcione@ospedalemonaldi.it

G. Aragiusto
Department of Hepatobiliary Surgery and Liver Transplantation, "A. Cardarelli" Hospital, Naples, NA, Italy

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Patient ages ranged from 2 to 82 years (mean = 37.1 years) and 66.6 % of patients were females. Indications for splenectomy are listed in Table 1. Splenectomy was performed mainly for idiopathic thrombocytopenic purpura (58.3 %), hereditary spherocytosis (19.7 %), and thalassemia (6.7 %). Nineteen patients (6.4 %) in this series were affected by hematologic malignancies, 16 lymphomas, and 3 myeloproliferative disorders. Sixteen patients (5.3 %) had concomitant cholecystectomy and liver resection was performed in one case (0.3 %).

Preoperative ultrasonography (US) was performed in all cases to assess the volume of the spleen and to identify accessory spleens (AS). Spleen volume was between 250 and 1,000 ml (mean = 320 ml). In the cases of hematologic malignancies, mean spleen volume was 550 ml (range = 400–1,000 ml). Accessory spleens were found in 25 cases (8.3 %), with five patients having two or three AS; the presence of AS was confirmed by laparoscopic examination and the AS were removed. Two hundred fifty-five patients (85.0 %) received meningococcal, pneumococcal, and *Haemophilus influenzae* type B vaccinations 1 month before surgery. Antibiotic prophylaxis 12 h before the surgical procedure and perioperative antithrombotic therapy were administered in all cases.

In the first 92 consecutive cases of this series, the patient was placed in dorsal decubitus with legs abducted. However, as our experience increased, the lateral approach (LA) became the procedure of choice (208 cases). The patient is placed in a 70° right lateral decubitus position as shown in Fig. 1. The table is tilted in a slight reverse Trendelenburg position and flexed 30° to open the space between the iliac crest and the costal margin. The surgeon and the first assistant stand on the patient's ventral side, while the second assistant and the scrub nurse stand on the dorsal side. The video monitor is placed in front of the surgeon at the level of the patient's shoulders. Pneumoperitoneum is created using an open Veress-assisted technique [5] and insufflation pressures are set at 12 mmHg. Four trocars are placed as shown in Fig. 2 and a 30° telescope is used.

Prior to initiating any dissection, a careful search for AS is performed. The next operative step is mobilization of the splenic flexure of the colon. Then the gastrosplenic ligament is opened to allow entry into the lesser sac (Fig. 3). The splenic artery is identified and dissected free from the upper border of the pancreatic tail (Fig. 4) and clipped approximately 2 cm from the splenic hilum in order to decrease blood supply to the spleen and reduce its volume. The division of the gastrosplenic ligament is completed and all the short gastric vessels are divided using harmonic scalpel. The next step is progressive mobilization of the

Table 1 Indications for splenectomy

Indication	No. of cases (%)
Idiopathic thrombocytopenic purpura	175 (58.3)
Hereditary spherocytosis	59 (19.7)
Thalassemia	20 (6.7)
Myeloproliferative disorders	3 (1.0)
Lymphomas	16 (5.4)
Splenic cysts	15 (5.0)
Splenomegaly in cirrhotic patient	1 (0.3)
Splenic abscess	1 (0.3)
Metastatic disease	5 (1.7)
Splenic aneurysm	1 (0.3)
Iatrogenic spleen injury	2 (0.7)
Sarcoma	1 (0.3)
Splenic tuberculosis	1 (0.3)

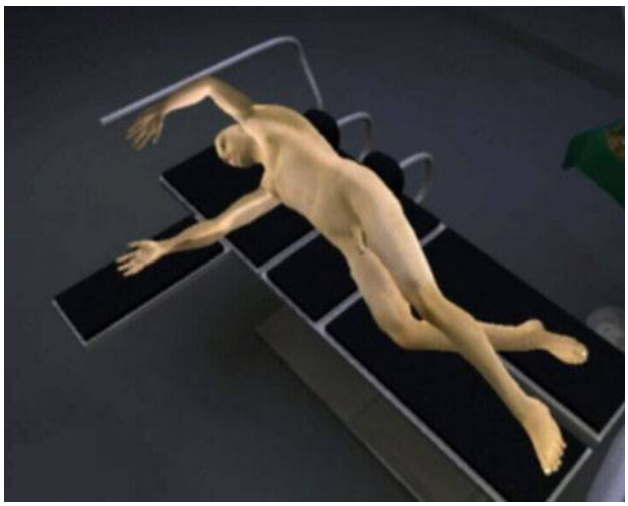

Fig. 1 The patient is positioned in a right lateral decubitus

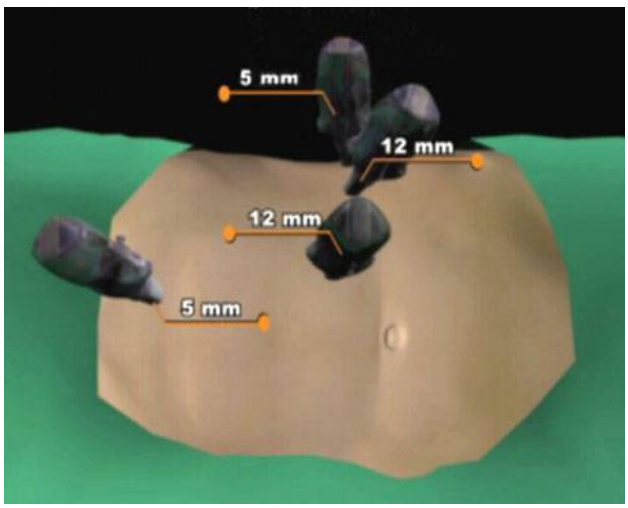

Fig. 2 Trocar position in the right lateral decubitus. Two 12-mm and two 5-mm trocars are used

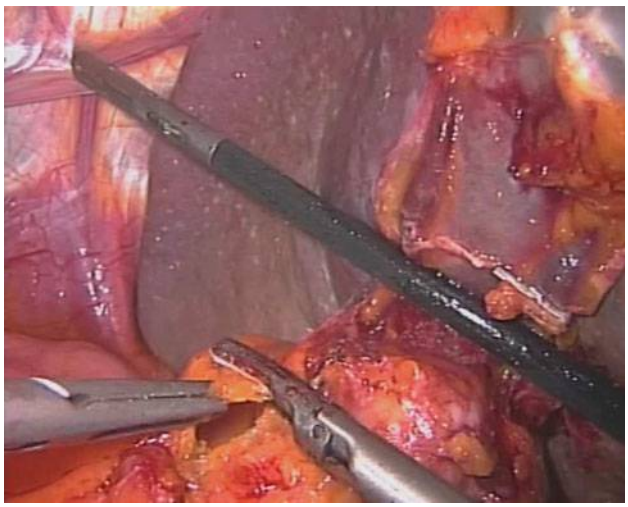

Fig. 3 Lesser sac opening. The medial aspect of the spleen is exposed through a gentle lateral retraction with an atraumatic grasper and the gastrosplenic ligament is opened to allow entry into the lesser sac

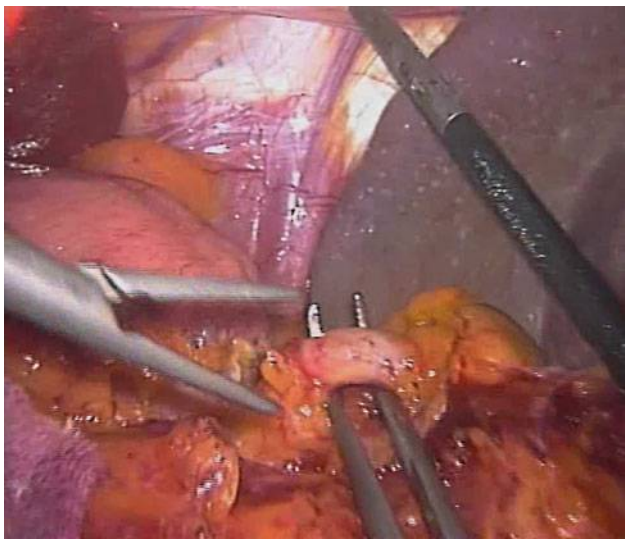

Fig. 4 The splenic artery is identified and dissected free from the superior border of the pancreatic tail

spleen by division of the posterior (splenorenal ligament) and superolateral (splenopancreatic ligament) peritoneal attachments. The splenic vein is then isolated at the hilum; thanks to the previous ligation of the splenic artery and to the lateral decubitus of the patient, the vein is not under strain and it can be easily clipped (Fig. 5). At this stage, the splenic artery and vein are divided, completing splenic mobilization. The last operative step is spleen removal using a 15-mm retrieval bag. The spleen is morcellated for removal in case of benign disease. Otherwise, the presence of malignant disease requires the specimen be removed intact through a suprapubic incision. At the end of the

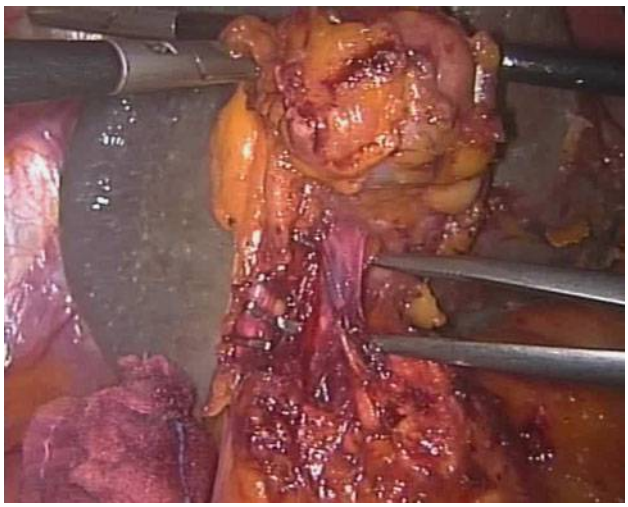

Fig. 5 Control of the hilar vessels. The splenic artery has been previously clipped but not divided. Now the vein can be easily dissected at the hilum before ligation

procedure a drain is inserted through the port incision on the middle axillary line and left in the upper-left quadrant for 1 or 2 days.

Results

LS was performed using the anterior approach (AA) in the first 92 consecutive cases and the LA in the next 208 cases, regardless of either spleen volume or indication for splenectomy. Spleen volume was similar between the anterior (mean = 350 ml) and the lateral (mean = 370 ml) approaches. We evaluated the results of the procedure with respect to operative time, conversion rate, blood loss and need for hemotransfusion, postoperative pain, morbidity and mortality, diet resumption, hospital stay, and return to normal activity. Outcomes were analyzed in relation to the approach used (Table 2). Mean operative time was 75 min (range = 25–360 min) and was longer for AA (mean = 80 min) than for LA (mean = 60 min). Conversion to open splenectomy occurred in two cases (0.7 %) due to intraoperative severe bleeding; both conversions occurred in our early experience in patients affected by hematologic malignancies who underwent LS with AA. Intraoperative blood loss ranged from 20 to 800 ml (mean = 200 ml) and was greater for AA (mean = 110 ml) than for LA (mean = 30 ml). Nine patients (3.0 %) received a mean of 1.8 units of packed erythrocytes (range = 1–3 units) and 8 of them underwent LS with AA. Postoperative pain was assessed by means of a 0–10 numeric pain intensity scale (0, absence of pain; 1–3, mild pain; 4–7, moderate pain; 8–10, severe pain): 63.0 % of patients had mild pain, 28.7 % moderate pain, and 8.3 % severe pain. Overall morbidity was 13 % (39/300). Complications occurred in 29 of the 92 cases (31.5 %) treated with

the AA and in 10 of the 208 cases (4.8 %) treated with the LA; they were detailed in relation to the approach used (Table 3). The incidences of fluid collections in the splenic fossa, subphrenic abscesses, and pleuritis were lower in the LA group. Three patients (1.0 %) required reoperation because of postoperative bleeding, subphrenic abscess, and intestinal ischemia, and two of them were affected by hematologic malignancies. Diet was resumed in 1.5 days after surgery (range = 1–3 days). Mean postoperative hospital stay was 4.5 days (range = 2–22 days) and was longer for AA (mean = 5.2 days) than for LA (mean = 3.1 days); patients with hematologic malignancies had a mean hospital stay of 6.7 days. Mean time to return to normal activity was 10.2 days (range = 5–15 days); LA allowed a quicker recovery than AA. One patient (0.3 %) died 30 days after surgery due to evolution of a pre-existing malignancy. No late complications were observed during 1–5-year follow-up.

Table 2 Outcomes of laparoscopic splenectomy

	Anterior approach ($n = 92$)	Lateral approach ($n = 208$)
Operative time (min)	80 (40–360)	60 (25–125)
Conversion rate	2 (2.2 %)	0
Blood loss (ml)	110 (50–800)	30 (20–200)
Hemotransfusion	8 (8.7 %)	1 (0.5 %)
Postoperative pain	51 (55.4 %) Mild	134 (64.4 %) Mild
	32 (34.8 %) Moderate	58 (27.9 %) Moderate
	9 (9.8 %) Severe	16 (7.7 %) Severe
Morbidity	29 (31.5 %)	10 (4.8 %)
Reoperation	2 (2.2 %)	1 (0.5 %)
Oral intake (days)	1.6 (1–3)	1.5 (1–3)
Hospital stay (days)	5.2 (3–22)	3.1 (2–15)
Time to normal activity (days)	11.2 (8–15)	7.1 (5–8)
Mortality	1 (1.1 %)	0
Late complications	0	0

Table 3 Postoperative morbidity

Complication (%)	Anterior approach ($n = 92$)	Lateral approach ($n = 208$)
Bleeding	1 (1.1)	2 (1.0)
Fluid collections	10 (10.9)	2 (1.0)
Subphrenic abscess	3 (3.3)	0
Pleuritis	12 (13.0)	4 (1.9)
Intestinal ischemia	1 (1.1)	0
Portal thrombosis	0	1 (0.5)
Lower-limb thrombophlebitis	0	1 (0.5)
Pulmonary embolism	1 (1.1)	0
Toxic hepatitis	1 (1.1)	0

Table 4 Outcomes of laparoscopic splenectomy for all diseases and for hematologic malignancies

	Overall ($n = 300$)	Hematologic malignancies ($n = 19$)
Operative time (min)	75 (25–360)	95 (60–360)
Conversion rate	2 (0.7 %)	2 (10.5 %)
Blood loss (ml)	200 (20–800)	250 (150–800)
Hemotransfusion	9 (3.0 %)	4 (21.0 %)
Postoperative pain	189 (63.0 %) Mild	10 (52.6 %) Mild
	86 (28.7 %) Moderate	7 (36.9 %) Moderate
	25 (8.3 %) Severe	2 (10.5 %) Severe
Morbidity	39 (13.0 %)	6 (31.6 %)
Reoperation	3 (1.0 %)	2 (10.5 %)
Oral intake (days)	1.5 (1–3)	1.8 (1–3)
Hospital stay (days)	4.5 (2–22)	6.7 (4–22)
Time to normal activity (days)	10.2 (5–15)	12.4 (9–15)
Mortality	1.0 (0.3 %)	1.0 (5.3 %)
Late complications	0	0

Outcomes for all diseases and for hematologic malignancies are reported in Table 4.

Discussion

During the 1950s surgical treatment of hematologic disorders was once reserved for patients not responsive to medical treatment because morbidity and mortality after splenectomy were extremely high. In 1991 LS was performed for the first time [1] and since then it has gained favor over conventional surgery because it allowed significant reduction of both mortality and morbidity rates [6, 7]. Therefore, the development of the laparoscopic technique has increased the number of splenectomies performed as opposed to continued medical therapy [8].

Nowadays LS can be considered the gold standard for the treatment of hematologic disorders [9, 10], and this surgical approach is preferred especially by young patients who find the small scars cosmetically preferable. It is also of great value for the management of other benign and malignant splenic diseases [11, 12]. Besides, LS can be used successfully as an immediate treatment option in hemodynamically stable patients with severe splenic injury [13, 14], as the laparoscopic approach has the same hemostatic efficacy as the open technique, but with much better outcome for the patient [4].

Portal hypertension from liver cirrhosis, severe uncorrected coagulopathy, and massive splenomegaly should be considered contraindications for LS. There is concern

about LS in splenomegaly and there is no unanimous definition of splenomegaly in the literature. We routinely perform an US examination to assess the splenic volume and it provides a reliable and accurate determination [15]. In our experience, a CT scan does not provide significant advantages and it should be reserved for those cases in which adjunctive information about the anatomy is required. Although the potential for complications increases with spleen size and splenomegaly has been considered a relative or absolute contraindication for LS, nowadays an enlarged spleen does not contraindicate LS [16]. Massive splenomegaly should be defined as a maximum spleen diameter exceeding 25 cm, an estimated spleen volume exceeding 1,000 ml, or both. Spleen volume should be considered more reliable than diameter. Based on our experience, if the spleen is over 1,000 ml, LS is technically demanding due to the limited abdominal working space, with an increased risk of bleeding and difficulty retrieving the spleen. In such cases we prefer a traditional open approach for splenectomy, as published data have demonstrated that LS in massive splenomegaly is associated with higher operative time, conversion rate, blood loss, hospital stay, and overall morbidity [17, 18]. The open approach can be performed quickly and safely without significantly increasing hospital stay or morbidity [19]. On the other hand, several authors report that hand-assisted LS is a valid approach and recommend it as a primary procedure in these cases [20, 21].

Identification and excision of AS in LS have been much debated. Some authors reported that the laparoscopic approach does not allow complete detection of AS, so preoperative or postoperative investigation with a CT scan or splenic scintigraphy using 99m-Tc-labeled heat-denatured red blood cells has been proposed [22, 23]. In our experience, accurate detection of AS can be obtained preoperatively with an US scan. Recent reports have shown the accuracy of laparoscopy in identifying AS so the role of CT scans routinely performed before surgery remains unclear [24]. In case of an incomplete response or recurrence of hematologic disease after surgical treatment, denatured red blood cell scintigraphy can be useful to identify AS.

As laparoscopy has become the standard approach for most splenectomy cases, standardization of the surgical technique needs to be defined [25, 26].

LS represents a minimally invasive approach to the abdominal cavity; nevertheless, its therapeutic effects and outcomes are comparable to open surgery. Advantages of the laparoscopic approach when compared to the traditional open approach include the possibility to perform other concomitant abdominal operations such as cholecystectomy, appendectomy, and Meckel's diverticulectomy, without enlarging surgical incisions.

We initially adopted the AA because we were more comfortable with it. As our experience increased, we started using the LA, with the patient placed in the right lateral decubitus position. It provides better exposure of the splenic hilum and the pancreatic tail because the abdominal viscera are retracted away from the upper-left quadrant by gravity, allowing easier dissection of the splenic hilar structures and greater vascular control [27–29]. Some authors reported that the LA results in reduction of the number of trocars needed, operative time, intraoperative blood loss, and hospital stay as well as a lower conversion rate [30]. Our series confirms these findings. Moreover, the LA led to a significant decrease in postoperative complication rate, with minimal morbidity at the surgical site; only 1 % of fluid collections were observed and no subphrenic abscesses occurred. Standardization of the surgical procedure and extensive experience of the surgeon in addition to adequate instrumentation can induce a significant reduction in operative time, conversion rate, and complication rate.

The number and optimal sites for insertion of trocars and disposition of the instruments are determined by the operator. In our experience, the ideal number of trocars is four, as a fourth trocar can be helpful in spleen retraction and exposure of anatomical structures. Although some surgeons perform LS with good results using only three trocars, we believe that a four-trocar placement technique is still minimally invasive and preferable with respect to exposure of anatomical structures and hemostasis.

The hilar vascular control is widely accomplished using an endovascular stapler, and it has been reported that the use of radiofrequency [31, 32] or ultrasonic shears [33] is safe for this purpose. However, we consider it safer to accurately dissect the vessels at the splenic hilum and clip them individually in order to avoid pancreatic tail injury, thus reducing the development of pancreatic fistulas or fluid collections in the splenic fossa.

Laparoscopic surgery is recommended for malignant diseases requiring splenectomy, although it may be more technically challenging, thus requiring extensive experience [2]. We recommend the LA, even for patients with larger spleens or hematologic malignancies or both, as malignant diseases often result in splenomegaly. In such cases, splenectomy can be performed using the same surgical technique, provided that the ports are placed more caudally on the abdomen in relation to the lower pole of the spleen. The presence of hematologic malignancy has been reported as an independent predictor for intraoperative complications and surgical conversion [34]. In our series conversion was required only for hematologic malignancies. Morbidity and length of hospital stay for patients with hematologic malignancies have been reported to be similar to those associated with benign diseases, despite having

larger spleens, more blood loss, and longer operations [35, 36], that have been also highlighted in the present study. Nevertheless, in our series, splenectomy for hematologic malignancies resulted in a higher morbidity rate, more postoperative pain, and longer hospital stay. Such results could be explained by frequent adherence of the spleen to the diaphragm and the need for an additional incision for specimen retrieval.

In conclusion, we consider the laparoscopic approach the gold standard for splenectomy. Important steps to prevent surgical pitfalls are adequate control of hemostasis in order to reduce the conversion rate, avoidance of parenchymal rupture and cell spillage, and, moreover, the excision of AS that can be responsible for the failure of the surgical treatment. LS requires extensive experience in laparoscopic surgery, adequate patient positioning and trocar placement, and most of all a gentle and meticulous dissection of the spleen.

Disclosures Prof. F. Corcione and Drs. F. Pirozzi, G. Aragiusto, F. Galante, and A. Sciuto have no conflicts of interest or financial ties to disclose.

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