Original Article

Technique of laparoscopic splenectomy

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Background: Indications for laparoscopic splenectomy have rapidly increased and it is now considered the standard approach for almost all diseases requiring splenectomy, including benign and malignant disease. The aim is to evaluate the safety and effectiveness of laparoscopic splenectomy in a large cohort of patients in a laparoscopic referral center.

Methods: We retrospectively analyzed 141 patients undergone surgery for spleen-related diseases from 2010 to 2019. All patients underwent laparoscopic splenectomy were selected according to European Association for Endoscopic Surgery guidelines. Exclusion criteria were American Society of Anesthesiologists (ASA) IV and severe portal hypertension and spleen diameter >30 cm. Early and mid-term results have been evaluated.

Results: From 2010 to 2019, 108 patients underwent laparoscopic splenectomy. Mean operative time was 70 min (range, 50–120 min) with a conversion rate of 4.6% (5 patients). Among the 105 patients completed laparoscopically, 21 (20.4%) postoperative complications were reported: 2 early hemorrhage (2%), 4 (3.7%) fluid collections in the splenic fossa, 6 (5.5%) pneumonia and atelectasis and 9 (8.3%) cases of transient fever. Sixty-six patients (64.1%) reported mild pain, 22 patients (21.4%) moderate pain and 15 patients (14.6%) had severe pain. The 15 patients (14.6%) undergone specimen extraction through the suprapubic incision reported a higher pain compared with those in which spleen morcellation was performed (6.2 *vs.* 3.4, P<0.05). The mean hospital stay was 4 days (range, 3–6 days), with a mean time to return to normal activity of 7 days (range, 4–10 days). No late complications during the mean 3 years follow-up (range, 1–4 years) were observed.

Conclusions: Laparoscopic splenectomy is safeness and effectiveness despite it requires extensive experience in laparoscopic surgery, adequate patient positioning and trocars positioning.

Keywords: Laparoscopic splenectomy (LS); splenectomy; surgical technique; spleen; outcomes

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Introduction

Laparoscopic splenectomy (LS) is the gold standard procedure to remove the spleen in elective patient (1), but remains a very delicate procedure due to fragility of parenchyma and capsule of the spleen and its close connections with stomach, pancreas and colon. Indications for LS have rapidly increased and it is now considered the standard approach for almost all diseases requiring splenectomy, including benign and malignant hematologic disorders and also non-hematologic malignancies also spleen injury, managed laparoscopically, are increasing over the years (2,3).

An adequate learning curve and a standardized technique are necessary to reduce complications and conversion rate which however remain higher than those reported for most

other advanced laparoscopic procedures (4).

The aim of this study is to evaluate the safety and effectiveness of LS in a large cohort of patients in a laparoscopic referral center.

Methods

We retrospectively analyzed 141 patients undergone surgery for spleen-related diseases from 2010 to 2019 in the Department of Surgery of S. Eugenio Hospital in Rome. Indication to LS for hematologic disorders was always given by Division of Hematology of S. Eugenio Hospital and by our Regional Reference Centre for Thalassemias and Congenital Anemias (RRCTCA).

All patients were selected according to the European Association for Endoscopic Surgery (EAES) guidelines (2). Exclusion criteria were American Society of Anesthesiologists (ASA) IV and severe portal hypertension. Supermassive spleen with maximum diameter superior to 25 cm was considered a very important limit, but not an absolute contraindication. Diameter ≥30 cm was considered a contraindication.

Preoperative computed tomography or ultrasonography was always performed in order to identify accessory spleens and to measure splenic diameter and volume. All patients received vaccination for pneumococcal, meningococcal and Haemophilus Influenzae B about 2–4 weeks before surgery. Antibiotic prophylaxis was performed at the induction of anesthesia. In cases of increased thromboembolic risk, perioperative low molecular weight heparin was administered.

At the beginning of the experience the patients underwent laparoscopic surgery in right lateral decubitus. This position was soon abandoned; we preferred the anterior approach with the patient in supine position with the lower limbs spread. This allowed a good access to the omental pouch, an excellent visualization and control of the splenic hilum, the stomach, the body-tail of the pancreas offering the possibility to carry out other associated procedures.

The operating table was tilted in reverse Trendelenburg position and with a right rotation of 30°. The surgeon was between the patient legs and the camera driver to the patient's right. An assistant took place on the left side of the camera driver. The scrub nurse was to the right of the surgeon. The monitor was positioned at the level of the patient's left shoulder.

The surgical technique described below is related to the patients operated in supine position. After induction of pneumoperitoneum at 14 mmHg with Veress needle in the left paraumbilical region, a 10-mm trocar was positioned in the same site. In 68 patients (63.0%) were introduced other two trocars: a 5-mm one at the point between the upper third and the lower two thirds of the left paramedian line and a 10-mm trocar some centimeters below the left subcostal area, depending on the longitudinal length of the spleen, on the anterior axillary line. In the remaining 40 cases (37.0%) a fourth 5-mm trocar was placed.

After a careful exploration of the abdomen, the first step was the incision of the splenocolic and phrenicocolic ligament to mobilize the left flexure of the colon. Section of the splenocolic ligament permitted the subsequent dissection of the splenorenal ligament, with a posterior approach of the splenic hilum. After a complete division of the gastrosplenic ligament, the short gastric vessels were closed and sectioned along greater gastric curvature using radiofrequency dissector and an exploration of the lesser sac was allowed.

As previously described by Corcione *et al.* (5) the splenic artery was identified and dissected free from the upper border of the pancreatic tail and closed with a hem-o-lok approximately 2–3 cm from the splenic hilum, in order to reduce blood supply to the spleen and its volume. The radiofrequency device was also used to completely detach splenodiaphragmatic ligament; this manoeuvre allowed to lift the spleen, making splenic vessels stretched and straight; these were easily closed and divided with linear endoscopic stapler with vascular cartridge, close to the splenic hilum.

Concerning the removal of the spleen, in case of benign disease the specimen was introduced in a 15-mm retrieval bag, morcellated and extracted through an access for a 10-mm trocar in the shape of fragments and flesh; a meticulous care was taken to avoid pulp spillage in abdomen. In case of malignant disease, the specimen was removed whole and intact through a Pfannestiel incision or through already present surgical scars. In all patients, after reduction of intra-abdominal pressure to 9–10 mmHg, a careful check of hemostasis was done. At the end of the procedure a drain was placed through the port incision on the middle axillary line and left in the upper-left quadrant for 1 or 2 days.

Early and mid-term results have been evaluated considering these parameters: conversion rate, operative time, intraoperative complications, postoperative morbidity and mortality, reoperation rate, postoperative pain [Visual Analogue Scale (VAS) score], time of resumption of peristalsis, time of oral intake, length of hospital stay, time

Table 1 Indications and contraindication to laparoscopic splenectomy in the case series

Indication
Hemolytic anemias
Acquired autoimmune anemia
Congenital hemolytic anemia
Congenital hemoglobinopathies
Thrombocytopenia
Idiopathic thrombocytopenic purpura
Thrombotic thrombocytopenic purpura
Felty's syndrome
Malignancies
Hodgkin lymphoma
Non-Hodgkin lymphoma and leukemias
Miscellanea
Contraindications
ASA IV
Portal hypertension
Diameter ≥30 cm

ASA, American Society of Anesthesiologists.

to return to normal activity.

Statistical analysis

SPSS® version 17.0 (IBM, Armonk, New York, USA) was used for statistical analysis. Data were expressed in median with interval. The Mann-Whitney U test was used to analyze quantitative variables and $P<0.05$ was considered statistically significant.

Results

From 2010 to 2019, 141 patients were operated for spleen-related disease; out of these 28 patients (all in the benign disease group) were excluded from the laparoscopic approach because of: spleen diameter ≥30 cm (17 cases), severe cardiopathy (4 cases), and portal hypertension (7 cases). A total of 113 patients (69 males and 44 females, mean age of 27.0±4.4) underwent LS. In the present study 5 patients operated with the laparoscopic lateral approach were excluded from the analysis to have a homogeneous case series. As shown in *Table 1*, most of indications for LS were for benign hematological disorders (90 patients, 84%), conversely 15 patients (16%) underwent surgery for malignancy.

Table 2 Pre- and postoperative data

Data	Value
Intraoperative data	
Operative time (min), mean [range]	70 [50–120]
Intraoperative complications, n (%)	5 (4.6)
Estimated blood loss (cc), mean [range]	85 [40–310]
Conversion rate, n (%)	5 (4.6)
Postoperative data	
Mortality	0
Overall morbidity, n (%)	21 (20.4)
Postoperative pain (VAS), mean [range]	3.1 [2.9–6.5]
Oral intake (days), mean [range]	1.5 [1–3]
Hospitalization (days), mean [range]	4 [3–6]
Readmission rate	0

VAS, Visual Analogue Scale.

Mean operative time was 70 min (range, 50–120 min). The mean intraoperative blood loss was 85 cc (range, 40–310 cc), excluding five cases converted for hemorrhage, with a mean of 0.4 (range, 0–3) units of concentrated red blood cells transfused.

In 41 patients (38%) a macrobiopsy of the liver was performed to evaluate hepatic siderosis grade and, in viral patients, the hepatopathy stage.

In 40 cases (38.0%) a fourth 5-mm trocar was used: in 22 patients it was positioned in right hypochondrium to perform a cholecystectomy for associated cholelithiasis; in 18 patients in left subxiphoid region to medially retract the larger curvature of the stomach and to better expose the splenic hilum.

Conversion to open splenectomy occurred in 5 cases (4.6%) due to intraoperative bleeding from vessels or from spleen parenchyma. All the conversions occurred in the early phase of the experience, within the first 30 cases.

As shown in *Table 2*, in the 103 cases carried out laparoscopically, we registered 21 (20.4%) minor and major postoperative complications: two early hemorrhage (1.9%) in the first postoperative day; 4 (3.7%) fluid collections in the splenic fossa and pleuritis; 6 (5.6%) pneumonia and

atelectasis and 9 (8.3%) cases of transient fever despite none evidence of hematoma or infection were detected.

One of the 2 hemorrhages required a reintervention that was performed laparoscopically. The bleeding was identified from a short gastric vessel and it was controlled by the radiofrequency dissector. The other complications were treated medically, increasing the hospital stay.

Pain was evaluated with VAS score during the hospitalization and within the first post-operative week. Sixty-six patients (64.1%) reported mild pain; in 22 patients (21.4%) moderate pain was registered, and 15 patients (14.6%) had severe pain. All patients were well treated with paracetamol 1 g twice a day and none of them required pain killer and/or paracetamol after the first postoperative week.

The 15 patients (14.6%) undergone specimen extraction through the suprapubic incision reported a higher pain compared with those in which spleen morcellation was performed (6.2 *vs.* 3.4, P<0.05).

The resumption of peristalsis and nutrition per os occurred in an average of 1.5 postoperative days (range, 1–3 days), moreover the mean hospital stay was 4 days (range, 3–6 days), despite a longer hospital stay in patients with malignancies was detected (P<0.05) but none of all patients was readmitted after discharge. Mean time to return to normal activity was 7 days (range, 4–10 days). No late complications during the mean 3 years follow-up (range, 1–4 years) were observed.

Discussion

In 1910 Sutherland and Burghard (6) described the first splenectomy in a patient affected by hereditary spherocytosis. In 1950's postoperative morbidity was very high and mortality exceeded 15% (7); because of this and considering the fair effectiveness of therapies, splenectomy was reserved to not responding to medical treatment patients. This situation lasted until 1991 when Delaitre and Maignien (1) performed the first LS.

Nowadays LS is the gold standard for the treatment of hematological disorders (8) and this surgical approach is preferred due to the small scars realized. The minimally invasive approach to the abdominal cavity has better therapeutic effects and results compared to the open surgery (9). This technique is able to produce better results in long-term efficacy in resolution of hematological diseases, particularly the autoimmune ones. The effectiveness of LS was registered in 60–80% of cases of autoimmune hemolytic anemias (particularly in idiopathic form), in 80–90% of cases of idiopathic thrombocytopenic purpura and in 89% of patients suffered from thrombotic thrombocytopenic purpura. In hereditary spherocytosis LS is curative until 100%. Good results are also registered in major and intermedia thalassemia with splenomegaly syndrome and progressive transfusion-dependent anemia (10-12). According to our experience, LS should be the treatment of choice for the management of benign and malignant splenic diseases, but portal hypertension from liver cirrhosis, severe uncorrected coagulopathy and supermassive 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. The recent EAES guidelines (2) confirmed the laparoscopic approach is preferable to open surgery for most indications because it reduces complications and shortens recovery despite there was no agreement concerning the indication of splenomegaly, that is defined when a diameter is 15 cm and massive with a diameter of 20 cm; the study concluded the surgeon's surgical skills may direct the choice between open, hand-assisted and laparoscopy. The potential for complications increases with spleen size and massive splenomegaly should be considered relative contraindication for LS.

We had no experience in hand-assisted splenectomy because we do not consider it a laparoscopic procedure and the open technique was used in a few cases furthermore we are not able to compare these different approaches for the small sample size. Our report shows the efficacy, the safety and the effectiveness of the totally laparoscopic approach in terms of post-operative complications, hemorrhage and postoperative pain, even in splenomegaly with a maximum diameter up to 25 cm.

Concerning the position of the patient, some Authors prefer the lateral approach since the abdominal viscera are retracted away by gravity providing a good exposure of the splenic hilum and the pancreatic tail (13,14). Other Authors maintain that the lateral approach results in reduction of trocars needed, less intraoperative blood loss, and lower conversion rate (9). In a recent report Corcione *et al.* concluded the lateral approach was associated with shorter operative time (60 *vs.* 80 min), less blood loss and reduced postoperative complications (5).

We initially adopted the lateral approach with the patient placed in a flexed right lateral decubitus, but soon we abandoned this position because the spleen is too close to the trocars, with difficulty of organ manipulation and we chose supine position as the standard approach (15). In this

way we had the best exposition of the splenic vessels and hilum without any contact with the spleen before closing the splenic artery, particularly of its anterior side, which must be well accessible in case of bleeding. The supine approach allows to do the operation in most cases with three trocars only, avoiding the necessity to use a trocar to insert an instrument to maintain the spleen away from its hilum, as is mandatory in the lateral approach. With the supine position we didn't experienced a long operative time, a major blood loss or a greater number of complications as stated by the Authors who prefer the lateral setting. As the matter of fact our data are the same of those obtained by other Authors with the lateral approach. The anterior approach has also the advantage of performing other concomitant abdominal operations such as cholecystectomy or appendectomy without enlarging the surgical incisions or change trocars or patient position, finally the anterior approach may provide a short learning curve because of well-known laparoscopic landmarks and this may reduce intra and postoperative complications however it should be accepted that both right lateral and supine position are efficient; definitive choice should be based on the individually gained experience.

Similarly, the surgeon determines the number and trocars location. In our experience we used three trocars in majority of cases, but a fourth trocar was introduced to perform an associated cholecystectomy or, in case of massive splenomegaly, to retract greater gastric curvature and better expose the vascular structures. We utilized in all cases a triangular shaped position of ports, as previously described, paying attention to adjust the height based on body habitus and spleen size. Bleeding is the main complication and cause for conversion during LS. Use of the endovascular stapler is reported to shorten and facilitate hilar dissection compared with the former techniques of ligation or clipping (16-18).

Recently, electrothermal bipolar vessel sealer (LigaSure™) or ultrasonic coagulating shears (Ultracision Harmonic Scalpel™, Ethicon Endosurgical, Cincinnati, OH, USA) have been used for dissection of smaller polar vessels and the small gastric vessels (19), vessel-containing tissue (20,21), or even the greater hilar vessels (22). Romano *et al.* (23,24) reported the safe use of LigaSure™ for hilar vessels with a diameter up to 7 mm in patients with normal-sized to slightly enlarged spleens as well as lower blood loss, shorter operative time, and even lower costs than with other techniques.

In all cases we controlled the hilum vessels, after closing the main trunk of the splenic artery with a hem-o-lok, with a linear stapler with vascular cartridge. We called this method "the stapling technique" (15).

In our opinion this method is easy, safe, fast and efficient. The employment of radiofrequency sealer allows avoiding the use of monopolar scissors, bipolar dissectors and clips in closing and sectioning short vessels and ligaments. In any case it should be avoided the preliminary application of clips close to hilum, because clips, intervening in the action line of stapler, could spoil it, with disastrous effects.

Conclusions

We consider the laparoscopic technique the gold standard for splenectomy. Important steps to prevent surgical pitfalls are an adequate control of haemostasis in order to reduce the conversion rate, avoid parenchymal rupture and cell leakage and, moreover, the excision of the splenic artery that may be responsible for treatment failure surgical. LS requires extensive experience in laparoscopic surgery, adequate patient positioning and trocars positioning and above all a delicate and meticulous dissection of the spleen.

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(as revised in 2013). Approval of our ethical committee and individual consent for this retrospective analysis were waived.

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