Stapleless, clipless, and ligatureless laparoscopic splenectomy: possibilities and hazards

Ayman Essawi, Mohamed Ibrahim, ElAshraf Thabet

General Surgery Department, Fayoum University Hospitals, Fayoum, Egypt

Correspondence to Mohamed Ibrahim, Assistant Professor at General Surgery Department, Fayoum University, Fayoum, 63514, Egypt. +201002662279; fax: +20842160180; e-mail: mohamedibrahim555@hotmail.com

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Background: Elective open splenectomy is now fading in favor of the laparoscopic approach in different indications to remove the spleen. Reports are being published using either the LigaSure or the Harmonic Scalpel vessel sealing systems beside the classic hemoclips and Endo GIA staplers when dealing with the hilar vascular pedicle. **Methods:** 35 laparoscopic splenectomies were carried out for different indications since February 2013 till September 2016. **Results:** Splenic weights ranged from 140 to 1625 grams. Patient presentations were thalassemia major (n=16), hypersplenism (n=9), immune thrombocytopenic purpura (n= 6), hereditary sphirocytosis (n=2), lymphoma (n=1), benign splenic neoplasms (n=1). The Maryland LigaSure was the sole vessel sealing system used for Individual dissection and division of hilar, polar and marginal splenic vessels and for freeing the spleen of its ligamentous attachments. No other sealing system, clips, or staplers were used. Operative time ranged from 47 to 165 minutes. Only one case had to be converted due to bleeding. Sparing the converted case, blood loss ranged from 0 to 150 ml. Complications included one conversion due to hilar bleeding and one subphrenic collection. **Conclusion:** The sole utilization of the Maryland LigaSure system is safe, time sparing and cost effective in elective Splenectomy for different indications.

Keywords:
clipless, laparoscopic splenectomy, ligatureless, stapleless

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Introduction

Since the first laparoscopic splenectomy (LS) by Delaitre and Mignen in 1991, the procedure has gained wide acceptance and has become the gold standard for elective splenectomy in many splenic disorders [1–3]. LS is associated with less postoperative and wound complications [4]. Arrays of methods were exercised to control and divide the hilar vasculature. The linear stapler was the most commonly used in addition to clips, harmonic shears, and LigaSure [3]. With the introduction of the Maryland LigaSure (Valley Lab.), we found that dissection of hilar vessels and their division was much easier even than the 5- and 10-mm straight LigaSure devices. LS could be completed in 35 consecutive elective cases that are being evaluated in this study.

Patients and methods

The study protocol was approved by the Faculty Ethical Committee, Fayoum University. Since February 2013 to February 2016, 49 splenectomies were done in our hospital. Of them, 35 (71.4%) underwent LS. LS candidates were 21 females and 14 males, with an age ranging from 11 to 61 years (mean, 26.5 years). BMI ranged from 17 to 31 kg/m^2 (mean, 23.3 kg/m^2), as shown in Table 1. American Society for Anesthesiology scoring was I (n=31) and II (n=4). The preoperative ultrasound splenic span measured ranged from 12 to 24 cm (mean, 16 cm). Indications for surgery were thalassemia major (n=16), hypersplenism (n=9), immune thrombocytopenic purpura (n=6), hereditary spherocytosis (n=2), lymphoma (n=1), and benign splenic neoplasms (n=1) as shown in Table 2. All patients received Streptococcus pneumoniae, Haemophilus influenzae, and meningococcal vaccination at least 3 weeks before surgery. Platelet transfusions were given, if needed, 3 h before surgery in patients with platelet counts less than 30 000/cmm [5]. Operative time is the lapse between the first incision and wound closure. Amount of blood loss was measured by subtracting the irrigation fluid volume from the suction bottle volume.

Surgical technique

Patients were kept in the right lateral position with the left shoulder thrown slightly to the back, and the operating table was in the anti-Trendlenburg position and flexed opposite the patient's lumbar region. A nasogastric tube was inserted. Veress

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needle was put in the left hypochondrium to establish pneumoperitoneum. A 10-mm optic port was inserted lateral and superior to the umbilicus and used for 30° viewing scope. A 5-mm left lumbar port was used as a working port and is placed slightly down in the lumbar region for the dissecting shears to be in plain and perpendicular to the splenic vessels. Two 5-mm ports are inserted in the epigastrium and along the left posterior axillary line. The last one is for the assistant to use a peanut gauze held by a grasper for retracting the spleen laterally during hilar dissection. Accessory spleens are searched for and excised. After separating the left colic flexure from the spleen, division after sealing of vascular structures is carried out starting from the lower splenic pole to the upper one. The pancreatic tail is separated from the splenic hilum, and areolar space between them is dissected till behind the hilar vessels. Short gastric vessels proximate to the splenic hilar vessels are dissected and separated for a short distance only to create a space between them and the upper limit of the hilar vessels. This space is deepened posteriorly to create a tunnel, making it easier to control and delineate the splenic hilum. Arteries are divided first, and veins are divided following their collapse shortly after. For larger vessels with diameters larger than the instrument tip, we start by sealing splenic artery first. This leads to collapse of the vein, and in nearly all the cases, we were comfortably able to seal it. If by any means we found the vessel extending beyond the tips of the blades of the instrument, we put a sling around it using one or two silk thread. Minimal traction on this sling made it easy for the blades of the LigaSure (Valley Lab., Boulder, Colorado, USA) to control and seal the vessel.

When pedicle bleeding was encountered, it was controlled by a gauze pressure held by LigaSure through the right hand of the operator while using noncrushing clamp on the left hand to occlude the vessel accurately, then the gauze is removed slowly, and the vessel is sealed. All pedicle bleeding encountered were minor.

The rest of the short gastric vessels are divided up to the upper pole of the spleen. The left diaphragmatic cruss is usually visualized at this point. A gauze is left there between the upper splenic pole and the diaphragm. Dissection was then proceeded to separate the posterior splenic attachments, which were kept intact till the end of the procedure. The gauze left aids in visualizing and completing the upper pole separation when working our way up behind the spleen on leino-diaphragmatic attachments. All dissection and vessel sealing were performed using the LigaSure Maryland vessel-sealing system (Valley Lab.). This curved instrument with a blunt tip can separate and dissect fine and thicker tissues with ease and have credible sealing characteristics even for larger vessels. We did not use ligatures, laparoscopic staplers, or clips. The spleen is put in a thick improvised zipper nylon retrieval bag and delivered through a small Pfannenstiel incision. Splenic focal lesions entailed keeping an intact spleen. In hematologic diseases, it can be fragmented within the bag before extraction using a sponge forceps.

Table 1 Patients' demographics

Results of LS performed patients	*n*=35
Sex (male/female)	14/21
Mean BMI	23.3±7.7
Mean age	26.5±34.5

LS, laparoscopic splenectomy.

Table 2 Indications for splenectomy in this series

Indication for splenectomy	*n* (%)
Thalassemia major hypersplenism	16 (45.7)
ITP	9 (25.7)
Hereditary spherocytosis	6 (17.1)
Lymphoma	2 (5.7)
Benign splenic neoplasms	1 (2.8)

ITP, idiopathic thrombocytopenic purpura.

Results

Thirty-five patients were enrolled into the study. Mean operative time was 62 min (range, 47–165 min). Sparing the converted case, the mean amount of blood loss was 41 ml (range, 0–150 ml). Splenic weights ranged from 140 to 1625 g (mean, 840 g). There were three ectopic spleens discovered: two of them near the hilum, and one near the gastro-splenic ligament. The nasogastric tube was removed after 6 h. Oral fluids were started 12 h later. Mean hospital stay was 3.6 days (range, 2–5 days), as shown in Table 3. Morbidities included one subphrenic collection that merited readmission and sonographic-guided aspiration; the patient recovered completely. One conversion occurred owing to hilar bleeding. There were no mortalities.

Table 3 Intraoperative and postoperative data

Results of LS performed patients	*n*=35
Mean operative time (min)	62±103
Estimated blood loss (ml)	41±109
Mean splenic weight (g)	840±785
Mean spleen diameter (cm)	16±8
Mean hospital stay (day)	3.6±1.4
Complication rate (*n*=1) (%)	0.028
Conversion rate (*n*=1) (%)	0.028

LS, laparoscopic splenectomy.

Discussion

Splenectomy surgery is not an infrequent procedure in Egypt. Owing to the endemicity of viral hepatitis and thalassemia, most Egyptian surgeons are familiar with the open procedure. However, owing to lack of experience and other financial issues, LS is still confined to a limited number of centers and university hospitals. Like other laparoscopic procedures, LS offers numerous advantages over open splenectomy. In their meta-analysis reviewing 15 years of literature, Cheng *et al*. [6] supported the conclusion of superiority of LS as the better surgical approach for splenic disorders remedy with its advantage of rapid recovery and minimal physical damage. The main cause for conversion of LS is uncontrollable bleeding from the hilar vessels [7]. The splenic hilar vasculature can be controlled through three ways. The first is Endo GIA stapler, which is used in most LS cases abroad [8]. Difficulty of applying the jaws of the stapler to the isolated vascular structures and hemorrhage may occur [3]. Moreover, the tail of the pancreas can be caught and injured between the jaws of the stapler leading to pancreatic fistula or pancreatitis [9]. The main drawback of the stapler in our country is its expense. The second way is to use ligatures and/or clips where operative time should be spent in delineating and skeletonizing vessels. A lot of clipses might be left behind as potentially harmful foreign bodies [9]. Tan *et al*. [10] used a cheap method of double proximal vessel ligation and distal vessel clips application before cutting in between. This method may lengthen operative time and ligatures may tear vessels [11]. The third method is to divide the splenic vessels using the LigaSure vessel-sealing shears: it is safe in sealing arteries up to 7 mm in diameter and is Food and Drug Administration approved. It works by creating a seal formed from denatured collagen and elastin within the vessel wall and surrounding connective tissue. At 20 days, this seal is characterized by intrinsic fibrosis with minimal inflammation [12,13]. In their paper published in 1998, Kennedy *et al*. [12] used an in-vitro model of porcine renal arteries. They stated that the median acute vessel (arterial) burst strength for the LigaSure was 900 mmHg, equal to that for hemoclips and ligatures and significantly higher than that for ultrasonic coagulating shears, conventional bipolar coagulating shears, or conventional bipolar coagulators [12]. Concerning LigaSure closure and division of veins, a study on porcine model by Landman *et al*. [14] stated that it can be used to close veins up to 12 mm in diameter. Lateral thermal spread is also kept to a minimum (<2 mm), with low smoke production [15]. This helps safe dissection around the pancreatic tail. Before setting this study, we noticed that most of our earlier conversions were owing to venous not arterial bleeding. Contrary to veins, bleeding arteries are easier to locate, can be precisely held by gaspers, and controlled if bled. Shabahang *et al*. [16] found superiority of the LigaSure vessel-sealing shears over clipping in LS, but the number of their study patients was small. Conversion rate owing to bleeding ranges from 5 to 46% [17]. One (3%) patient was converted owing to bleeding in our series. Common indications for LS in our series were different compared with other studies. Hemolytic anemias, especially thalassemia, ranked first in our list, whereas idiopathic thrombocytopenic purpura topped the indications in studies done in developed countries, where Barbaros and colleagues performed LS in 29 patients, for idiopathic thrombocytopenic purpura in 20 (69%) patients, thrombotic thrombocytopenic purpura in two (6.9%) patients, hereditary spherocytosis in three (10.3%) patients, lymphangioma in two (6.9%) patients, and Hodgkin's lymphoma and splenic cyst in one patient for each. The mean operative time was 71.3±19.8 min, the estimated intraoperative blood loss was 85±23 ml, and the mean splenic diameter and weight were 10.7 ±2.68 cm and 250±90 g, respectively. No mortality but postoperative complications occurred in three patients (pancreatic fistula, trocar site infection, and deep venous thrombosis in one patient each) [18].

Our mean operative time was 62 min (range, 47–165 min), which was not different compared with other studies [4,17]. Twenty-one cases in our series had a splenic span of 18–24 cm, whereas 14 cases had a splenic span of 12–18 cm, indicating working on splenomegaly in most of our cases. Sparing the converted case, the mean amount of blood loss was 41 ml (range, 0–150 ml). This is comparable to other studies [1]. Mean postoperative hospital stay was 3 days (range, 2–6 days), which is not different from other studies. In teaching our younger fellows LS, which is a technically demanding procedure, it is all about the three P's of laparoscopic surgery in general: a plan to correctly place the working ports putting the vessel-sealing device at right angle to hilar vessels; a plain created and advanced posteriorly between the pancreatic tail and lower hilar vasculature, and finally patience in carrying out dissection.

Conclusion

LS can be consistently and safely carried out with the sole use of the 5-mm Maryland LigaSure and needless

of clips, ligatures, or staplers. It gives the merits of credible hemostasis and precise dissection especially between the hilar vessels and pancreatic tail.

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Conflicts of interest
There are no conflicts of interest.

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