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TOPIC HIGHLIGHT

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Laparoscopic splenectomy for hypersplenism secondary to liver cirrhosis and portal hypertension

Xiao-Li Zhan, Yun Ji, Yue-Dong Wang

Xiao-Li Zhan, Yun Ji, Yue-Dong Wang, Department of General Surgery, Second Affiliated Hospital Zhejiang University College of Medicine, 88 Jiefang RD, Hangzhou 310009, Zhejiang Province, China
Author contributions: Zhan XL and Wang YD performed the literature search and wrote the paper; Ji Y and Wang YD reviewed the paper; Wang YD gave final approval of the manuscript.
Correspondence to: Yue-Dong Wang, MD, PhD, FACS, Department of General Surgery, Second Affiliated Hospital Zhejiang University College of Medicine, 88 Jiefang RD, Hangzhou 310009, Zhejiang Province, China. wydong2003@hotmail.com
Telephone: +86-571-87315253 Fax: +86-571-87022776
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Abstract

Since the first laparoscopic splenectomy (LS) was reported in 1991, LS has become the gold standard for the removal of normal to moderately enlarged spleens in benign conditions. Compared with open splenectomy, fewer postsurgical complications and better postoperative recovery have been observed, but LS is contraindicated for hypersplenism secondary to liver cirrhosis in many institutions owing to technical difficulties associated with splenomegaly, well-developed collateral circulation, and increased risk of bleeding. With the improvements of laparoscopic technique, the concept is changing. This article aims to give an overview of the latest development in laparoscopic splenectomy for hypersplenism secondary to liver cirrhosis and portal hypertension. Despite a lack of randomized controlled trial, the publications obtained have shown that with meticulous surgical techniques and advanced instruments, LS is a technically feasible, safe, and effective procedure for hypersplenism secondary to cirrhosis and portal hypertension and contributes to decreased blood loss, shorter hospital stay, and less impairment of liver function. It is recommended that the dilated short gastric vessels and other enlarged collateral circulation surrounding the spleen be divided with the LigaSure vessel sealing equipment, and the splenic artery and vein be transected en bloc with the application of the endovascular stapler. To support the clinical evidence, further randomized controlled trials about this topic are necessary.

Key words: Laparoscopy; Splenectomy; Liver cirrhosis; Portal hypertension; Hypersplenism

Core tip: With meticulous surgical techniques and advanced instruments, laparoscopic splenectomy is becoming a technically feasible, safe, and effective procedure for hypersplenism secondary to cirrhosis and portal hypertension, and contributes to decreased blood loss, a shorter hospital stay, and less impairment of liver function. It is recommended that the dilated short gastric vessels and other enlarged collateral circulation surrounding the spleen be divided with LigaSure vessel sealing equipment, and blunt dissection be avoided. Use of the vascular stapler is reported to shorten and facilitate hilar dissection compared with the former techniques of ligation or clipping.

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INTRODUCTION

Millions of patients with chronic hepatitis B or C infection and chronic alcohol consumption may develop liver cirrhosis[1,2], which can lead to portal hypertension and hypersplenism. Portal hypertension increases the risk of variceal bleeding and results in a bleeding tendency due to thrombocytopenia[3]. For patients with cirrhosis, bleeding portal hypertension, and secondary hypersplenism, splenectomy and devascularization or shunt surgery were necessary[2]. Recent advances in interferon therapy have contributed to the elimination of hepatitis C virus both in patients with compensated cirrhosis and in those without cirrhosis[4,5]. Patients who have hypersplenism with splenomegaly, however, cannot receive such treatment due to thrombocytopenia, leukocytopenia, or both[5,6], so they are good candidates for splenectomy.

Open splenectomy (OS) has been performed for hypersplenism since 1950[7], but OS is excessively invasive in terms of blood loss and wound pain. For patients with hypersplenism who have poor liver function, splenectomy is associated with high rates of morbidity and mortality. Catheter-based arterial embolization has gradually become more popular, but some severe complications have been reported, which limit its wide use[2,8].

Laparoscopic splenectomy (LS) was first reported in 1991[9]. Since then, many studies have demonstrated the advantages of the laparoscopic approach over OS including a shorter hospital stay, decreased blood loss, faster recovery, and better quality-of-life outcomes. LS has become the golden standard for removal of normal to moderately enlarged spleens, even in malignant splenic disorders[10-16]. Mastery of the laparoscopic skills and the advances in technology have led to an increasing use of LS for hypersplenism secondary to liver cirrhosis and portal hypertension[2,3,17-24], but the safety of LS for patients with hypersplenism has not yet been established. Portal hypertension from liver cirrhosis is still considered a contraindication to LS in many institutions[25,26]. The aim of this article is to give an overview of the latest development in laparoscopic splenectomy for hypersplenism secondary to liver cirrhosis and portal hypertension, as well as to evaluate the feasibility and safety of laparoscopic splenectomy in portal hypertension.

SURGICAL INDICATIONS

Mastery of laparoscopic skills and the advances in technology have allowed a wide range of minimally invasive procedures to replace their open counterparts and led to better outcomes, allowing surgeons to apply the technique to disease processes that were previously regarded as contraindications to LS[27]. In keeping with the precept that laparoscopic surgery should hold to the same indications as the corresponding open procedure, the indications for LS are the same as those for OS. Splenectomy can be used in the prevention of increased elimination of the corpuscular elements of the blood and relieving symptoms caused by an enlarged spleen, possibly including abdominal distension, pain, and fullness or early satiety, or it may be used for staging purposes in case of malignant diseases[25].

Splenectomy is generally indicated for cirrhotic patients whose platelet count drops below (30-50) × 10^9/L[2,20]. Watanabe *et al*[20] did LS in hepatocellular carcinoma patients with platelet counts ⩽ 30 × 10^9/L, or in patient receiving interferon therapy with a platelet count ⩽ 50 × 10^9/L or with a past history of severe thrombocytopenia caused by interferon therapy. Hirooka *et al*[28] reported that splenectomy was performed according to the following criteria: (1) thrombocytopenia (platelet count < 8 × 10^9/L); (2) leukocytopenia (white blood cell count < 2 × 10^8/L); or (3) in the case of consenting splenectomy. To date, splenectomy has been recommended for those patients with liver cirrhosis who have a bleeding tendency due to thrombocytopenia, endoscopic treatment-resistant esophagogastric varices or difficulty in undergoing surgical treatment or those patients who remain unsuitable for chemotherapy for hepatocellular carcinoma due to thrombocytopenia[5,28,29], and also for cirrhotic patients who require antiviral therapy[5,30-32] or have portal hypertensive gastropathy[33]. For patients with cirrhosis, bleeding portal hypertension and secondary hypersplenism, LS and devascularization were indicated[2,21,22,29,34].

Low-risk patients with stage Child-Pugh A or B liver cirrhosis are preferred to receive the procedure[3,20,21]. The absolute contraindications for laparoscopic surgery in portal hypertension are patients who can not tolerate general anesthesia, have intractable coagulopathy, and/or have any contraindications to laparoscopy[21].

SURGICAL TECHNIQUES

Laparoscopic splenectomy

LS can be performed using a lateral, semilateral, or supine approach depending upon the surgeon preference, spleen size, patient characteristics, and the need of concomitant procedures[25]. The anterior or supine position allows for a good access to the omental pouch and an excellent visualization of the splenic hilum. Some authors stated that this approach may be advantageous in case of very large spleens[14,35]. The splenic artery may be ligated early, thereby diminishing the risk of severe hemorrhage[21,35]. The anterior (or supine) position is indicated in case concurrent procedures need to be performed (*e.g.*, cholecystectomy, or biopsies of other organs)[26,35]. Difficulties arise in exposing and dissecting the ligamental structures as well as the dorsal vessels and the splenic hilum, due to their close relationship to the tail of the pancreas[25,26]. With the fully lateral approach, the patient is positioned at a 90-degree angle to the operating table. The spleen and viscera fall medially due to gravity, facilitating the dissection of the ligaments and hilar structures. Thus, this approach allows for safe vascular control. Visualization of the tail of the pancreas is good, thereby minimizing the risk of pancreatic injury[25,26]. For the majority of indications the hemi- (or semi-) lateral approach is preferred by most of the authors[35]. With this approach, the patient's position can be adjusted to surgical requirements by tilting the table so that a fully supine or fully lateral position is obtained. Some authors prefer a hemilateral position at the beginning of the procedure for easy access to the lower sac and division of the short gastric vessels[25,27,29]. The table then can be tilted to a more lateral position in which the spleen and other organs (stomach and intestine) fall medially by gravity. This allows for easier access to the posterior face of the spleen and the perisplenic ligaments[25,26]. Thus the dissection and ligation of the vessels at the splenic hilum are facilitated while the tail of the pancreas is spared.

The surgeon operates from the right side of the operating table using a 10-mm 30-degree scope. In general, four operative ports are used for LS[27,35], and the placement of the trocars depends upon the size of the spleen. A 10-mm trocar is placed to the superior right of the umbilicus for the camera. Another 10-mm operating trocar is placed in the left midclavicular line just below the border of the spleen to pass the LigaSure vessel-sealing equipment (LigaSure AtlasTM; Tyco Healthcare, Boulder, CO, United States) or harmonic shears (Harmonic Scalpel; Ethicon EndoSurgery, Cincinnati, OH, United States). A 5-mm trocar is placed in the subxiphoid space for allowing the use of a supplementary retractor or grasper. A 12-mm trocar is placed in the left midaxillary line halfway between the costal margin and the iliac crest or below the border of the spleen for the application of the endoscopic linear vascular stapling device and other supplementary instruments[27].

The procedure begins with the division of the splenocolic attachments and the opening of the gastrocolic ligament to access the lesser sac. Whenever possible, the splenic artery is dissected and tied at the upper border of the pancreas in patients with splenomegaly[27,29]. The splenogastric ligament (including short gastric vessels) and the splenorenal ligament are divided with the LigaSure vessel-sealing equipment or harmonic shears. The splenic hilum is dissected cautiously, and the splenic artery and vein are transected en bloc with the application of a linear laparoscopic vascular stapler (EndoGIA; AutoSuture, Norwalk, CT, United States, or Endolinear Cutter; Ethicon Endosurgery)[21,27]. Use of the vascular stapler can shorten and facilitate hilar dissection compared with the former techniques of ligation or clipping[25], also the clipping technique is not a safe procedure for massive splenomegaly because of the high conversion rate[36]. In addition, should bleeding ensue within the hilum, vascular staplers or suture must be used to control the bleeding. As few clips as possible are used because these may interfere with the use of vascular staplers and sutures. The remaining spleen diaphragmatic attachments are divided using the LigaSure vessel-sealing equipment or harmonic shears, therefore completing the splenectomy. The resected spleen is placed in a large specimen bag, then morcellated and retrieved[27]. Some authors reported that an electromechanical morcellator was used to remove the large spleen without a cumbersome intracorporeal bag or enlarged incision[29,37].

Laparoscopic azygoportal disconnection

Most patients underwent the laparoscopic Hassab's operation. The patient is put in the reverse Trendelenburg position, and another 10-mm operating trocar is placed in the left midclavicular line just below the costal margin. After finishing the splenectomy, dissection begins by approaching the left crus, which can be accomplished with the LigaSure vessel sealing equipment or harmonic shears, followed by opening the gastrohepatic ligament and identifying the right crus. The gastric coronary vein is visualized and its branches toward the esophagus and proximal stomach are divided near the esophagus and stomach walls with the LigaSure. At least 6-10 cm of the distal esophagus is dissected through the hiatus, and the paraesophageal venous collaterals are divided[21,22,34,38].

Five patients underwent the laparoscopic modified Sugiura procedure in one study. After finishing the para-esophagogastric devascularization, the lower esophagus of 2 patients was transected and then reanastomosed with a circular stapler (EEA; Ethicon) through an 8-10-cm accessory incision, and the spleen was extracted through the accessory incision. Gastrotomy in 3 patients was made on the anterior wall of the stomach, and a circular stapler (ILS, ECS25; Ethicon) was then introduced through the gastrotomy. The esophagus was tied around the stapler rod with a 3-0 polypropylene thread, then the stapler was fired and removed. The gastrotomy was closed with a straight stapler. The spleen was put into a big bag and then morcellated and retrieved[21].

The most important intraoperative complication during LS and azygos-portal disconnection is bleeding, which is the main cause of conversion. Capsule or small vessel tears may cause oozing, which contaminates the operating field and make the surgical procedure more difficult. It is very hard to manage massive hemorrhage from the major vessel or capsule fracture by laparoscopy; therefore, the prevention of bleeding during the procedure is fundamental. Generally, the harmonic shears can divide a 3-mm diameter vessel, and LigaSure vessel-sealing equipment can divide a 7-mm diameter vessel safely. It is recommend that the dilated short gastric vessels and other enlarged collateral circulation surrounding the spleen, distal esophagus and proximal stomach be divided with the LigaSure vessel sealing equipment, and blunt dissection be avoided[21,27].

Hand-assisted technique

Hand-assisted laparoscopic surgery is an alternative laparoscopic approach in which a minilaparotomy is planned and performed to enable the surgeon to introduce his or her hand while the pneumoperitoneum is maintained and the dissection maneuvers are performed under videoendoscopic control. It simplifies the performance of difficult procedures for experienced surgeons and can initiate the less experienced surgeons in advanced laparoscopic surgery[39].

Hand-assisted LS is a valid approach. It should be considered to avoid conversion to open surgery for mas-

Figure 1 Morcellated and retrieved spleen after laparoscopic resection of massive splenomegaly and hypersplenism secondary to portal hypertension in a child.

sive splenomegaly. The inserted hand allows for tactile feedback and can assist in the surgical process during dissection, retraction, and placement of the enlarged spleen into the retrieval bag. Furthermore, unexpected situations such as hemorrhage or adhesions can be controlled. The spleen then can be removed via the additional incision, often without morcellation. Some studies have shown that hand-assisted LS is a very feasible and appropriate procedure for cirrhotic patients with splenomegaly and hypersplenism, and it significantly facilitates the surgical procedure and reduces the operational risk[40-44]. In cases of splenomegaly, hand-assisted LS results in shorter operating times, lower conversion rates, and fewer perioperative complications compared with the purely laparoscopic approach[25]. The main drawback of hand-assisted laparoscopic surgery is that it requires an additional incision, thus increasing trauma[39].

Laparoscopic splenectomy for portal hypertension in children

LS in the pediatric population is a relatively uncommon procedure, but it has shown the same advantages over OS as for adults, such as similar or less blood loss, a similar or lower complication rate, a shorter hospital stay, and better cosmesis. Less postoperative pain and earlier return to normal activities are especially important for pediatric patients. If splenectomy is indicated for children, the laparoscopic approach should be preferred[25,45]. Only there are few reports about LS with or without devascularization for hypersplenism and portal hypertension[46,47]. One study involves 6 cases of hypersplenism secondary to portal hypertension, and the results have shown that LS for children with portal hypertension and massively enlarged spleens is technically feasible, safe, and effective (Figure 1). Splenomegaly is not a contraindication for LS in children; in fact, significant benefits might be gained with the use of the laparoscopic approach[47]. Another study reports LS and periesophagogastric devascularization for portal hypertension in 6 children, and the conclusion is that laparoscopic massive splenectomy with selective devascularization of the lower esophagus and the upper stomach is a technically feasible, effective, and safe surgical procedure. It has all the benefits of minimally invasive surgery and offers a new alternative modality for children with bleeding portal hypertension and hypersplenism[46].

Historically, splenomegaly was considered a contraindication for LS because the working space is limited, especially in children[47]. Large spleen size can, in fact, interfere with visualization of the spleen and with the identification, isolation, and division of its vessels. Very large spleens can be more fragile and therefore more prone to bleeding from tearing. Moreover, the size can interfere with spleen extraction using either a bag or additional incision. Although massive splenomegaly is not a contraindication to laparoscopic splenectomy, the parents should be informed of the longer duration of surgery and the theoretically higher risk of complications[45].

FEASIBILITY AND SAFETY

In this article, we selected 19 studies to evaluate the feasibility and safety of LS in portal hypertension. If there were multiple reports about this topic in an institution, the earliest study was used for analysis. All studies were observational, including 9 non-randomized comparative studies[2,3,20,22-24,38,44,48] and 10 case series[5,17,19,21,29,37,42,43,46,49]. A total of 302 LS procedures were performed in 9 studies. The rate of conversion varies between studies, from 0% to 9.6%. In total, 15 (4.97%) conversions from laparoscopic to open surgery were necessary mainly because of massive intractable bleeding, 13 patients underwent LS using the hand-assisted technique. Five reports involve the comparison between laparoscopic and open splenectomy for hypersplenism secondary to liver cirrhosis[2,20,23,24,48]. Four studies show that LS required longer operating times than OS in portal hypertension[2,23,24,48], but one does not[20]. The duration of LS reported by different authors varies widely, from 150 to 237.7 min. Compared with patients who underwent OS, patients who underwent LS suffered less intraoperative blood loss and required fewer blood transfusions[2,20,23]. Five cases of post-operative bleeding were reported, and the postoperative hospital stay was also shorter after LS than OS[2,23,24,48]. The outcomes for selected studies of LS are shown in Table 1.

One hundred and thirty-eight patients underwent LS and devascularization in 6 studies, and 11 (7.97%) patients required conversion to open surgery. Two reports involve the comparison between laparoscopic and open surgery for bleeding portal hypertension, and show significantly less blooding duing laparoscopic surgery[22,38]. Laparoscopy resulted in fewer cases of pleural effusion, earlier passage of flatus, and shorter hospital stays. During a postoperative follow-up period of 2 to 50 mo, esophagogastric variceal rebleeding occurred in five patients (6.3%) who underwent laparoscopic surgery and in six (8.2%) patients who underwent open surgery (P = 0.638), and the 4-year mortality rates for these two

Table 1 Outcomes for selected studies of laparoscopic splenectomy in portal hypertension

Ref.	*n*	Operative time (min)	Blood loss (mL)	Conversion	Major complications	Hospital stay (d)	Additional procedures
Hashizume *et al*[29], 2002	73	210.1 ± 101.9	374.7 ± 352.4	7	0	31 ± 25.5	Devascularization (15)
Kercher *et al*[19], 2004	11	189 (79-245)	141 (10-60)	HALS (4)	0	2.6 (1-6)	0
Watanabe *et al*[20], 2007	25	173 ± 53	359 ± 280	HALS (4)	0	NR	0
Hama *et al*[3], 2008	17	171 ± 68	248 ± 312	HALS (3)	Bleeding requiring re-surgery (2)	10.0 ± 4.0	0
Zhu *et al*[2], 2009	81	174 ± 42	150.6 ± 135.4	5	0	8.2 ± 2.0	0
Akahoshi *et al*[5], 2010	21	237.7 ± 43.5	138.2 ± 190.6	HALS (2)	0	12.6 ± 7.3	0
Cai *et al*[23], 2011	24	224 ± 44	162 ± 126	1	Bleeding requiring re-surgery (1)	7.5 ± 1.7	Devascularization (5)
Ando *et al*[48], 2012	10	224 ± 56	342 ± 513	0	0	14.6 ± 3.5	0
Wang *et al*[24], 2013	40	150 ± 30	150 ± 110	2	Postoperative bleeding (2)	6.1 ± 2.2	0

LS: Laparoscopic splenectomy; HALS: Hand-assisted laparoscopic splenectomy; NR: Not reported.

Table 2 Outcomes for selected studies of laparoscopic splenectomy and devascularization

Ref.	*n*	Operative time (min)	Blood loss (mL)	Conversion	Major complications	Hospital stay (d)
Hashizume *et al*[17], 1998	10	287.5 ± 66.0	515.5 ± 507.9	1	0	12.7 ± 4.9
Wang *et al*[21], 2008	25	246 (180-330)	100-400	1	0	9 (6-15)
Li *et al*[46], 2009	6	214 ± 18	135 ± 48	0	0	NR
Zheng *et al*[22], 2009	7	180	100	0	Gastric perforation (1)	12
Jiang *et al*[37], 2013	10	288.0 ± 53.9	240.0 ± 217.1	0	0	11.3 ± 3.2
Cheng *et al*[38], 2013	80	254.4 ± 65.2	191.2 ± 163.2	9 (11.3%)	IH (2), EVR (2)	10.1 ± 2.5

LS: Laparoscopic splenectomy; NR: Not reported; IH: Intra-abdominal hemorrhage; EVR: Esophagogastric variceal rebleeding.

Table 3 Outcomes for selected studies of hand-assisted laparoscopic splenectomy in portal hypertension

Ref.	*n*	Operative time (min)	Blood loss (mL)	Conversion	Major complications or mortality	Hospital stay(d)	Additional procedures
Yamamoto *et al*[42], 2006	7	184.3 ± 54.9	166.4 ± 152.7	0	Mortality (1)	NR	Devascularization (7)
Uehara *et al*[49], 2009	5	237 ± 12	229 ± 100	0	Paralytic ileus (1)	16.7 ± 2.5	0
Wang *et al*[44], 2012	19	124 ± 42	92 ± 65	0	0	7.2 ± 2.8	0
Ando *et al*[48], 2012	6	341 ± 94	531 ± 390	0	Massive ascites (1)	19.8 ± 8.7	Devascularization (6)
Kakinoki *et al*[43], 2013	28	227 ± 100	236 ± 246	1	Bleeding requiring re-operation (1)	NR	Hepatectomy (4), Cholecystectomy (4), RFA (1), Devascularization (5)

HALS: Hand-assisted laparoscopic splenectomy; NR: Not reported; RFA: Radio frequency ablation.

surgical approaches were similar[38]. The outcomes for selected studies of LS and devascularization are shown in Table 2. Sixty-five patients underwent hand-assisted LS in 5 studies. Among them, 13 underwent splenectomy and devascularization using the hand-assisted technique. The outcomes for selected studies of hand-assisted LS are shown in Table 3.

The influence of laparoscopic surgery in patients with deteriorated liver function is of great concern. One study showed that no changes in liver function were noted 2 wk after LS for patients with hypersplenism secondary to liver cirrhosis[20]. Other studies investigated the effect of LS and OS procedures on liver function and found that the increases of aspartate aminotransferase, alanine aminotransferase, total bilirubin and direct bilirubin after surgery were less significant in the LS group, which indicated minor liver function impairment[2,50,51].

The immune responses in the LS group were significantly lower than those in the OS group. The LS group exhibited better preserved cellular immune response and faster recovery than the OS group on post-operative day 7[52].

CONCLUSION

Despite a lack of randomized controlled trial, a common consensus maintains that with meticulous surgical technique and advanced instruments, LS is a technically feasible, safe, and effective procedure for hypersplenism secondary to cirrhosis and portal hypertension, and contributes to decreased blood loss, a shorter hospital stay, and less impairment of the liver function. The results obtained will encourage surgeons to attempt a wider range of minimally invasive procedures as a replacement to their open counterparts. However, further randomized trials comparing open and laparoscopic splenectomy are mandatory for patients with liver cirrhosis and portal hypertension.

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