

Original Article

Study on the efficacies of splenic pedicle transection by using manual manipulation and Endo-GIA procedure for laparoscopic splenectomy

Yong Fan, Yong-Yong Liu, Ping Wang, Chen Wang, Xu-Sheng Li, Ying-Xin Kang, Bo-Xiong Kang, Yan-Hui Zhao, You-Cheng Zhang

Department of General Surgery, Lanzhou University Second Hospital, Lanzhou 730000, China

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Abstract: Laparoscopy splenectomy (LS) was adopted in surgery from 1980s, it has become the main way of exploring for treating spleen diseases. Compared with conventional open surgery, LS has been gradually accepted by physicians and patients due to its advantages, including minimal surgical injury, less intraoperative blood loss, quick postoperative recovery, shorter hospital period, better cosmetic result, less risk of postoperative infections and improved postoperative quality of life. Here, we try to investigate the splenic pedicle transection by using Endo-GIA (a linear stapling device) procedure and manual manipulation of secondary splenic pedicle for LS. A retrospective study was conducted on 60 patients who underwent LS. And patients were divided into two groups. 30 patients (group A) received splenic pedicle transection with Endo-GIA procedure and in the other 30 patients (group B) underwent secondary splenic pedicle transection for LS. Perioperative outcome measures of each group were recorded, including operation duration, intraoperative blood loss, postoperative flatus pass time, postoperative complications, drainage duration, hospital cost and length of hospital stay. Surgeries were successfully achieved in 60 patients. The operative duration of group A was significantly shorter than that of group B. However, group B was significantly superior over Endo-GIA group in terms of the intraoperative blood loss, postoperative flatus pass time, drainage duration, length of hospital stay and total cost of hospital stays. No significant differences were observed in postoperative fever, ascites and hyperamylasemia between two groups. Both of these two approaches for LS are safe and feasible. However, compared with Endo-GIA procedure, manual manipulation of secondary splenic pedicle for LS may leading to less intraoperative blood loss, results in less hospital expense, and hence can be widely adopted in clinical practice.

Keywords: Laparoscope, splenectomy, splenic pedicle

Introduction

Laparoscopic splenectomy (LS) was first reported by Delaitre and Maignienin 1991 [1]. Due to its noted advantages, for examples: minimal invasiveness, less postoperative pain, faster recovery, fewer complications, shorter hospital stay, better cosmetic results, LS has been widely utilized in clinical practice [2]. LS has gradually become the standard splenectomy in the treatment of patients with normal to moderate enlarged spleen [3-5].

In recently two decades, LS has made remarkable outcome for treating the enlarged spleen disease. Firstly, LS was used in patients with hepatic fibrosis accompanied by normal to

moderate splenomegaly and in patients with idiopathic thrombocytopenic purpura [6, 7]. In 1995, the procedure for LS treat the massive splenomegaly was further implemented [8]. In 2011, Zhu Jiangfan reported the feasibility of the initial transection of the splenic hilum during the treatment of hand-assisted LS for the massive splenomegaly [9].

In the present study, we performed a retrospective study to compare the clinical efficacies of two surgical approaches for LS by using either Endo-GIA procedure or secondary splenic pedicle transection. We attempt to investigate the clinical outcome of these two treatment approaches.

Material and method

Patients

Between May 2009 and May 2013, 60 patients undertook LS at the Department of General Surgery of our institution were enrolled in this study. The recruit criteria were as follows: (1) Grade I-III splenic injuries with stable vital signs; (2) Patients with cirrhosis accompanied by moderate or severe hypersplenism; (3) Benign splenic space-occupying lesions, such as hemangioma, hamartoma, or cyst. Preoperative B ultrasound or CT scan was performed to measure the size of the spleen. All the patients were took the preoperative gastroscopy checking. Patients with cirrhosis revealed the presence of mild to moderate esophageal or gastric varices without red spot and no history of pericardial vascular transection were excluded. Patient's liver function were classified by Child-Pugh score, and results showed there were 45 cases Grade A and 15 cases Grade B. Laboratory examination showed red blood cells (RBC) of $(2.12\sim6.15)\times10^{12}/L$, white blood cells of $(2.13\sim6.72)\times10^9/L$ and platelets of $(35\sim229)\times10^9/L$. All surgeries were performed by surgeons at the same surgical team.

Based on the operation implemented, 60 patients were divided into two groups. 30 patients undertook LS used Endo-GIA stapler were named Group A, and the other 30 took secondary splenic pedicle transection were called Group B.

Surgical procedures

For the standard surgical procedure, we followed the Feldman LS's protocol [3]. All patients were performed under intravenous anesthesia and endotracheal intubation. The pneumoperitoneum pressure was maintained at 13 mmHg (1 mmHg=0.133 kPa) approximately. Surgery was performed with patient in the Trendelenburg position (with the feet higher than the head by 15° and tilted to the right by 30°) in order to expose the spleen. The following operative ports were used in the surgery. A 10 mm trocar was placed through the umbilicus as exploring port. A 5 mm trocar and a 12 mm trocar were placed in the right midclavicular line at the subcostal margin and at the level of the umbilicus as principle operating ports, respec-

tively. The other 5 mm trocar was placed in the left midaxillary line at the level of the umbilicus for auxiliary operations and postoperative drainage placement.

For patients in group A, the procedure was initiated by separating the greater omentum along the left superior edge of the transverse colon and accessing to the omental sac to expose the superior part of the tail of the pancreas. The main branch of the splenic artery was freed and clamped. Subsequently, the adhesion at the lower pole of the spleen and the splenocolic ligament were freed. The lower pole of the spleen was gently lifted with intestinal forceps and the splenorenal ligament was divided. The spleen was lifted as much as possible to the superior and the right, with an effort to free the posterior of the splenic pedicle and the splenophrenic ligament. Precautions should be made to protect the tail of the pancreas. The splenogastric ligament and the splenic pedicle were exposed. The serosa was incised till the upper pole of the spleen using the LigaSure vessel-sealing system or an ultrasound knife. The splenic pedicle was freed as much as possible to make it thinner and excised using the Endo-GIA stapler (Covidien straight 45-3.5 mm reloads). In case the short gastric artery and the partial splenic ligament were not freed, either the Endo-GIA stapler or the LigaSure vessel-sealing system should be used to resolve the issue. Afterwards, the spleen was placed in a specimen retrieval bag. The spleen was fractured with forceps and retrieved by enlarging the auxiliary port at the left mid-axillary line to about 4 cm. Hereafter, the abdominal cavity was lavaged with 0.9% sodium chloride. Once no active bleeding was detected in the splenic bed, a drainage tube was placed in the splenic fossa [10].

For group B, the splenic pedicle was manipulated at a distance of 1 cm away from the spleen. The secondary branches of the splenic pedicle were carefully and gently dissected and separated from superficial to deep layers and from the inferior to the superior. Blood vessels were clamped and excised with appropriate clips depending on vascular diameters. Of all these vessels, the proximal portion of the splenic artery with a larger diameter was clamped with a double-clip, and the distal portion clamped with a single-clip. Vascular branches with smaller diameters were directly

Laparoscopic splenectomy for splenic pedicle transection

Table 1. Patients characters

		Group A	Group B	Statistic method	P value
Gender	Female	12	14	χ^2	>0.05
	Male	18	16		
Age		45.0±15.2	42.0±14.6	t	>0.05
Experienced traumatic splenic rupture		7	3	χ^2	>0.05
Cirrhosis-induced portal hypertension complicated with hypersplenism		19	22	χ^2	>0.05
Benign space-occupying lesions of the spleen		4	5	χ^2	>0.05
Vertical diameter of the spleen		13	12	χ^2	>0.05

Table 2. Comparison of perioperative outcome measures between two groups of patients undergoing LS ($\bar{x} \pm SD$)

Group	N	Operative duration (min)	Intraoperative blood loss (mL)	Postoperative flatus pass time (h)	Length of hospital stay (d)	Hospital cost (Ten thousand Yuan RMB)	Drainage duration (d)
Group A	30	125.0±50.4	300.10±50.36	31.6±5.3	12.16±1.34	4.65±0.80	7±3
Group B	30	152.0±35.3	230.90±9.92	28.5±3.2	9.68±0.98	3.31±0.50	5±2
P*		0.000	0.000	0.000	0.000	0.000	0.000

*: All the comparison were analyzed by two dependent sample t test.

coagulated and cut by using the LigaSure vessel-sealing system. The remaining procedures were the same as those described in group A.

Outcome measures

The outcome measures were recorded for each group, including operation duration, intraoperative blood loss, postoperative flatus pass time, drainage duration, hospital cost, length of hospital stay and complications.

Statistical analysis

Statistical analysis was performed using SPSS software (version 17.0). All normally distributed quantitative data were expressed as $\bar{x} \pm SD$. Differences between groups were analyzed using t test. Qualitative data were analyzed using χ^2 . $P < 0.05$ was considered statistically significant.

Results

Patients characters

Of these 60 patients, 34 were males and 26 females, with a mean age of (45.0±15.2) years. Ten cases were confirmed with traumatic splenic rupture, 4 with splenic cyst, 2 with splenic hemangioma, 1 with splenic lymphangioma, 2 with splenic hamartoma and 41 with cirrhosis-induced portal hypertension complicated with

hypersplenism. Of the cases of cirrhosis, 25 were hepatitis B (HBV) cirrhosis, 7 HCV cirrhosis, 6 alcoholic cirrhosis and 3 cirrhosis with unknown cause. The vertical diameter of the spleen ranged 12-25 cm. Splenomegaly (vertical diameter >20 cm) was detected in 25 cases and non-splenomegaly in 35 cases. Two patients had experienced hematemesis and melena. Patients characters in each group were showed in **Table 1**.

Comparison of perioperative outcome measures between groups

Surgeries were successfully achieved in all 60 patients, and no patient was converted to open surgery. Neither operative death nor portal vein thrombosis occurred in any case. The operative duration for group A was significantly shorter than that for group B ($P=0.000$). However, the approach implemented in group B was significantly superior over that in group A in terms of the intraoperative blood loss, postoperative flatus pass time, drainage duration, length of hospital stay and hospital cost ($P=0.000$) (**Table 2**).

Postoperative complications

No significant differences were observed in postoperative fever, ascites and hyperamylasemia between two groups ($P > 0.05$) (**Table 3**).

Table 3. Comparison of postoperative complications between two groups of patients undergoing LS (number of cases)

Group	N	Hyperamylasemia	Postoperative fever	Ascites
Group A	30	5	6	3
Group B	30	1	2	2
<i>P</i> *		0.195	0.254	1.000

Note: Group A: LS using Endo-GIA procedure; Group B: LS with secondary splenic pedicle transection. *: All the comparisons were analyzed by χ^2 test.

Discussion

Laparoscopic splenectomy (LS) was mainly used in patients with hepatic fibrosis accompanied by normal to moderate splenomegaly and in patients with idiopathic thrombocytopenic purpura [6, 7]. However, with the accumulation of surgical experience and the advanced in the laparoscopic equipment, LS has been attracting much attention and its indications gradually extend to the management of massive splenomegaly and the vascular excision at the gastric cardia and the gastric fundus [9-11].

The splenic artery is originated from the celiac trunk and travelled along the upper margin of the pancreas and accompanied by the splenic vein inferiorly and superiorly. When it reaches the splenic hilum, the splenic artery gives rise to two major branches, with one branch supplying the upper portion of the spleen and the other one supplying the lower portion, forming the secondary splenic pedicle. In 70% of patients, the fan-shaped terminal portions of the secondary splenic arteries and veins form the lobar arteries of the spleen entering the splenic parenchyma. One or several loose space in the splenic hilum between blood vessels of the upper pole and lower pole of the spleen is called the secondary splenic pedicle space, where the splenic pedicle can be accurately and reliably excised and ligated [12].

During conventional open surgery of splenectomy, meticulous dissection of blood vessels in the splenic hilum is restricted due to enlarged spleen, adhesion with surrounding tissue and splenic hypertrophy. The laparoscopy facilitates meticulous manipulations in certain small operative field due to its amplification feature. Currently, there are two principal approaches available for the management of blood

vessels in the splenic pedicle during LS, the primary and secondary splenic pedicle transection for LS. When implementing the former approach, perisplenic ligaments are freed and blood vessels in the splenic pedicle are disconnected once using Endo-GIA stapler. The advantage of the primary splenic pedicle transection for LS is a simple and fast procedure. However, when performing the latter approach, secondary vascular branches of the splenic pedicle are dissected anatomically and each clipped. Splenic pedicle transection using Endo-GIA procedure is a relatively simple and direct approach. But the staplers are expensive. Multiple applications of the stapler are required to manage wider pedicles and the following potential risks are expected: The shedding or loosening of the staples can cause major bleeding of hilum blood vessels. Transection of the splenic pedicle can result in arteriovenous fistula of the spleen. Damage to the tail of the pancreas can lead to pancreatic fistula [12].

In the present study, splenic pedicle transection using Endo-GIA procedure was performed in 30 patients, most of which were treated during the early stage of the development of this procedure at our institution. Of these patients, 3 patients had experienced incomplete transection of the splenic pedicle and resulted in the increased intraoperative blood loss, which were resolved by second application of the procedure. Bleeding from the transected section occurred in another three patients, which was considered to be resulted from insecure stapling due to the thick tissues of the splenic hilum or the bleeding from injured tail of the pancreas. Hemostasis was successfully achieved by ligation using noninvasive prolene sutures under laparoscopy. Five patients presented transient postoperative hyperamylasemia with a large volume of peritoneal drainage. The injury of the tail of the pancreas was considered. These patients were successfully treated by restricting diet and using somatostatin, without the presence of severe pancreatic leakage. Postoperative fever occurred in another six patients, with three patients confirmed with hyperamylasemia and the other three confirmed with splenic fossa effusion. All these complications were successfully controlled with enhanced anti-infection therapy and unimpeded drainage within 6-10 d. No apparent major postoperative hemorrhage occurred.

Secondary splenic pedicle transection involves individually clipping and transecting all secondary branches of both splenic arteries and veins at the splenic hilum, avoiding en bloc ligation [13]. We adopted this approach in LS. By taking advantage of the amplification feature of laparoscopy and using single vascular management, transection was achieved by dividing each blood vessel by about 1 cm along its path, followed by clipping and excising under direct vision. This approach is safe and reliable, resulting in less bleeding and avoiding the injury of the tail of the pancreas. The results of the present study showed that compared to secondary pedicle transection, Endo-GIA procedure resulted in shorter operation duration but more intraoperative bleeding, which might be caused by the unproficiency in the surgical techniques during the early stage of the development of this approach. In addition, secondary splenic pedicle transection was superior over Endo-GIA procedure in length of hospital stay, hospital cost, postoperative complications and drainage duration, demonstrating safe and economical features. Our study is consistent with the previous reports about secondary splenic pedicle transection for laparoscopic splenectomy (LS) [14-16]. However, secondary pedicle transection requires a higher level of surgical skill in meticulous, gentle and accurate manipulation during vascular dissection and excision, emphasizing safe manipulation of blood vessels proximal to the heart. Due to the high price of the equipment and more complications, Endo-GIA procedure was not acceptable in some patients, and its implementation was limited.

Intraoperative bleeding is one of the major reasons for the conversion of LS to open surgery. The management of blood vessels of the splenic pedicle is the key to the control of accidental bleeding. Endo-GIA stapler is suitable for the management of the magisterial type splenic vessels, whereas the distributed type splenic vessels should be managed by individually ligation or clamping, and the splenic pedicle should be manipulated adjacent to the spleen to achieve complete transection. As for patients with thickening of the splenic arteries, inapparent blood diseases with inapparent varices or mild splenomegaly, Endo-GIA procedure can be directly used to manipulate the splenic pedicle. However, for patients with massive splenomeg-

aly, thickening of blood vessels of the splenic hilum and apparent varices, blood vessels should be stripped, ligated and transected individually. Precautions should be taken to examine blood exudation or active hemorrhage at the proximal portion of freed splenic pedicle. Active bleeding can be resolved by clamping. Blood exudation from the surgical field can be treated by spraying hemostatic fibrin sealant, or by performing an "8" shape vascular suture or continuous suture, to prevent postoperative bleeding [17].

The splenic arterial trunk was freed and ligated before transection of the splenic pedicle, resulting in the ischemia of the spleen. As a result, the spleen shrunk significantly and became tough, thereby enlarging the operative field and enhancing the safety of the operation. Bleeding upon the transection of the splenic hilum is mostly resulted from splenic vein reflux, which is not in severe conditions and can be easily controlled. In addition, splenic vein reflux has not been affected after blocking the blood flow in the splenic arterial trunk. A large volume of blood inside the spleen returned to the blood circulation, which is equivalent to the effect of autologous blood transfusion, thereby reducing the use of transfusion.

In conclusion, being familiarized with the anatomy of blood vessels in the splenic pedicle and being proficient with the surgical techniques of secondary splenic pedicle transection during LS are critical for implementing this procedure in a safe and proficient way. Intraoperative bleeding is not increased when performing this procedure. Furthermore, the secondary splenic pedicle transection results in lower surgical cost, reduced postoperative complications and increased rate of surgical success. This approach may be appropriate option in clinical practice and could benefit the patients.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. You-Cheng Zhang, Department of General Surgery, Lanzhou University Second Hospital, Lanzhou 730000, China. E-mail: you_chengzhang58@163.com

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