

## Laparoscopic and open splenectomy and azygoportal disconnection for portal hypertension

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### Abstract

**AIM:** To compare the outcomes of laparoscopic and open splenectomy and azygoportal devascularization for portal hypertension.

**METHODS:** From June 2006 to March 2009, laparoscopic splenectomy and azygoportal disconnection (LSD) were performed on 28 patients with cirrhosis, bleeding due to portal hypertension, and secondary hypersplenism. Success was achieved in 26 patients. Demographic, intraoperative, and postoperative variables of the patients were compared.

**RESULTS:** Success of laparoscopic splenectomy and azygoportal disconnection was achieved in all but two patients (7.14%) who required open splenectomy and azygoportal devascularization (OSD). The operation time was significantly longer in patients undergoing LSD than in those undergoing OSD ( $235 \pm 36$  min vs  $178 \pm 47$  min,  $P < 0.05$ ). The estimated intraoperative blood loss was much more in patients receiving OSD than in those receiving LSD ( $420 \pm 50$  mL vs  $200 \pm 30$  mL,  $P < 0.01$ ). The proportion of patients undergoing laparoscopic and open splenectomy and azygoportal disconnection who received transfusion of packed red blood cells during or after the operation was 23.08% and 38.46%, respectively ( $P < 0.05$ ). The time of first oral intake was faster in patients after LSD than in those after OSD ( $1.5 \pm 0.7$  d vs  $3.5 \pm 1.6$  d,  $P < 0.05$ ). The hospital stay of patients after LSD was shorter than that

of patients after OSD ( $6.5 \pm 2.3$  d vs  $11.7 \pm 4.5$  d,  $P < 0.05$ ). The pain requiring medication was less severe in patients after LSD than in those after OSD (7.69% vs 73.08%,  $P < 0.001$ ). The overall complication rate was lower in patients after LSD than in those after OSD (19.23% vs 42.31%,  $P < 0.05$ ).

**CONCLUSION:** Laparoscopic splenectomy and azygoportal disconnection are the feasible, effective, and safe surgical procedure, and are advantageous over minimally invasive surgery for bleeding portal hypertension and hypersplenism.

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**Key words:** Liver cirrhosis; Portal hypertension; Hypersplenism; Laparoscopy; Devascularization

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### INTRODUCTION

Liver cirrhosis leads frequently to the development of ascites and formation of varicose veins in esophagus and proximal stomach. Variceal bleeding is the most severe complication of portal hypertension, which may occur in 30% of patients with cirrhosis with a 30-d mortality of 20% when the portal-systemic gradient reaches above 12 mmHg<sup>[1]</sup>. Cirrhotic patients with variceal bleeding occasionally require surgical intervention. The ideal surgical procedure is to effectively control bleeding with a little impairment of liver function and a low rate of encephalopathy<sup>[2]</sup>. The morbidity of traditional open splenectomy and azygoportal devascularization (OSD) developed first by Sugiura in the 1960s<sup>[3]</sup> is a

consequence of a large upper abdominal incision rather than removal of the spleen itself. Recent development in technical skills has extended the indications for laparoscopic removal of the spleen<sup>[4]</sup>, and significant progress in laparoscopic technology has enabled splenectomy and devascularization less invasive of the proximal stomach and distal esophagus.

Compared to open splenectomy, the advantages of laparoscopic splenectomy include decreased use of anesthetic agents, earlier initiation of oral diet, short hospital stay, and fewer complications<sup>[5-7]</sup>. However, few studies comparing the outcomes of open and laparoscopic splenectomy and azygoportal devascularization for bleeding varices are available. This study was to assess the in-hospital results of open and laparoscopic splenectomy and devascularization for portal hypertension.

## MATERIALS AND METHODS

### Patients

From June 2006 to March 2009, laparoscopic splenectomy and azygoportal disconnection were performed on 28 patients with cirrhosis, bleeding portal hypertension, and secondary hypersplenism and success was achieved in 26 patients (19 males, 7 females). The patients at the age 29-65 years (average  $41.5 \pm 21.8$  years) were admitted due to repeated variceal bleeding. The liver cirrhosis stage was Child-Pugh A in 17 patients, Child-Pugh B in 8 patients, and Child-Pugh C in 1 patient, respectively.

Of the 26 patients undergoing laparoscopic splenectomy and azygoportal disconnection (LSD), 23 had liver damage caused by chronic hepatitis B, 1 had alcoholic cirrhosis, and 2 had no history of hepatitis or chronic alcohol consumption and were diagnosed with cryptogenic cirrhosis. All patients had splenomegaly, and the diameter of spleen ranged 14-21 cm as shown at ultrasound, CT scan, and MRI before surgery.

The results of traditional OSD performed in January 2004 to June 2006 on the 26 patients were assessed retrospectively.

Demographic data of the patients undergoing LSD and OSD are shown in Table 1.

### Operation procedures

Laparoscopic splenectomy was performed with the patient placed at the right lateral semidecubitus position and the operating table slightly tilted to the reverse Trendelenburg position. The surgeon stood at the right side of operating table and 4 operative ports were used. A 10-mm trocar was placed at the right upper umbilicus for a 10-mm 30-degree telescope camera, and another 10-mm operating trocar was inserted into the left midclavicular line just below the border of spleen for passing the ultrasonic dissector or LigaSure vessel-sealing equipment. A 5-mm trocar was placed in the subxiphoid space, allowing for the use of a supplementary retractor or grasper. A 12-mm trocar was placed in the left axillary line halfway between the costal margin and iliac crest, for the application of an endoscopic linear vascular stapling

**Table 1** Characteristics of patients undergoing LSD and OSD (mean  $\pm$  SD), *n* (%)

Variable	LSD	OSD	P value
Patients ( <i>n</i> )	26	26	-
Average age (yr)	41.5 $\pm$ 21.8	44.6 $\pm$ 19.6	NS
Gender (M/F)	19/7	21/5	NS
Etiology			
HBV + cirrhosis	23 (88.46)	21 (80.77)	NS
Alcoholic cirrhosis	1 (3.85)	2 (7.69)	NS
Cryptogenic	2 (7.69)	3 (11.54)	NS
Child-Pugh score			
A	17 (65.38)	20 (76.92)	NS
B	8 (30.77)	5 (19.23)	NS
C	1 (3.85)	1 (3.85)	NS
Variceal bleeding events	3.2 $\pm$ 1.8	3.7 $\pm$ 1.6	NS

LSD: Laparoscopic splenectomy and azygoportal devascularization; OSD: Open splenectomy and azygoportal devascularization; HBV: Hepatitis B virus; NS: Not significant.

device and other supplementary instruments.

The spleen was mobilized starting at the lateroposterior side by dividing the splenocolic and splenodiaphragmatic attachments. Then, the splenogastric ligament (including short gastric vessels) and the splenorenal ligament were divided with the ultrasonic dissector or LigaSure vessel-sealing equipment. Splenectomy was performed by carefully dissecting the splenic hilum to protect the pancreas and en bloc transecting the splenic artery and vein using the linear laparoscopic vascular stapler (EndoGIA).

After splenectomy, dissection was begun by approaching to the left crus with the ultrasonic dissector or LigaSure vessel-sealing equipment, then the gastrohepatic ligament was cut open to identify the right crus. The gastric coronary vein was visualized, and all branches toward the esophagus and proximal stomach were divided with the ultrasonic dissector and LigaSure vessel-sealing equipment. At least 6 cm of the distal esophagus was dissected through the hiatus with the paraesophageal venous collaterals divided.

Finally, the spleen was put into an impermeable retrieval bag and morcellated for removal.

OSD was performed either through a midline laparotomy or a left subcostal incision using traditional methods.

Operation time, estimated blood loss, intraoperative blood transfusion, time (d) of postoperative oral diet intake, pain requiring medication, postoperative complications, and hospital stay were compared.

### Statistical analysis

Data were compared using the *t*-test, chi-square analysis, or Fisher's exact test, where applicable, and expressed as mean  $\pm$  SD. All statistical analyses were performed using the SPSS 13.0 for Windows. *P* < 0.05 was considered statistically significant.

## RESULTS

The demographic data included in this study are listed

**Table 2** Results and complications of LSD and OSD (mean  $\pm$  SD), *n* (%)

Variable	LSD	OSD	<i>P</i> value
Operative time (min)	235 $\pm$ 36	178 $\pm$ 47	< 0.05
Estimated blood loss (mL)	200 $\pm$ 30	420 $\pm$ 50	< 0.01
PRBC transfusion	6 (23.08)	10 (38.46)	< 0.05
Time of oral intake (d)	1.5 $\pm$ 0.7	3.5 $\pm$ 1.6	< 0.05
Pain requiring medication	2 (7.69)	19 (73.08)	< 0.001
Postoperative hospital stay (d)	6.5 $\pm$ 2.3	11.7 $\pm$ 4.5	< 0.05
Overall complication rate	5 (19.23)	11 (42.31)	< 0.05

PRBC: Packed red blood cells.

in Table 1. No difference was found in preoperative data between the two groups of patients.

The surgical results are shown in Table 2. Success of laparoscopic splenectomy and azygoportal disconnection was achieved in all but 2 patients (7.14%) who required open laparotomy because of intraoperative bleeding from the hilar vessels which was impossible to control by laparoscopic splenectomy. All the patients survived the surgery.

The operation time was significantly longer in patients undergoing LSD than in those undergoing OSD (235  $\pm$  36 min *vs* 178  $\pm$  47 min, *P* < 0.05). The estimated intraoperative blood loss was much more in patients undergoing OSD than in those undergoing LSD (420  $\pm$  50 mL *vs* 200  $\pm$  30 mL, *P* < 0.01). The proportion of patients undergoing LSD and OSD who received transfusion of packed red blood cells during or after the operation was 23.08% and 38.46%, respectively (*P* < 0.05).

The time of first oral intake was faster in patients after LSD than in those after OSD (1.5  $\pm$  0.7 d *vs* 3.5  $\pm$  1.6 d, *P* < 0.05). The hospital stay of patients after LSD was shorter than that of those after OSD (6.5  $\pm$  2.3 d *vs* 11.7  $\pm$  4.5 d, *P* < 0.05). The pain requiring medication was less severe in patients after LSD in those after OSD (7.69% *vs* 73.08%, *P* < 0.001).

As shown in Table 2, the overall complication rate was lower in patients after LSD than in those after OSD (19.23% *vs* 42.31% *P* < 0.05). Wound seroma, pancreatic fistula, pleural effusion, and asymptomatic portal vein thrombosis were found in 1, 1, 2, and 1 patient, respectively, after LSD. Amylase elevation with effusion around the pancreatic tail was drained under ultrasound guidance. Of the patients with pleural effusion, one underwent percutaneous drainage, the other received conservative treatment. Of the patients undergoing OSD, 2 had urinary complications, 4 had wound complications, 1 had pleural effusion, 2 had pneumonia, and 1 had incisional hernia. Emergency laparotomy reoperation for bleeding was not necessary following LSD, but bleeding occurred in 1 patient after OSD. No pancreatic fistula or postoperative portal vein thrombosis was observed after OSD.

During a postoperative follow-up period of 1-34 mo for the patients after LSD, liver failure or encephalopathy or esophageal variceal rebleeding did not recur, and all the patients had an improved quality of life.

## DISCUSSION

The portal gradient exceeding 12 mmHg in patients with portal hypertension due to liver cirrhosis may result in portosystemic collaterals, in which the esophageal and proximal stomach varices present a most important connection between portal and systemic blood circulation. Unfortunately, their tendency to bleed due to rupture of esophageal and proximal varices is the most life-threatening complication in patients with portal hypertension, which can significantly increase the mortality rate of patients with liver cirrhosis. The bleeding event occurs in 10%-30% of patients with liver cirrhosis within 1 year, and reoccurs in 40% of patients within 6 wk. The mortality of bleeding varicose veins increases up to 30% depending on the liver insufficiency<sup>[8-10]</sup>. After acute treatment of bleeding, subsequent bleeding should be prevented.

Surgery for portal hypertension and variceal bleeding has evolved widely in terms of techniques and indications. Many treatment modalities available suggest that no single therapy is entirely satisfactory for all patients or for all clinical situations. Currently, shunt and devascularization surgeries are two basic surgical methods, but shunt procedures are more commonly used in Western countries and devascularization procedures are more commonly used in China<sup>[11,12]</sup>. The ideal surgical procedure for patients with bleeding portal hypertension and secondary hypersplenism should control bleeding, correct hypersplenism, avoid recurrence of bleeding, with little impairment of liver function and a low rate of encephalopathy.

The laparoscopic splenectomy has become the gold standard for removal of normal to moderately enlarged spleens. However, it is really more challenging when laparoscopic splenectomy is performed on patients with cirrhosis, portal hypertension, and splenomegaly, because portal hypertension and the severity of liver cirrhosis are the risk factors for high intraoperative blood loss during laparoscopic splenectomy<sup>[13]</sup>. In addition, it is difficult to remove the extremely enlarged spleen because of its higher conversion rate<sup>[14]</sup>.

Less invasive laparoscopic devascularization of the lower esophagus and upper stomach was performed partly through experimentation<sup>[15]</sup> or minilaparotomy<sup>[16-21]</sup>.

In this study, success of laparoscopic splenectomy and azygoportal disconnection was achieved in all but 2 patients. The patients recovered uneventfully after operation. The indications for laparoscopic splenectomy and azygoportal disconnection are similar to those for OSD. We prefer to perform laparoscopic splenectomy and azygoportal disconnection for patients with liver cirrhosis at Child-Pugh A and B. The absolute contraindications of laparoscopic splenectomy and azygoportal disconnection are patients who are not able to tolerate the general anesthesia, intractable coagulopathy, and/or unfitted to laparoscopy.

The most important intraoperative complication during laparoscopic splenectomy and azygoportal disconnection is bleeding, which is the most common

reason for conversion to open surgical procedure. Furthermore, since conversion is usually done due to lack of working space or bleeding, the operation time of converted patients is longer, leading to more blood loss than open splenectomy. However, laparoscopic splenectomy cannot effectively control massive hemorrhage from the major vessels or capsule fracture. In many cases, bleeding interferes with the dissection and does not result in any other event. Therefore, the crucial point of devascularization technique is to prevent the brisk bleeding from dilated vessels like enlarged azygoportal collaterals. Capsule or small vessel laceration may cause oozing, which contaminates the operating field and makes the surgical procedure more difficult. We recommend that complete mobilization of the spleen before operation is a safe option for adequately controlling the hilar vessels and any possible bleeding during the procedure. The splenic artery should be dissected and ligated whenever it is found superior to the pancreatic tail during the operation for splenomegaly. This maneuver can reduce the size and bleeding of spleen with a certain autotransfusion effect. Although vessels within the splenic hilum can be dissected and divided individually with vascular clips in some cases, the manipulation is quite tedious and not encouraged. In addition, if bleeding occurs in the hilum, vascular staplers should be used to control it. Use of clips should be limited since it may interfere with the use of vascular staplers.

Technical advances that have facilitated laparoscopic splenectomy and azygoportal disconnection are the availability of LigaSure vessel-sealing equipment and ultrasonic dissector, which facilitate the performance of very difficult laparoscopic procedures. LigaSure vessel-sealing equipment is safer than ultrasonic dissector in dividing the surrounding tissues of spleen, distal esophagus and proximal stomach, including parasophageal venous collaterals, and can thus be used for mobilization of the spleen and esophagogastric devascularization. As use of clips may interfere with the use of LigaSure vessel-sealing equipment to stop the bleeding, it is wiser not to use any clips during esophagogastric devascularization.

The LigaSure vessel-sealing system has been developed for the safe closure of arteries up to 7 mm<sup>[22]</sup>. Although the data about venous closure are lacking, this system can be used to close veins up to 12 mm<sup>[23]</sup>. Kwok *et al*<sup>[24]</sup> showed that the LigaSure sealing system can treat grades 3 and 4 of hemorrhoids.

In our series, intraoperative bleeding during LSD was a rare event, leading to conversion to OSD in only 2 cases (7.14%). The estimated blood loss was significantly lower in patients undergoing LSD than in those undergoing OSD.

The overall complication rate was lower in patients after LSD than in those after OSD. The main complications of LSD included pancreatic fistula and thromboembolic event, which did not occur after OSD. Meanwhile, incisional hernia was uncommon after LSD but occurred in 1 patient after OSD.

In summary, LSD can alleviate postoperative pain, earlier recovery bowel function and feeding, has

better cosmetic results, reduce the hospital stay and recovery time, and is thus advantageous over minimally invasive surgery and OSD. We believe that laparoscopic splenectomy and azygoportal disconnection is a technically feasible, safe, and preferred procedure for bleeding varices due to hypersplenism. LSD should primarily be attempted in all patients with portal hypertension, if judged technically feasible and the general condition of the patient allows laparoscopy.

## COMMENTS

### Background

Liver cirrhosis leads frequently to the development of ascites and formation of varicose veins in esophagus and proximal stomach. Variceal bleeding is the most severe complication of portal hypertension, which occurs in 30% of patients with cirrhosis. Cirrhotic patients with variceal bleeding occasionally require surgical intervention. Traditional open splenectomy and azygoportal devascularization (OSD) are performed due to large upper abdominal incision rather than removal of the spleen itself. Recent development in laparoscopic technology has enabled splenectomy and devascularization of the proximal stomach and distal esophagus less invasive.

### Research frontiers

Less invasive laparoscopic devascularization of the lower esophagus and upper stomach is performed partly through minilaparotomy. However, few studies are available on the outcomes of open and laparoscopic splenectomy and azygoportal devascularization for bleeding varices due to portal hypertension.

### Innovations and breakthroughs

Few studies are available on the outcomes of open and laparoscopic splenectomy and azygoportal devascularization (LSD) for bleeding varices due to portal hypertension. The aim of the present study, was, therefore, to assess the in-hospital results of open and laparoscopic splenectomy and azygoportal devascularization for portal hypertension. The results show that LSD can alleviate postoperative pain, earlier recovery bowel function and feeding, has better cosmetic results, reduce hospital stay and recovery time, and is thus advantageous over minimally invasive surgery and OSD.

### Applications

Laparoscopic splenectomy and azygoportal disconnection is a technically feasible, safe, and preferable procedure for bleeding varices due to portal hypersplenism. LSD should primarily be attempted in all patients with portal hypertension, if judged technically feasible and if the general condition of the patient allows laparoscopy.

### Terminology

Portal hypertension: Increased pressure in the portal vein. When the blood flow in the liver is obstructed, the blood can become backed up into the intersections of the portal venous system and the systemic venous system. The intersections of these two systems are small, fragile blood vessels known as capillaries. These vessels are not able to withstand the increased blood pressure and become engorged or dilated. Such vessels can be seen on the surface of esophagus or stomach during endoscopy. They are fragile and at a risk of bleeding. Portal hypertension can be managed through diet, medications, endoscopic therapy, surgery, or radiology. Once the bleeding episode is stabilized, treatment options should be prescribed based on the severity of symptoms and the function of liver.

### Peer review

Although laparoscopic splenectomy and azygoportal disconnection are not easy to perform, they represent a new and alternative procedure for portal hypertension and are advantageous over open splenectomy and azygoportal disconnection.

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