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Analysis of risk factors for massive intraoperative bleeding during laparoscopic splenectomy

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Abstract
Background/Purpose. Laparoscopic splenectomy is occasionally converted to open surgery due to massive intraoperative bleeding. The aim of this study was to identify the risk factors for massive bleeding during laparoscopic splenectomy.
Methods. Fifty-three patients underwent laparoscopic splenectomy. The indications were hematologic disease in 25 patients, liver cirrhosis in 17 patients, and other conditions in 11 patients. Univariate analysis was conducted with Fisher's exact test, and multivariate analysis was conducted with a stepwise logistic regression model.
Results. None of the patients required open surgery. Blood loss of more than 800 ml was defined as massive intraoperative bleeding. Univariate analysis showed significant risk factors for massive bleeding to be liver cirrhosis, portal hypertension, splenomegaly, Child class, and preoperative platelet count. Independent risk factors in the multivariate analysis were portal hypertension and Child class.
Conclusions. Careful attention to intraoperative bleeding during laparoscopic splenectomy is necessary for patients with portal hypertension and/or deteriorated liver function.

Key words Laparoscopic splenectomy · Intraoperative bleeding · Liver cirrhosis · Portal hypertension · Liver function

Introduction

Since Delaitre and Maignien first reported the laparoscopic splenectomy procedure in 1991,[1] it has been shown to be technically feasible and safe. Laparoscopic splenectomy is currently the procedure of choice worldwide for removal of the spleen. Many investigators have compared laparoscopic versus open splenectomy for hematologic disease and have shown the superiority of laparoscopic splenectomy over conventional surgery in terms of length of hospital stay and occurrence of complications.[2–4] However, more hemorrhagic complications occur with the laparoscopic approach when conversions due to bleeding are included in the analyses.[4] Reports regarding long-term follow-up after laparoscopic splenectomy are not so many, and there have been no prospective randomized trials of laparoscopic versus conventional splenectomy for patients with hematologic disorders.

Conversion from laparoscopic splenectomy to open surgery is occasionally experienced; reported conversion rates range from 0% to 19%.[2,3,5,6] Conversion to open surgery is usually in response to massive intraoperative bleeding. Some authors suggest that portal hypertension, which can lead to such bleeding, contraindicates laparoscopic splenectomy.[2,3] Therefore, it would be useful to be able to predict those at risk of massive intraoperative bleeding before a laparoscopic procedure is initiated. We reviewed outcomes among our patients and attempted to identify risk factors for massive bleeding during laparoscopic splenectomy.

Patients and methods

During the period August 1993 through November 2004, 53 Japanese patients underwent laparoscopic splenectomy at either the first Department of Surgery, Oita University Faculty of Medicine, or the Department of Surgery, Matsuyama Red Cross Hospital. There were 31 men and 22 women, with an average age of 39.9 ± 22.3 years (mean ± SD). Indications were hematologic disease in 25 patients (idiopathic thrombocytopenic purpura [ITP] in 21 and hereditary spherocytosis in 4), liver cirrhosis in 17 patients, splenic tumor in 8 patients (inflammatory pseudotumor in 4, malignant lymphoma in 2, and epidermoid cyst in 2), splenic artery aneurysm

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in 2 patients and idiopathic portal hypertension in 1 patient. Twelve of the 17 patients with liver cirrhosis showed concomitant portal hypertension, expressed as present or prior esophagogastric varices; the patient with idiopathic portal hypertension also showed evidence of esophagogastric varices. Liver cirrhosis and idiopathic portal hypertension were diagnosed pathologically, and etiologies of cirrhosis included viral hepatitis in 14 patients, alcoholism in 2, and autoimmune reaction (primary biliary cirrhosis) in 1. Nineteen of the 21 ITP patients took steroid daily (mean ± SD, 22.0 ± 14.4 mg/day). Ten of the 53 patients (18.9%) also underwent an additional minor operation: cholecystectomy in 6 patients, limited devascularization (ligation of left gastric artery and vein) in 3 patients, and aneurysmectomy in 1 patient. Blood loss and operation time during these additional operations were excluded from the data analysis. Preoperative liver function was classified as Child class A in 41 patients and Child class B in 12 patients. High-dose intravenous immunoglobulin therapy was performed in 17 patients with ITP, and platelet transfusions were performed in 16 patients. The mean preoperative platelet count reached 12.0 ± 8.1/mm^3 just prior to surgery. The mean prothrombin index was 102.3 ± 28.8%, and mean body mass index was 22.1 ± 3.7 kg/m^2. Splenomegaly was diagnosed by ultrasonography and/or computed tomography, as described previously.[7,8]

Laparoscopic splenectomy was performed with or without CO_2 pneumoperitoneum, as described previously.[9,10] The two procedures did not differ in terms of patient position, devices used, or dissection of the spleen; the same surgeons performed both procedures. After dissection of the spleen from the surrounding tissues, an endoscopic autosuture device (EndoGIAII; U.S. Surgical, Norwalk, CT, USA) was used to divide the splenic pedicle (Fig. 1). The spleen was then placed into a large specimen retrieval bag (EndoCatchII; U.S. Surgical) and morcellated with fingers and/or forceps before removal. Thirty-nine of the 53 patients (73.6%) underwent laparoscopic splenectomy with pneumoperitoneum, and the remaining 14 patients (26.4%) underwent an abdominal wall-lifting procedure. The procedures were determined without any prior intention.

Potential predictive factors for massive intraoperative hemorrhage during laparoscopic splenectomy were thought to be the following: age, sex, liver cirrhosis, portal hypertension, steroid intake, additional minor operation, Child class, preoperative platelet count, prothrombin index, body mass index, splenomegaly, total weight of morcellated spleen, and operative procedure (pneumoperitoneum or wall-lifting). Although spleen weight could not be determined before surgery, it was included to indicate massive splenomegaly (≥500 g).

Fig. 1. Laparoscopic view of division of the splenic vessels at the splenic hilum with an endoscopic autosuture device

Univariate analysis of risk factors for massive bleeding during laparoscopic splenectomy was conducted with Fisher's exact test. Factors for which the P value obtained on univariate analysis was less than 0.05 were used in subsequent multivariate analysis with a stepwise logistic regression model. The Mann-Whitney U-test was used to examine differences between groups. $P < 0.05$ was accepted as statistically significant in all analyses, and values were expressed as means ± SD. Statistical analyses were conducted with SPSS software for Windows (SPSS, Chicago, IL, USA).

Results

There was no conversion to open surgery. Operation time was 201.7 ± 75.5 min, and intraoperative blood loss was 360.2 ± 502.9 ml. Skin incisions for the removal of splenic tissues averaged 3.0 ± 1.9 cm in length. Average total weight of the morcellated spleen was 265.3 ± 314.7 g. Eight of nine patients with blood loss of more than 800 ml required blood transfusion. Therefore, blood loss of more than 800 ml was defined as massive intraoperative bleeding. After surgery, three patients (5.7%) had complications (port site bleeding, wound infection, enterocolitis), and the one patient with port site bleeding required emergency hemostasis. All three of these patients had portal hypertension and two of the three experienced massive intraoperative bleeding. None of the patients died, and postoperative hospital stay was 12.3 ± 6.8 days.

The amount of intraoperative hemorrhage was significantly greater in patients with portal hypertension than in patients without portal hypertension (939.0 ± 694.3 ml versus 172.1 ± 202.2 ml; $P < 0.001$). Although

Table 1. Univariate analysis of perioperative clinical parameters for massive intraoperative bleeding during laparoscopic splenectomy

Variables	No. of patients	Intraoperative bleeding of >800 ml		*P* value
		(–) *n* = 44	(+) *n* = 9	
Age (years)				
<60	41	34	7	1.000
≥60	12	10	2	
Sex				
Male	31	26	5	1.000
Female	22	18	4	
Liver cirrhosis				
(–)	36	36	0	<0.001
(+)	17	8	9	
Portal hypertension				
(–)	40	39	1	<0.001
(+)	13	5	8	
Steroid intake				
(–)	34	26	8	0.133
(+)	19	18	1	
Minor additional operation				
(–)	43	36	7	1.000
(+)	10	8	2	
Child class				
A	41	39	2	<0.001
B	12	5	7	
Preoperative platelet count ($\times 10^4/mm^3$)				
<10	27	19	8	0.024
≥10	26	25	1	
Prothrombin index (%)				
<70	4	2	2	0.129
≥70	49	42	7	
Body mass index (kg/m^2)				
<25	43	37	6	0.346
≥25	10	7	3	
Splenomegaly				
(–)	25	25	0	0.002
(+)	28	19	9	
Morcellated spleen weight (g)				
<500	47	40	7	0.267
≥500	6	4	2	
Operative procedures				
Pneumoperitoneum	39	34	5	0.222
Wall-lifting	14	10	4	

blood loss was significantly greater in patients with splenomegaly (diagnosed by imaging) than in patients without splenomegaly (546.7 ± 617.3 ml versus 151.3 ± 182.1 ml; $P = 0.003$), there was no significant difference between patients with or without massive splenomegaly (morcellated weight, <500 g, 344.0 ± 513.0 ml versus ≥500 g, 487.3 ± 432.1 ml; $P = 0.467$).

Univariate analysis showed that significant risk factors for blood loss greater than 800 ml during laparoscopic splenectomy were liver cirrhosis, portal hypertension, splenomegaly, Child class, and preoperative platelet count (Table 1). By multivariate analysis, independent risk factors for massive hemorrhage were portal hypertension ($P = 0.006$) and Child class ($P = 0.039$).

Discussion

We studied the value of laparoscopic splenectomy in patients with relative contraindications, such as portal hypertension and hypersplenism.[2,3] Hashizume et al.[6] performed laparoscopic splenectomy on 73 patients with portal hypertension, with good results; the conversion rate was 9.6%, blood loss was 374.7 ± 352.4 ml, and complications were encountered in 11.0% of the pa-

tients. However, even in Japan, it is not usual to perform laparoscopic splenectomy in patients with portal hypertension; by the end of 2001, only 131 Japanese patients with hypersplenism and portal hypertension had undergone this procedure.[11] Laparoscopic splenectomy is still considered a controversial treatment for hypersplenism.[12] Although some recent studies have included patients with hypersplenism and portal hypertension,[13] it may be difficult to include these conditions as general indicators for laparoscopic splenectomy.

In our study, 939.0 ± 694.3 ml of blood was lost during laparoscopic splenectomy in patients with portal hypertension, but there was no conversion to open surgery. Portal hypertension and liver dysfunction were independent risk factors for massive intraoperative hemorrhage. The question arises whether the volume of blood loss is greater with laparoscopic splenectomy than with open surgery. Although many comparative studies of laparoscopic and open splenectomies in patients with hematologic disorders have been reported, there has been no case-control comparative study in patients with portal hypertension. Recent studies estimated blood loss of 350 to 1500 ml during open splenectomy,[14,15] and there is a possibility that the laparoscopic approach results in greater intraoperative blood loss.

New techniques have been developed to prevent massive bleeding during laparoscopic splenectomy. Romano et al.[16] reported the use of the LigaSure Vessel Sealing System (Valleylab, Boulder, CO, USA) for laparoscopic splenectomy, which resulted in decreased operation time and increased safety. This new system provides excellent hemostasis and reduces the risk of serious blood loss. It is also useful in patients with portal hypertension.[17] Another new technique is splenic artery embolization just prior to laparoscopic splenectomy. Iwase et al.[18] performed laparoscopic or laparoscopy-assisted splenectomy 2 to 4 h after embolization in 16 patients and encountered no massive bleeding during surgery. Ligature of the splenic artery close to the pancreas before mobilization of the spleen, an alternative to splenic artery embolization, may also be effective in reducing blood loss during laparoscopic splenectomy.

Brody et al.[5] investigated factors predictive of the conversion of laparoscopic splenectomy to open surgery in ITP. Decreased perioperative platelet counts were related to conversion to open surgery, but age, American Society of Anesthiologists (ASA) score, and spleen size were not so related. Splenomegaly, excluding massive splenomegaly, appears to have no influence on the rate of conversion from laparoscopic splenectomy to open surgery.[19,20] However, Mahon and Rhodes[21] reported that the conversion rate for patients with a spleen weighing less than 1 kg was 0%, whereas the conversion rate for patients with a spleen weighing more than 1 kg was 60%. Spleens weighing more than 3200 g required conversion to open surgery in all patients.[20] In our study, massive splenomegaly was represented by a morcellated spleen weighing more than 500 g; only two patients had a spleen weighing more than 1 kg. We found that no conversion was necessary, and a spleen weighing 500 g or more did not affect the amount of massive intraoperative bleeding. Therefore, a spleen size of less than 1000 g appears not to affect laparoscopic splenectomy.

A metaanalysis showed that laparoscopic splenectomy, in comparison to open splenectomy, was associated with significantly fewer pulmonary, wound, and infectious complications.[4] Targarona et al.[22] conducted a multivariate analysis and showed that postoperative complications were significantly associated with surgeon inexperience, spleen weight, and diagnosis of malignant neoplasm. Patel et al.[23] also conducted a multivariate analysis, and reported that patients with splenomegaly (>1000 g) were 14 times more likely to experience postoperative complications than those without. In the present study, only three patients, with portal hypertension, experienced postoperative complications. Although massive bleeding during the operation probably promoted these complications, portal hypertension may also be a risk factor for complications of laparoscopic splenectomy.

Laparoscopic splenectomy is now considered a safe and effective treatment for patients with a hematologic disorder. A relatively large spleen can also be safely removed laparoscopically. However, massive bleeding during laparoscopic splenectomy does occasionally occur in patients with hypersplenism and portal hypertension. Although no comparison between laparoscopic and conventional open splenectomies in patients with portal hypertension has been published, there is a possibility that the laparoscopic approach increases intraoperative blood loss. Therefore, careful attention to complications is necessary when laparoscopic splenectomy is performed in patients with portal hypertension.

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