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Case Series

Importance of the vessel distribution at splenic hilum for laparoscopic Warshaw procedure

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ABSTRACT

The laparoscopic Warshaw procedure (LWP) is a considered to carry a risk of splenic infarction and perigastric varices formation. We retrospectively analyzed the clinical outcomes and relationship between the distribution of the splenic hilum vessels and splenic infarction in patients who underwent LWP from February 2007 to February 2017. A total of 19 patients underwent LWP, and the median follow-up duration was 78 months. The median operative time and blood loss were 295 min and 200 gr. Six patients with splenic partial infarction and 3 with gastric varices were detected, but they have not needed any treatments. According to the classification by Michels, the distribution of splenic vessels were divided as distributed type and magistral type at the splenic hilum. In our study, 16 patients were distributed type and 3 were magistral type. Three of the 16 patients developed splenic infarction in distributed type. In contrast, all of magistral patients showed splenic infarction. Although LWP is a safe procedure, there is a high risk of splenic infarction if the splenic vessel distribution is a magistral type. Understanding the type before surgery leads to the identification of an appropriate vascular dissection position and reduces postoperative complications.

Keywords: Laparoscopic Warshaw procedure, Splenic vessels distribution, Spleen preserving distal pancreatectomy, Splenic infarction

INTRODUCTION

Laparoscopic spleen-preserving distal pancreatectomy (LSPDP) is widely used for the treatment of benign and/or low-grade malignant tumors in the pancreatic body and tail. A major advantage with preservation of the spleen is maintaining immunity against bacteria and neoplasms. Shoup et al reported that the incidence of infectious complications in DP with splenectomy was 28%, whereas the incidence of complications in splenic preservation was only 9%.[1] However, weak points of spleen preservation include the insufficiency of lymph node dissection and the difficulty of the surgical techniques.

There are two surgical methods that enable preservation of the spleen. One involves preserving the splenic artery and vein, which was reported by Kimura et al.[2] The other involves cutting the splenic artery and splenic vein and is known as the Warshaw procedure.[3] Laparoscopic DP is associated with a reduction in the morbidity rate and hospital stay compared to conventional surgery.[4] Because of the simplicity of the procedure, LWP has an advantage in reducing the operation time and blood loss compared to LSPDP with splenic vessels preserving.[5] However, LWP has risks of splenic infarction and gastric varices formation due to left-sided portal hypertension.[6-9] Therefore, it is important to preserve the splenic hilum vascular arcade as well as the left gastroepiploic vessels

and short gastric vessels. However, the relationship between the splenic hilum vessel distribution and splenic infarction or varices formation in LWP has not been described.

In the present study, we describe the influence of splenic vessels distribution on splenic infarction, according to the classification by Michels, the distribution of splenic vessels as distributed type (vessels spread to splenic hilum like fan shape) and magistral type (vessels spread to splenic hilum narrowly) at the splenic hilum.[10]

CASE SERIES

From February 2007 to February 2017, a total of 19 patients underwent LWT for benign or low-grade malignant lesions in the pancreatic body and tail at our institution. This study was reviewed and approved by the Ethics Committee of the Nagasaki University Hospital. The characteristics of the patients are described in Table 1. The average tumor size was 5 cm, and 78% (14/18) of pathological diagnoses were pancreatic cystic disease.

We retrospectively analyzed the operative and long-term outcomes. We also examined the relationship between the type of splenic hilum vessel distribution and the splenic vessel number and presence of splenic infarction. The distribution of the splenic hilum vessels was evaluated using contrast enhancement computed tomography (CE-CT) with the SYNAPSE VINCENT software program (Fujifilm, Tokyo) and classified into distributed type (vessels spread to the splenic hilum in a fan shape) and magistral type (vessels spread to the splenic hilum narrowly) at the splenic hilum (Figure 1). The number of splenic vessels was counted on CE-CT (Figure 2). Patients were followed up for their laboratory data and CE-CT findings within 3 months, 6 months and 1 year after the operation, and every year thereafter.

The operative and long-term outcomes were described as median values. Clinical outcomes were statically analyzed using Fisher's exact test and Mann-Whitney U tests with the IBM Statistical package of social sciences (SPSS) Statistics 21 software program (SPSS Inc., Chicago, IL).

Surgical procedure

In the LWP procedure, after induction of general anesthesia, patients were placed in the supine position. After obtaining pneumoperitoneum, the lessor sac was opened using the laparoscopic LigasureTM Vessel Sealing System (Covidien, Mansfield, MA, USA). During dissection of lessor sac, the left gastroepiploic vessels and short gastric vessels were needed to preserve for maintaining the blood flow to the spleen. The important part of LWP is obtaining a favorable laparoscopic view, so we used two threads to lift the stomach. After achieving the appropriate view, the tumor location was confirmed by laparoscopic ultrasonography, and the resection line of the pancreas was determined. The splenic artery was divided from the pancreas, and the pancreas was tunneled into using the Endo RetractTM Maxi (Covidien). A 4-Fr nylon tube was useful for encircling and hanging the pancreas. During vessels transection, a 4-Fr nylon tube was effective for securing the stapler insertion and ensuring an appropriate field of view. After mobilizing the pancreas from the retroperitoneum, we confirmed the end of the pancreatic tail and made sure to preserve the furcation point of the splenic artery and splenic hilum vascular arcade as well as the left gastroepiploic vessels and short gastric vessels (Figure 3). Finally, we checked the color of the spleen and confirmed the blood flow using laparoscopic ultrasonography.

RESULTS

The operative and long-term outcomes are described in Table 2, and the median follow-up duration was 71 (range 16-132) months.

Table 1: Characteristics of patients.

	LWT (n=19)
Gender (M:F)	3:16
Age (year)	54.4 (30-83)
BMI (kg/m^2)	24.1 (18.2-35.8)
Tumor size (cm)	5 (0.7-11.4)
Pathological diagnosis	
MCN	5
IPMN	3
SCN	3
SPT	3
Metastasis	2
NET	2
Chronic pancreatitis	1

Table 2: Operative and long-term outcomes.

	LWT (n=19)
Operative time (min.)	295 (201-512)
Blood loss (gr.)	200 (5-3250)
Pancreatic fistula (Grade B, C)	0/19 (0%)
Postoperative days peak platelet counts (days)	12 (5-27)
Partial splenic infarction	6/19 (32%)
Varices formation	3/19 (16%)
Local recurrence (%)	0/19 (%)

The median operative time, blood loss and hospital stay were 295 min (201-512), 200 gr (5-3250) and 16 (8-29) days. There were no grade B or C pancreatic fistulae. All patients' platelet counts turned to normal within one month. Six patients (32%) with splenic partial infarction and 3 (16%) with gastric varices were detected, but they have not needed any treatments. Regarding the

classification of splenic hilum vessels distribution, 16 out of 19 cases were distributed type, and 6 were magistral type.

Table 3: Relationship between classification of splenic hilum vessels distribution and splenic infarction.

	Distributed type (n=16)	Magistral type (n=3)
Infarction （＋）	3 (23%)	3 (100%)
Infarction （－）	13	0
Infarction area	25 (10-40)	40 (25-60)

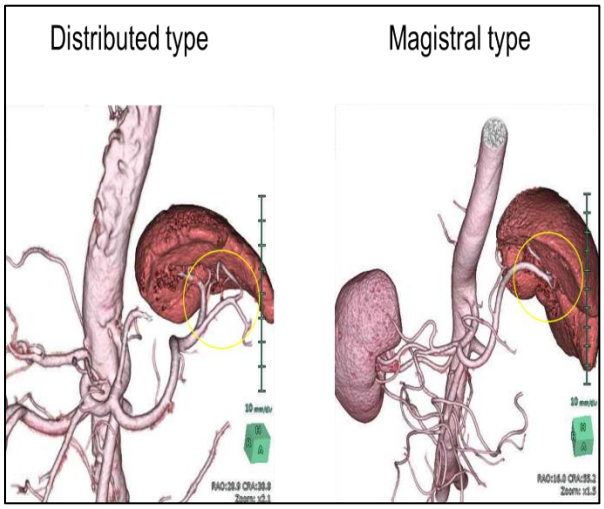

Figure 1: Classification of splenic hilum vessels distribution. Distributed type: vessels spread to splenic hilum like fan shape. Magistral type: vessels spread to splenic hilum narrowly.

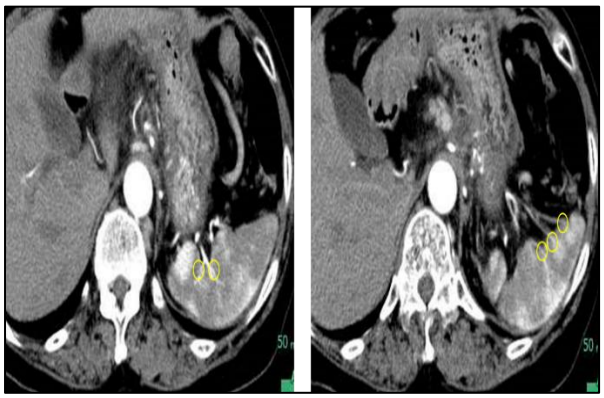

Figure 2: Relationship between number of splenic vessels and infarction.

Three of 16 distributed type patients (23%) developed splenic infarction. In contrast, all of the magistral type patients (100%) showed splenic infarction. The incidence of splenic infarction was significantly higher among the magistral type patients than in the distributed type patients ($p<0.01$). The rate of splenic infarction area was 10%, 25% and 40% in the distributed type patients and 25%, 40% and 60% in the magistral type patients (Table 3). The number of vessels in the splenic hilum was significantly lower in the patients who developed splenic infarction. However, the condition of all six of the patients with splenic infarction improved spontaneously without any treatment. The type of splenic hilum vessel distribution in the three perigastric varices cases was distributed type. Perigastric varices formation was not related to the type of splenic hilum vessel distribution. In the three perigastric varices cases, there were no gastric submucosal changes on endoscopic findings. None of these cases have needed any treatments.

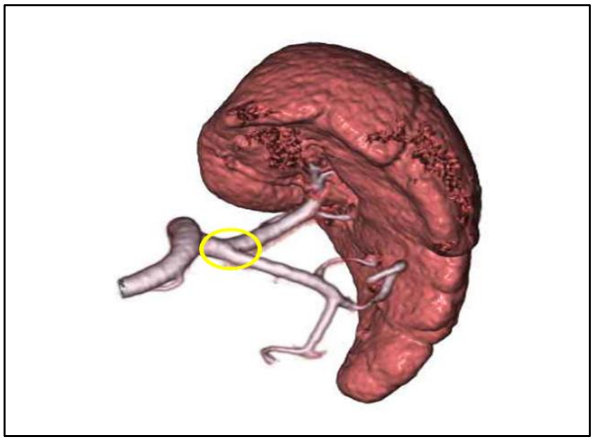

Figure 3: Furcation point of the splenic artery. Preservation of the furcation point of the splenic artery and splenic hilum vascular arcade.

DISCUSSION

LSPDP is widely used in the pancreatic surgery field. The advantages of preserving the spleen are well known; preservation reduces the risk of infection, including overwhelming post-splenectomy infection and the incidence of cancer.[2,11-13] Furthermore, distal pancreatectomy with splenectomy was associated with an increased risk of grade B or C pancreatic fistula.[14,15] Furthermore, the enlarged visual effect of laparoscopic surgery is a feasible way of confirming the small vessels from front and back, thereby helping to prevent small-vessel injury.

For the above reasons, LSPDP is the first choice for treating benign and low-grade malignant tumor in our institution. The LWP has been considered useful for reducing blood loss and operation times compared to LSPDP with SVP because of the simplicity of the procedure.[16] However, due to advances in laparoscopic techniques, recent reports have failed to note any marked difference in the outcomes between the LWP and LSPDP with SVP.[17-19] LSPDP is safe and efficient from the viewpoint of preserving the spleen in both LWT and LSPDP with SVP. For these reasons, for tumors close to splenic vessels and/or in cases of difficult dissection from splenic vessels, we select the LWP.

A recent meta-analysis noted no significant difference between the LWP and LSPDP with SVP in the overall rate of postoperative complications, including perigastric collateral vessels.[20,21] However, Miura et al and Tien et al showed a high risk of perigastric varices formation detected on CT (70% and 29.7%, respectively) after an open Warshaw technique. In our series, only 3 patients (16%) developed perigastric varices.[6,7] In two of these three cases, the distance between the tumor and splenic hilum was within 5 mm. Because the distance between the tumor and the splenic hilum was relatively small, the cutting line was close to the splenic hilum, resulting in perfusion injury and perigastric varices formation. There was an increase of one patient from our past report in 2014, and this patient has subsequently been routinely followed up, with CT and endoscopic examinations performed; however, there have been no gastric submucosal changes on endoscopic findings, and the patient hasn't needed any treatments.[22] The differences in the varices formation rates between the present and previous reports are considered to be due to differences between laparoscopic and laparotomy, with the enlarged visual effect of laparoscopic surgery making it possible to preserve the vascular arcade of the splenic hilum more reliably.

In addition to perigastric varices formation, splenic infarction frequently occurred after the Warshaw technique. Kim et al and we 22 have reported that asymptomatic splenic infarction occurred in 54.2% (66/122) and 24% (4/17) of patients who underwent LWP, respectively, but recovered within 3 and 6 months after operation, provided the splenic hilum vessels were sufficiently preserved.[17] In contrast, Ferrone et al reported that 3 of 156 patients (1.9%) needed splenectomy after an open Warshaw technique due to abdominal pain and a fever.[8] Stefano et al reported the results of a meta-analysis of splenic infarction between the LWP and LSPDP with SVP. Those authors found that the LWP was associated with a significantly higher incidence of splenectomy than LSPDP with SVP.[21] In the present study, the rate of splenic infarction was 32% (6/19) and we evaluated the correlation between splenic vessel distribution in the splenic hilum and splenic infarction. The distributed type was the major type of splenic vessel anatomy, as splenic vessels spread to the splenic hilum in a fan shape and formed an arcade at the splenic hilum. In magistral type, the splenic trunk is long, and branches cluster more closely in the splenic hilum with a poor arcade. However, in the present study, we showed a technique for preserving the furcation point of the splenic artery and splenic hilum vascular arcade, thereby preventing splenic infarction; the infarction rate was 100% in the magistral type. These results indicated that completely maintaining the splenic perfusion was difficult in magistral type due to poor formation of the vascular arcade. However, preserving the furcation point limited the extent of splenic infarction and did not result in intervention-requiring complications.

The patency of vessels after LSPDP with SVP has been reported by several authors. Yoon et al described the obliteration rate of the splenic vein as 50.1% at 6 months after LSPDP with SVP.[23] Collateral vessel formation was confirmed in 41% (9/22) of patients. According to their findings, the risk factors for poor patency of splenic vessels were postoperative pancreatic fistula and intra-abdominal collection. Hwang et al also reported the obliteration rate of the splenic vein after LSPDP with SVP to be 17.2% (5/30) and the perigastric varices formation rate to be 13.8% (4/30), but no splenic infarction. Comparing these results with our own, LSPDP with SVP seems able to prevent the occurrence of splenic infarction, but there is no marked difference in the rate of perigastric varices formation. Even when splenic infarction occurred, it disappeared in all cases, and no adverse events were observed.

This study had several limitations owing to its retrospective nature and the number of cases is small. Despite several limitations were existed, this is the first study to describe the influence of splenic vessels distribution on splenic infarction, according to the classification by Michels, the distribution of splenic vessels as distributed type (vessels spread to splenic hilum like fan shape) and magistral type (vessels spread to splenic hilum narrowly) at the splenic hilum.

CONCLUSIONS

In conclusion, although LWP is a safe procedure, there is a high risk of splenic infarction if the splenic vessel distribution is a magistral type. Understanding the type before surgery leads to the identification of an appropriate vascular dissection position and reduces postoperative complications. A larger study is needed to confirm the safety and efficacy of the LWP and its short- and long-term outcomes.

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