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Original article

Laparoscopic spleen-preserving distal pancreatectomy with and without splenic vessel preservation: The role of the Warshaw procedure

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ABSTRACT

Background/objectives: Laparoscopic spleen-preserving distal pancreatectomy (LSPDP) for low-grade malignant pancreas tumors was recently demonstrated. Although the procedure with splenic vessel preservation (SVP) is optimal for LSPDP, SVP is not always possible in patients with a large tumor or a tumor attached to splenic vessels. This study aimed to analyze the safety of two procedures: LSPDP without SVP, known as the Warshaw technique (lap-WT), and LSPDP with SVP (lap-SVP).
Methods: Seventeen patients who underwent a lap-WT and seven patients who underwent a lap-SVP were investigated retrospectively.
Results: The median follow-up duration was 45 (range 17–105) months. In the lap-WT and lap-SVP patients, the sizes of the tumors were 5 (1.3–12) and 1.5 (1–4) cm; the operative times were 304 (168–512) and 319 (238–387) min; the blood loss was 210 (5–3250) and 60 (9–210) gr; the length of the postoperative hospital stay was 15 (8–29) and 18 (5–24) days; the peak platelet counts were 37.2 (14.6–65.2) and 26.4 (18.8–41) $\times$ $10^4/\mu L$, and splenomegaly was observed in 10 (59%) and three (43%) patients, respectively. In both procedures, there was no local recurrence. In the lap-WT group, splenic infarctions were seen in four (24%) patients and perigastric varices were seen in two (12%) patients. All of these patients were observed conservatively.
Conclusions: Both the lap-WT and lap-SVP were found to be safe and effective, and in cases in which the tumor is relatively large or close to the splenic vessels, lap-WT can be used as the more appropriate procedure.

Introduction

Spleen-preserving distal pancreatectomy (SPDP) is a suitable procedure for patients with benign or low-grade malignant pancreas tumors [1] because these patients are likely to survive for a long time, and therefore it is important to preserve their immunological function; in other words, to preserve the spleen. There are two spleen-preserving methods in SPDP: in one, the splenic artery and vein are preserved, and in the other they are excised [2–4]. Although the preservation of splenic vessels is optimal for SPDP, it is sometimes difficult to preserve splenic vessels in patients with an unusually large tumor or a tumor attached to splenic vessels. SPDP with excision of the splenic artery and vein was first described in 1988 by Warshaw [5], in a report describing a technique that was successfully performed in 22 of 25 consecutive patients. This Warshaw technique (WT) spread widely as the best option for SPDP.

At the same time, laparoscopic surgical techniques have become well established in recent years, and several reports on laparoscopic distal pancreatectomy for low-grade malignant pancreatic tumors have been published [6–11]. In the Warshaw technique, the postoperative splenic circulation is maintained by the collateral vessels via the short gastric vessels. Thereby, this blood flow induces gastric varices [12]. Several research groups have described the risk of the development of gastric varices or splenic infarction linked to the Warshaw technique [12–14], but splenomegaly and

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the elevation of platelet counts following the use of the Warshaw technique have not been reported in detail. In the present study, we describe both a way to preserve the splenic blood supply when performing the laparoscopic Warshaw technique (lap-WT) and our long-term results (including those concerning splenic circulation) in a comparison with laparoscopic SPDP with splenic vessel preservation (lap-SVP).

Materials and methods

Between September 2005 and January 2013, a total of 24 patients diagnosed with benign or low-grade malignant pancreas tumors underwent laparoscopic SPDP in our Department of Surgery. Of those, 17 patients underwent lap-WT and the other seven patients underwent lap-SVP. The lap-WT procedure was indicated for relatively large tumors and for tumors located close to splenic vessels. The patients' characteristics are described in Table 1. The sizes of the tumors in the group of lap-WT patients were larger than those of the lap-SVP patients. In both groups, no tumor oppressed the splenic vessels and no collateral vessels developed preoperatively. Both procedures included hand-assisted laparoscopic surgery (HALS) and single-incision laparoscopic surgery (SILS).

We retrospectively analyzed the operative outcomes and the long-term outcomes (especially of splenic circulation) afforded by the two procedures. The platelet counts were evaluated on blood tests. The splenic volume was calculated on computed tomography (CT) scans using SYNAPSE VINCENT software (Fujifilm, Tokyo). The patients were followed up by CT scan within 3 months, at 6 months, 1 year after the operation, and once per year thereafter. We defined postoperative splenomegaly as when the splenic volume increased more than 120% compared to the preoperative volume. Perigastric varices with a venous dia. > 5 mm were diagnosed on enhanced CT scan. All data are expressed as the median with range. The follow-up duration between two procedures was compared by the Mann–Whitney *U*-test using GraphPad PRISM6 for Mac.

Surgical techniques

Under general anesthesia, the patient was placed in the supine position. We used three 5-mm and one 12-mm working ports for the laparoscopic distal pancreatectomy. A 12-mm port at the umbilicus was also used for the 10-mm flexible laparoscope (Olympus, Tokyo). The port placement for laparoscopic pancreatic surgery using HALS and SILS has been reported [15,16].

In the lap-WT procedure, after pneumoperitoneum was achieved, the greater omentum was divided near the right gastroepiploic artery to widely reveal the anterior side of the pancreas body and tail. The splenocolic ligament and gastrosplenic ligament were not divided, in order to maintain the blood supply to the spleen. After laparoscopic ultrasonography was performed to confirm the location of the tumor and to determine the resection line of the pancreas, the dissection of the pancreas was started at the inferior side of the pancreas near the resection line, and the pancreas was removed from the retroperitoneal space by rolling the pancreas to the superior side.

The splenic artery was mobilized near the dissection line of the pancreas and divided by clipping both the proximal and distal sides; however, the splenic vein was not mobilized from the pancreas. An endoscopic linear stapler (End-GIA, Covidien, Norwalk, CT, USA) was used to resect the pancreas with the splenic vein (Fig. 1a). Thereafter the distal pancreas dissection from the retroperitoneal space was continued to reach the hilum of the spleen. In this process, we thought it was important not to dissect the splenocolic ligament, gastrosplenic ligament (including short gastric vessels), and left gastroepiploic vessels.

The structure consisting of these ligaments encircles the hilum of the spleen, and the pancreas was dissected along the dotted line shown in Fig. 1b and c. The pancreas tail was then divided carefully so as not to damage the small vessels in the hilum of the spleen. The dissected pancreas was placed in an endoscopic retrieval bag and extracted from the umbilical wound. Lastly, we observed the color of the splenic surface to confirm the blood supply, using laparoscopic ultrasonography.

In the lap-SVP procedure, following the division of the greater omentum as in lap-WT, the splenocolic ligament and gastrosplenic ligament were divided. After the confirmation of the location of the tumor using laparoscopic ultrasonography, the dissection of the pancreas was conducted as in the lap-WT procedure. Not only the splenic artery but also the splenic veins were mobilized from the pancreas. After the pancreas was resected using the endoscopic linear stapler, a distal pancreatectomy was performed as in the lap-WT procedure.

Table 1
The characteristics of the 24 patients with benign or low-grade malignant pancreas tumors.

	lap-WT ($n = 17$)	lap-SVP ($n = 7$)
Gender (M/F)	3/14	4/3
Age (yrs)	49 (30–83)	70 (50–86)
BMI (kg/m^2)	22.3 (18.2–35.8)	22.8 (17.2–25.5)
Tumor size (cm)	5 (1.3–12)	1.5 (1–4)
Procedure (Lap/HALS/SILS)	5/10/2	4/1/2
Pathological diagnosis	Cases (malignancy)	
IPMN	3	1
MCN	4 (1)	1
SPT	3 (1)	1 (1)
SCN	2	0
Chronic pancreatitis	1	1
Metastasis	2	1
Others	2	2

lap-WT, laparoscopic Warshaw technique.
lap-SVP, laparoscopic splenic vessels-preserving technique.
BMI, body mass index.
Lap, laparoscopic HALS, hand-assisted laparoscopic surgery.
SILS, single incision laparoscopic surgery.
IPMN, intraductal papillary mucinous neoplasm.
MCN, mucinous cystic neoplasm SPT, solid-pseudopapillary tumor.
SCN, serous cystic neoplasm.

Results

The outcomes of each procedure are summarized in Table 2. All of the intended lap-SVP procedures were performed successfully without conversions to lap-WT procedures. In all patients who underwent the lap-SVP procedure, the patency of the splenic vessels was confirmed postoperatively on an enhanced CT scan. The median follow-up duration was 45 (range 17–105) months. The follow-up duration of the lap-WT group was significantly longer than that of the lap-SVP group (55 [23–105] vs. 38 [17–45] months, respectively; $P < 0.05$). In the lap-WT and lap-SVP groups, the median operative times were 304 (168–512) and 319 (238–387) min; the median operative blood loss was 210 (5–3250) and 60 (9–210) gr, and the median length of postoperative hospital stay was 15 [8–29] and 18 [5–24] days, respectively. There was no Grade B or C pancreatic fistula based on the International Study Group of Postoperative Pancreatic Fistula (ISGPF) [17], and no local recurrence following either procedure was observed.

The postoperative peak platelet counts in the lap-WT and lap-SVP patients were 37.2 (14.6–65.2) and 26.4 (18.8–41) × 10^4/μL, respectively. Although the platelet counts in the lap-WT and lap-SVP groups rose to the peak levels on 12 [5–16] and 12 [5–17]

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