bleeding, even if specialists for LAG (more than 200 cases of experience) performed surgery.[21] The present study was conducted following the standardization period; in other words, feasibility of laparoscopic D2 lymph node dissection following standardization could be investigated as a preliminary study.

As expected, the operation time for the complete D2 group was longer (by about 30 min) than for the D1 + beta group, due in part to the additional lymph nodes that required dissection. Thus, in patients with middle third gastric cancer, D2 lymph node dissection is achieved by the removal of station 11p (along with the splenic artery) and 12a (along with the proper hepatic artery) lymph nodes as well as D1 + beta lymph node dissection. In addition, station 14v (surface of superior mesenteric vein at the level of lower border of pancreas) lymph nodes were dissected if the tumor was located in the lower third of the stomach.

The quality of lymph node dissection is occasionally determined from the number of retrieved lymph nodes.[7,11] In the present study, the number of retrieved lymph nodes was significantly larger for the complete D2 group than for the D1 + beta group. This difference might be a result of the aggressive lymph node dissection, including dissection from the suprapancreatic area, for the complete D2 group.

The higher frequency of postoperative morbidity following complete D2 lymph node dissection was of some concern, since a European randomized trial reported a higher frequency of postoperative morbidity after D2 lymph node dissection compared with those following either D0 or D1 lymph node dissection.[15,16] Intraoperative bleeding and postoperative pancreas-related infections were of particular concern for the complete D2 group since the procedure requires the exposure of major vessels and the pancreas capsule, both of which could be injured during the procedure. In the present study, one patient of complete D2 group required conversion due to uncontrollable bleeding even though all operations were performed by experienced surgeons. However, the incidence of postoperative morbidity and mortality was not different, and any other intraoperative complication was not observed. We consider, therefore, laparoscopic D2 lymph node dissection can be performed safely. However, since it is a technically difficult procedure, standardization of the laparoscopic procedure is required, and experienced surgeons should carry out the surgery.

The current study has some limitation, however, since the long-term outcome has not been evaluated, and the number of patients who underwent complete D2 dissection is relatively low. Continued monitoring of patients is required to determine the long-term efficacy of laparoscopic D2 lymph node dissection, thereby enabling its acceptance as a standard surgical procedure for advanced gastric cancer. Moreover, well-designed prospective study comparing LADG with D2 lymph node dissection and conventional open gastrectomy with D2 lymph node dissection is required as a next step.

In conclusion, LADG with complete D2 lymph node dissection is a safe procedure, provided experienced surgeons perform the surgery following standardization. To be accepted as a standard treatment, well-designed prospective study is warranted in the future.

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Technical note

Left-sided approach for suprapancreatic lymph node dissection in laparoscopy-assisted distal gastrectomy without duodenal transection

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Abstract

Laparoscopy-assisted distal gastrectomy (LADG) with extended lymph node dissection has not yet been widely adopted for the treatment of gastric cancers because of the perceived complexity of the procedure. Suprapancreatic lymph node dissection is one of the most important and demanding procedures in this approach. The techniques of duodenal transection within the abdominal cavity or taping of the common hepatic or splenic artery had traditionally been adopted for suprapancreatic nodal dissection during open surgery. In 2005, we developed a new laparoscopic procedure to safely and simply perform suprapancreatic lymph node dissection in LADG. We introduced a left-sided approach for the dissection of lymph nodes in the left gastropancreatic fold, where the body of the stomach is turned over and lifted ventrally to expose the left gastropancreatic fold through the opened lesser sac, without duodenal transection, and the suprapancreatic lymph nodes are resected en bloc in reverse order, i.e., including the lymph nodes along the proximal splenic artery (station 11p), around the celiac artery (station 9), and along the common hepatic artery (station 8a). Between April 2005 and December 2007, a total of 391 patients with cT1,2 gastric cancer underwent this surgical approach. In all patients, surgery was completed safely with favorable outcomes; mean operating time was 239 min and mean blood loss was 63 ml. The complication rate was 4.6% (18/391); there were ten conversions (2.6%) and no mortality. The aim of the present study was to describe the surgical technique of our new approach for LADG with extended lymph node dissection and to evaluate the treatment outcomes achieved by this technique.

Introduction

Recently laparoscopy-assisted gastrectomy, as well as endoscopic submucosal dissection, (ESD) has been adopted as a less invasive treatment choice than open gastrectomy for gastric cancer [1]. However, laparoscopy-assisted distal gastrectomy (LADG) with extended lymph node dissection for cT1,2 gastric cancer is a technically demanding procedure, and therefore has not yet been widely adopted.

To perform reliable and safe extended lymph node dissection in LADG, efforts have focused on the replication of techniques established for open surgery, including duodenal transection and the taping of main arteries [2, 3]. However, laparoscopic procedures replicating the procedures of open surgery tend to be technically difficult and time-consuming because of differences in the surgical environments, such as vision or space in the surgical field [4–6].

Suprapancreatic lymph node dissection is one of the most important and demanding procedures in laparoscopic extended lymph node dissection [7]. In suprapancreatic lymph node dissection, many practitioners transect the duodenum before performing the celiac lymph node dissection and start the dissection procedure at station 8a lymph nodes (along the common hepatic artery), and then extend towards the station 9 lymph nodes (along the celiac artery) and station 11p lymph nodes (along the proximal splenic artery) [2, 3, 5]. In these conventional procedures, bleeding from lymph node station 8a and the transected duodenum frequently extends to the left side of the left gastropancreatic fold and compromises the accuracy of the lymph node dissection procedures. For this reason, we developed a new laparoscopic procedure for suprapancreatic lymph node dissection, a left-sided approach via the left gastropancreatic fold through the opened lesser sac. In this approach, the suprapancreatic lymph nodes are dissected from the left side to the right side.

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In the present study, we assessed the feasibility of the left-sided approach for suprapancreatic lymph node dissection in LADG, without duodenal transection, and evaluated the treatment outcomes in 391 patients with LADG achieved by this technique; outcome factors included estimated blood loss, operation time, and numbers of retrieved lymph nodes.

Patients and methods

Patients

The subjects were 391 gastric cancer patients who underwent LADG at our hospital between April 2005 and December 2007. All patients were diagnosed with gastric cancer that was located in the middle or lower third of the stomach and in which the depth of tumor invasion was limited to the proper muscular layer (cT1,2 cancer). D2 Lymph node dissection or modified D2 dissection (D1+beta or D1+alpha) was performed for these gastric cancers. The extent of dissection was determined according to the Japanese Gastric Cancer Association *Gastric cancer treatment guideline* [8].

Surgical technique

The surgical procedures for LADG combined with D2 lymph node dissection are described as follows. The patient was placed in the supine position with the legs apart, using Levitator Stirrups (SKYTRON, Grand Rapids, MI, USA), the right arm was placed along the body trunk, and the body trunk was immobilized using a Magic Bed (Nikko Fines Industries, Tokyo, Japan). A video monitor was placed above the head of the patient. Pneumoperitoneum was created by the injection of carbon dioxide at 10–12 mmHg and a 30° oblique laparoscope was inserted through the umbilical port. Under the view of the laparoscopic image, a total of four ports (each 5 to 12 mm) were inserted into the left upper, left flank, right upper, and right flank quadrants (Fig. 1).

The surgeon stood on the left side of the patient, with the assistant on the right side, and the camera operator stood between the patient's legs. Before the lymph node dissection was started, a falciform was tied to the abdominal wall to retract the liver. The gastrocolic ligament, including lymph node station 4d, was divided using Autosonix Ultra Shears (Tyco Healthcare, Tokyo Japan), which gave access to the lesser sac. By continuing to dissect the gastrocolic ligament to the right side, the area between the anterior sheet of the transverse mesocolon and the second part of the duodenum was sufficiently separated before lymph node dissection of stations 14v and 6 was done. The periphery of the anterior superior pancreatic duodenal vein was exposed to confirm the end point of these lymph node dissections.

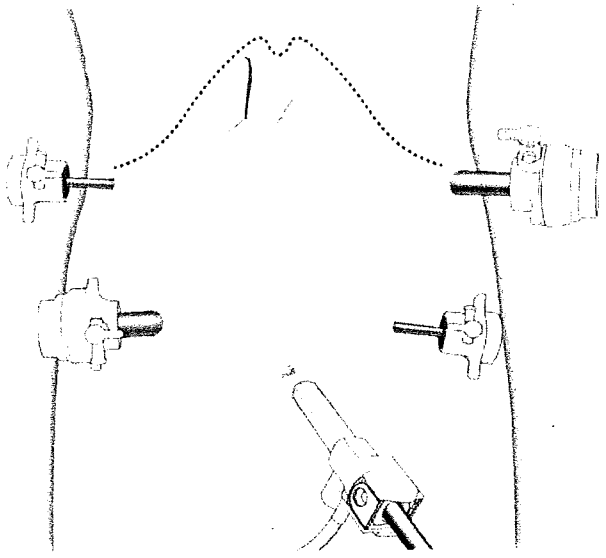

Fig. 1. Illustration shows 10-mm port at the umbilicus, 10-mm port in the left upper quadrant, 5-mm port in the left flank, 5-mm port in the right upper quadrant, and 12-mm port in the right flank

The assistant vertically lifted the right gastroepiploic vessels, using left-hand grasper forceps, and pulled down the middle colic vessels, using right-hand grasper forceps. The superior mesenteric vein, middle colic vein, gastrocolic vein, and the aforementioned anterior superior pancreatic duodenal vein were exposed; then lymph node station 14v was dissected. After division of the origin of the right gastroepiploic vein, using a clip (Lapro-Clip [single absorbable ligating clip cartridge]; Tyco Healthcare] and Autosonix Ultra Shears, lymph node dissection of station 6 was started from this point and continued in the upper direction. The surface of the head of the pancreas was carefully exposed during lymph node dissection of station 6. The right gastroepiploic artery was divided, using a clip and LigaSure (Tyco Healthcare), at station 6 (Fig. 2A).

The surgeon then changed sides to stand on the right of the patient. The gastrocolic ligament, including lymph node station 4sb, was divided 4 cm distal to the epiploic arcade towards the lower pole of the spleen, and the origins of the left gastroepiploic vein and artery were divided using a clip and LigaSure.

Before starting lymph node dissection of stations 12a and 5, the bulb of the duodenum and the supraduodenal artery were exposed and one or two supraduodenal arteries were cut. In the conventional technique, the duodenum is transected in the abdominal cavity before the hepatoduodenal ligament is dissected. By comparison, with the new technique, the hepatoduodenal

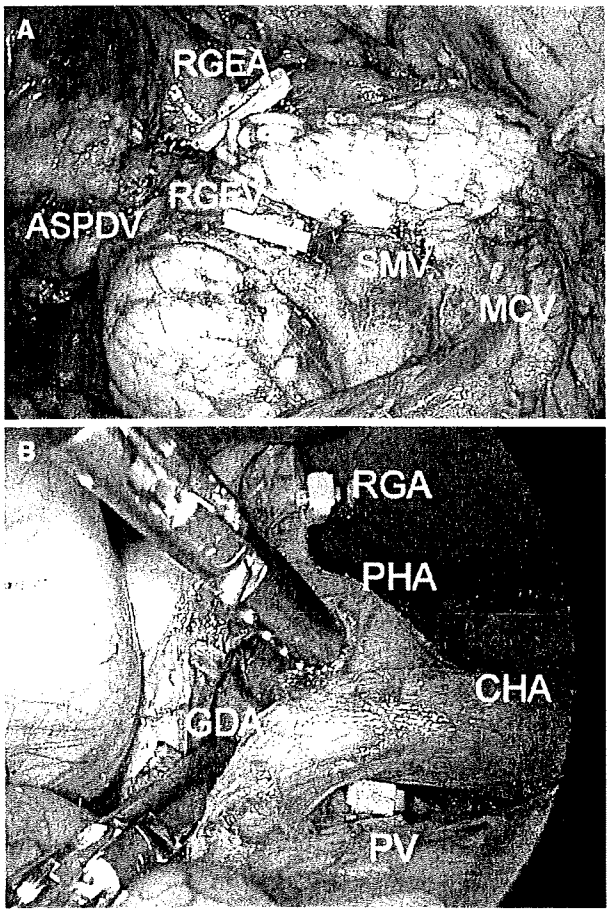

Fig. 2. **A** Completion of dissection of lymph node stations 14v and 6. Clips are placed at the resection stump of the right gastroepiploic vein (*RGEV*) and at the resection stump of the right gastroepiploic artery (*RGEA*). **B** Completion of dissection of lymph node stations 12a and 5. A clip was placed at the resection stump of the right gastric artery (*RGA*). The portal vein (*PV*) was exposed behind the common hepatic artery (*CHA*). *ASPDV*, anterior superior pancreatoduodenal vein; *SMV*, superior mesenteric vein; *MCV*, middle colic vein; *GDA*, gastroduodenal artery; *PHA*, proper hepatic artery

ligament is dissected without transecting the duodenum. After cutting the supraduodenal artery, the assistant lifted the right gastric vessels in the left vertical direction. The antrum of the stomach was pulled caudally, the pedicle of the right gastric artery and vein were pulled to the left, and the hepatoduodenal ligament was tensioned.

The hepatoduodenal ligament was dissected on the right side of the proper hepatic artery, and the front surface of the portal vein was exposed using the horizontal laparoscopic view. To confirm the upper edge of the lymph node dissection of station 12a, the bifurcation of the right and left hepatic arteries was exposed. The proper hepatic artery was skeletonized and the right gastric artery and vein were divided at their origin, using a clip and LigaSure, to allow complete dissection of the lymph nodes at stations 12a and 5 (Fig. 2B).

Next, the operator started the suprapancreatic lymph node dissection. The assistant gently pulled out the left gastropancreatic fold (the pedicle of the left gastric artery) from the dorsal side and lifted it vertically towards the abdominal wall. The assistant also pulled the pancreas caudally to extend the left gastropancreatic fold (Fig. 3B).

Dissection of the suprapancreatic lymph nodes at stations 11p, 9, 7, and 8a started at the left side of the left gastropancreatic fold at the upper edge of lymph node station 9. The pancreatic capsule was dissected, using Autosonix Ultra Shears, at the line of the suprapancreatic border toward the pancreatic tail as far as the root of the posterior gastric artery. The avascular area behind the upper body of the stomach was then dissected further into the medial side up to the left crus of the diaphragm. The splenic vein was exposed and the proximal splenic artery was skeletonized to dissect the lymph nodes at station 11p, which are located between the splenic artery and vein (Fig. 3C).

By dissecting the cephalic side of the left gastropancreatic fold from the left side the left gastric vessels can be sufficiently exposed by pulling, thus facilitating identification. The left gastric artery was exposed and divided, using a clip and LigaSure (Fig. 4A). The portal vein was exposed to confirm the origin of the left gastric vein, and the left gastric vein was divided using a clip and Autosonix Ultra Shears. The common hepatic artery was exposed and skeletonized, and lymph node station 8a was dissected in a cephalic direction to expose the right crus of the diaphragm (Fig. 4B). The cardiac lymph nodes at station 1 and the lymph nodes along the lesser curvature of the stomach at station 3 were then removed (Fig. 5).

In all patients, a 4- to 5-cm midline incision was made after the completion of the intracorporeal lymph node dissection. Reconstruction was performed via the incision extracorporeally in all patients who underwent LADG.

Results

The clinical characteristics of the patients who underwent LADG are summarized in Table 1 and include the following results: mean operating time, 239 ± 56 min; mean blood loss, 63 ± 127 ml; and mean number of dissected lymph nodes, 36 ± 11. Of the 391 gastric cancer patients who underwent LADG, 10 patients were converted to open surgery. A criterion of conversion to open surgery was the intraoperative diagnosis of N2

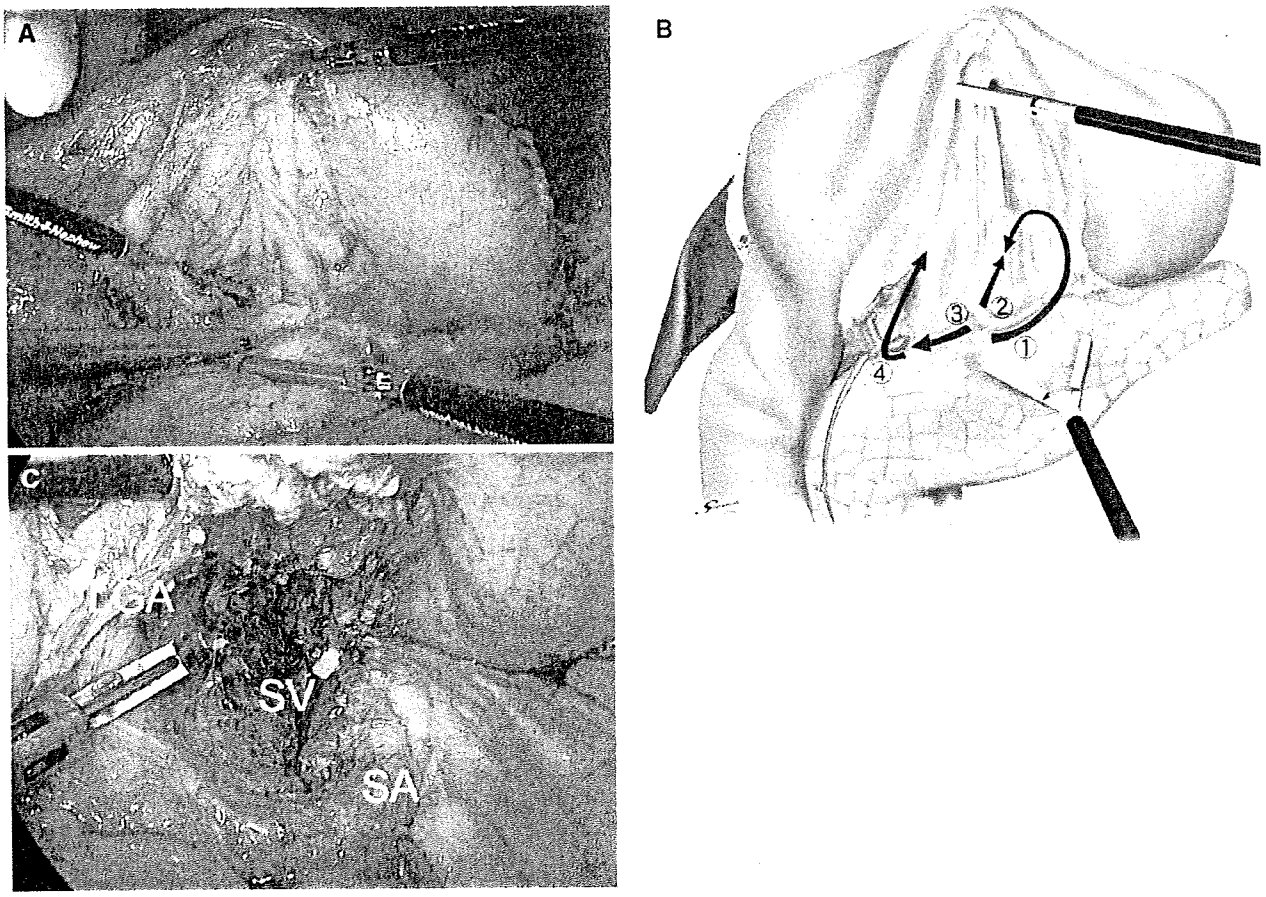

Fig. 3. **A** Lifting the left gastropancreatic fold. An assistant lifted the pedicle of the left gastric artery and vein (left gastropancreatic fold) using a right-hand grasper. **B** Procedure for suprapancreatic lymph node dissection; direction is shown from *1* to *4*. **C** Dissection of lymph node station 11p. The left side of the left gastropancreatic fold is held to lift the fold, and the no. 11p lymph node is dissected from the base of the splenic artery (*SA*) towards the periphery. *SV*, Splenic vein; *LGA*, left gastric artery

metastasis; 8 of the 10 patients were converted to open surgery for additional lymph node dissection. Other reasons for conversion included one case of injury to Henle's gastrocolic trunk during dissection of station 6 and one case of severe adhesion of the stomach to the pancreas, possibly due to chemotherapy for malignant lymphoma of the pancreas. The overall incidence of postoperative complications was 4.6%. The postoperative complications included seven cases of pancreatic fistula, five cases of intraabdominal abscess surrounding the stump, two cases of anastomotic leakage, and three cases of surgical site infection. In one case, the patient developed small-intestinal obstruction, and required further surgery for an internal hernia on postoperative day 12. There was no mortality associated with surgery. Time to the beginning of oral intake was 2 ± 0 days. Mean postoperative hospital stay was 13 ± 10 days.

Discussion

In order to perform extended lymph node dissection safely and accurately during LADG for the treatment of gastric cancer, special techniques are required for dissecting the suprapancreatic lymph nodes, including lymph node stations 8a, 9, and 11p, and 12a, where expanding the visual field is particularly difficult [2, 3, 7]. For the dissection of lymph node station 12a, it is necessary to stretch the hepatoduodenal ligament in the longitudinal and horizontal directions. In open gastrectomy, the entire pancreas head is manually pulled in the caudal direction by an assistant in order to stretch the hepatoduodenal ligament in the longitudinal direction, and the duodenal bulb is dissected to stretch the hepatoduodenal ligament in the horizontal direction. In previously described laparoscopic techniques, similar to

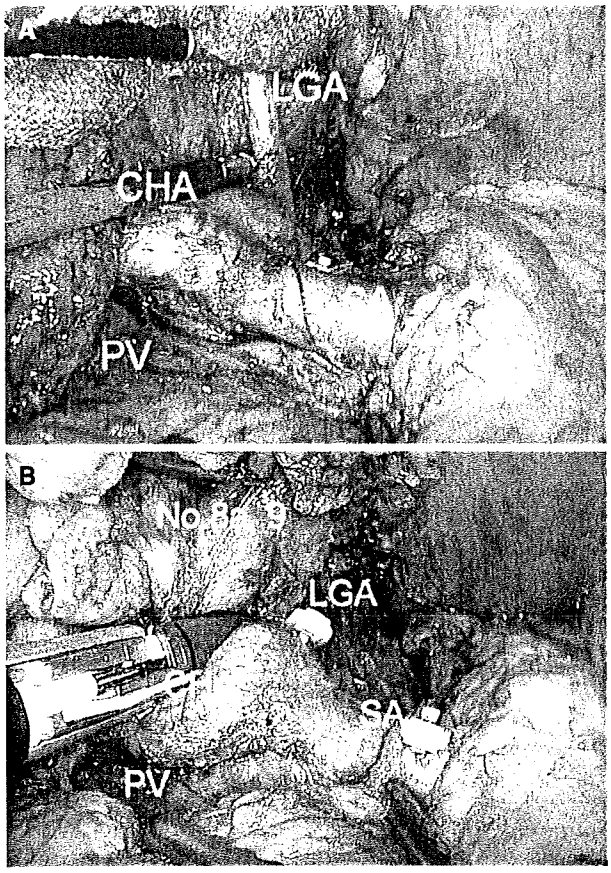

Fig. 4. **A** Dissection of the left gastric artery (*LGA*). The left gastric artery is confirmed from the left side of the celiac trunk, and a clip is placed at the base to cut the artery, using LigaSure. **B** Dissection of lymph node station 8a. Lymph node station 8a was dissected after cutting the left gastric artery and vein

the technique in open gastrectomy, the duodenum has been transected to stretch the hepatoduodenal ligament in the horizontal direction, but this dissection eliminates the site for longitudinal pulling [2, 3, 9]. As a result, it is necessary to stretch the hepatoduodenal ligament longitudinally by taping the common hepatic artery. Even with this technique, the hepatoduodenal ligament cannot be fully stretched in the longitudinal direction, and the proper hepatic artery is taped to compensate for the horizontal expansion.

With our technique, instead of transecting the duodenum in the abdominal cavity, the pyloric region is strongly pulled in the left caudal direction in order to pull the hepatoduodenal ligament in the longitudinal direction. With laparoscopy, near horizontal close-up images are obtained, and by observing the hepatoduodenal ligament horizontally from the right side and pulling the right gastric artery to the left, the front

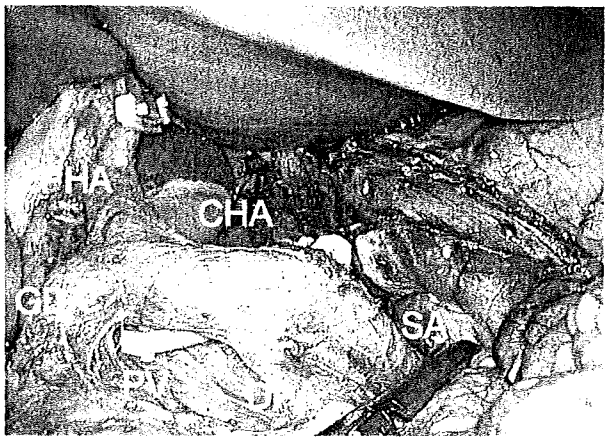

Fig. 5. Completion of dissection of lymph node station D2. Clips are placed at the resection stump of the left gastric vein and artery and right gastric artery. *DPA*, dorsal pancreatic artery

surface of the portal vein can easily be accessed, thus making it possible to reliably dissect the lymph node at station 12a. In addition, not transecting the duodenum avoids contaminating the visual field due to bleeding from the cutoff stump, and not taping the vessels simplifies and shortens the surgery time.

In conventional laparoscopic suprapancreatic lymph node dissection, the common hepatic artery and splenic artery are taped, and lymph nodes are generally dissected from right to left, starting with lymph node station 8a, followed by lymph node station 9 and then 11p. However, there are many small vessels and lymphatic vessels around the lymph nodes at station 8a, and if this area is dissected first, the subsequent left gastric artery and vein dissections, and the dissections of lymph node stations 9 and 11p, are sometimes more difficult due to contamination of the visual field by bleeding and lymph leakage. By comparison, with our technique, the left gastropancreatic fold is pulled in the ventral direction through the opened lesser sac, and the suprapancreatic lymph nodes are dissected from left to right. Because the suprapancreatic lymph node dissection is started from this area and the cranial side of the left gastric artery and vein is sufficiently detached before dissection, it becomes easier to stretch the left gastric artery and vein in the ventral direction and to confirm well-stretched suprapancreatic lymph nodes. Furthermore, because the left gastric artery and vein are dissected before lymph node station 8a, vessels can be treated safely in a dry state without the presence of blood and lymph.

In conventional laparoscopy-assisted surgery, when stretching the area between the common hepatic artery and splenic vein and the area between the splenic artery and vein, the artery is taped and pulled in the caudal

Table 1. Characteristics of patients who underwent LADG with the new technique of lymph node dissection

Number of patients	391
Sex	
Male / Female	231/160
Age average (years)	62 ± 12
Body mass index (kg/m^2)	23 ± 3
Duration of operation (min)	239 ± 56
Blood loss (ml)	63 ± 127
No.of dissected lymph nodes	36 ± 11
Degree of lymph node dissection	
D2 / modified D2	41/350
Clinical staging	
IA / IB / II	369/20/2
No. of patients with conversion to open surgery (%)	10 (2.6)
Further lymph node dissection	8
Bleeding	1
Adhesion	1
Postperative complications (%)	18 (4.6)
Pancreatic fistula	7
Intraabdominal abscess	5
Anastomotic leakage	2
Surgical site infection	3
Ileus	1
Time until starting oral intake (days)	2 ± 0
Postoperative hospital stay (days)	13 ± 10

Data values are presented as means ± SD. Body mass index = body weight/height^2 (kg/m^2)
LADG, laparoscopy-assisted distal gastrectomy

direction to ensure a sufficient visual field. The advantage of our technique is that the splenic vein is easy to access by pulling up the left gastropancreatic fold ventrally through the horizontal field of the magnified view provided by laparoscopy, which makes dissection in this area safe and reliable without taping the common hepatic and splenic arteries.

In this manner, by not transecting the duodenum inside the abdominal cavity during laparoscopic lymph node dissection, it becomes possible to securely lift the entire stomach, and because it is not necessary to tape vessels, it becomes easier to stretch the hepatoduodenal ligament and perform the station 12a lymph node dissection. In addition, because laparoscopy provides horizontal and close-up images of deep areas, it is possible to approach the left side of the left gastropancreatic fold, and as a result, suprapancreatic lymph node dissection can be performed in a dry state.

Suprapancreatic lymph node dissection is considered to be more demanding in obese patients. The present study included eight patients with body mass index (BMI) values between 30 and 35.6 kg/m^2, all of whom were operated on safely without postoperative complications. This may be because our technique is more suitable for obese patients than the conventional procedure, because the operative field is easily obtained by pulling up the left gastropancreatic fold from the surrounding tissues. In the conventional procedure, the left gastropancreatic fold is hard to approach in obese patients due to the surrounding fat. For this reason, it was easier for both surgeons and assistants to acquire proficiency in our left-sided technique than the conventional procedure; requiring only about ten cases to establish this surgical procedure.

Due to recent advances in surgical techniques, as well as advances in optical equipment and dissection devices, it is difficult to compare the present technique to past techniques. However, when compared to the conventional technique, suprapancreatic lymph node dissection in LADG was completed in a shorter time, possibly because the dissection could be developed safely and smoothly in a dry state. In the present study, an optimal number of lymph nodes was dissected, the incidence of postoperative complications associated with dissection, such as pancreatic fluid leakage, was low, and the procedure was completed safely.

Laparoscopic lymph node dissection for gastric cancer, in which suprapancreatic lymph nodes are dissected with a left-sided approach without duodenal transection, is more convenient than conventional methods. This approach can be performed easily, and we believe that the present technique will become more widely adopted and will contribute to the future success of LADG.

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