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HOW TO DO IT

Totally laparoscopic pancreaticoduodenectomy for locally advanced gastric cancer

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Abstract
Background In patients having locally advanced cancer of the stomach with suspected tumor infiltration to the pancreatic head or the duodenum, a concurrent pancreaticoduodenectomy with gastrectomy is occasionally prerequisite to achieve a microscopically tumor-free surgical margin.
Materials and methods We present the first series of successful totally laparoscopic pancreaticoduodenectomy (TLPD) for advanced gastric cancer with suspected infiltration to the pancreatic head.
Results TLPD was successfully performed without adverse events during surgery and resulted in favorable short-term outcomes of three patients with locally advanced gastric cancer with suspected invasion to the pancreas.
Conclusions Although TLPD for locally advanced gastric cancer is a technically difficult challenging operation that requires careful dissection along the major vessels, intracorporeal tie sutures, and the placement of an external drainage tube into a narrow pancreatic duct, this procedure is technically feasible and safe in the hands of experienced surgeons. Long-term follow-up is mandatory to validate oncological outcome.

Keywords Laparoscopic pancreaticoduodenectomy · Stomach neoplasm · D2 lymphadenectomy · Laparoscopic gastrectomy

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Introduction

Surgical resection with curative intent is the principle treatment for gastric cancer. In patients with advanced gastric cancer involving the pancreatic head or the duodenum, a pancreaticoduodenectomy (PD) is occasionally prerequisite to obtain a clear tumor-free resection margin [1–3].

Laparoscopic resection has now become the established procedure of choice for early gastric cancer in Japan and eastern countries. Its advantages over conventional open gastrectomy have been well documented, such as less postoperative pain, shorter recovery time, and improved cosmesis [4, 5]. Recent advances in laparoscopic techniques and instruments made several surgeons try to apply laparoscopic surgery to advanced gastric cancer [6–8].

Herein, we describe a first series of totally laparoscopic pancreaticoduodenectomy (TLPD), in which all surgical procedures of PD, gastric resection, and lymph node dissection were performed laparoscopically in three cases with advanced gastric cancer grossly infiltrated to the pancreatic head and/or adjacent organs.

Materials and methods

From January 2008 to October 2008, three patients (two men, one woman, mean age of 67.7) with advanced gastric cancer underwent successful TLPD at the Fujita Health University School of Medicine. Thoroughly preoperative assessment with upper gastrointestinal series, multidetector-row computed tomography (MDCT), magnetic resonance imaging, and endoscopic ultrasonography were performed for all the patients. The tumor was located at the lower third of the stomach with macroscopically suspected involve-

ment of the pancreatic head. This study was regarded as a clinical trial that was approved by the Institutional Review Board of our institute, and all patients and their families were informed about the possible risks and benefits of the whole clinical trial of treatment for the disease, and written informed consent was obtained.

Operative technique of TLPD

After a pneumoperitoneum of 10–12 mmHg was established, a flexible electrolaparoscope (LTF-VH, Olympus Medical Systems, Tokyo, Japan) was introduced through the intraumbilical port. The other four trocars were inserted under laparoscopic guidance, consisting of two 5-mm bilateral subcostal ports and two 12-mm bilateral low abdominal ports (Fig. 1). At the beginning of each operation, the peritoneal cavity was inspected and cytologic examination of peritoneal lavage was routinely performed to rule out peritoneal seeding. An avascular area of the gastrocolic ligament was divided toward the lower pole of the spleen using a laparosonic coagulation shears (LCS; SONOSURG-X, Olympus Medical Systems, Tokyo, Japan) or LigaSure (Valleylab, Boulder, CO, USA) and all lymph nodes along the gastroepiploic vessels (no. 4d) were dissected. And then, the division was extended distally toward the pylorus using LCS or LigaSure. After the opening of the gastrocolic ligament, a careful exploration using a laparoscopic ultrasound probe (Aloka SSD-1700, Aloka Co. Ltd., Tokyo, Japan, 7.5-MHz linear array transducer) was performed to determine whether tumor involves the duodenum and/or the head of the pancreas, and, if tumor invasion is suspected, TLPD was attempted.

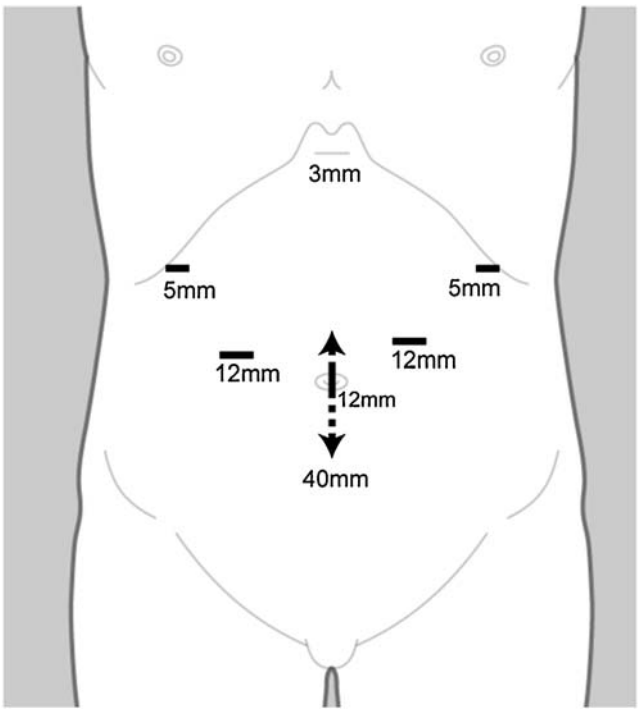

Fig. 1 Placement of surgical ports. The lateral segment of the liver was lifted using a retractor introduced close to the xiphoid process

The right gastroepiploic vessels were exposed and divided with single clip at their origins. The hepatoduodenal ligament was dissected, and then the proper hepatic artery and the common bile duct were exposed and taped. As preoperative imaging with MDCT, an aberrant right hepatic artery branching off the superior mesenteric artery (SMA) was found in case 1, and a common hepatic artery was found to arise from the SMA in case 2. The right gastric artery was identified and ligated with double clips. After cholecystectomy, the common bile duct was transected using LCS and intermittently clamped with a small vascular clamp (PL580S, Aesculap, Tuttlingen, Germany).

The perigastric lymph nodes (nos. 1 and 3) were dissected along with skeletonization of the upper third of the lesser curvature. The stomach was transected using an endoscopic stapling device (ETS 45, Ethicon Endo-Surgery, Cincinnati, OH, USA). The gastropancreatic ligament was approached from the lesser sac aspect and the celiac branch of the posterior vagus lying just cephalad to the left gastric artery was identified and divided using LCS. The root of the left gastric artery was divided with double clips, followed by dissection of lymph nodes along the left gastric artery (no. 7) and the common hepatic (no. 8a) and the celiac artery (no. 9). A tape around the hepatic artery was gently retracted to the left, and then the gastroduodenal artery was identified on the posterior duodenal aspect and divided with double clips.

The peritoneum along the inferior pancreatic margin was incised by electrocautery and dissection between the pancreas and anterior wall of the superior mesenteric vein proceeded upward (Fig. 2). Following the completion of dissection along the superior mesenteric vein, the pancreas was then transected using LCS or an ultrasonic dissector with application of electrocautery (SONOSURG-USU, Olympus Medical Systems, Tokyo, Japan; Fig. 3). A 4 F cuffed tube (Sumitomo Bakelite, Tokyo, Japan) was inserted through the incision into the pancreatic duct and tied tightly with a 4-0 absorbable surgical suture. A Kocher dissector was placed behind the pancreas and through the third portion of the duodenum. The transverse colon was lifted up, the duodenojejunal flexure identified, and the upper jejunum divided using ETS 45. The small vessels and tributaries between the duodenum and the uncinate process and the superior mesenteric vein were carefully secured and divided with LCS or LigaSure. Finally, the resected organs and lymph nodes were placed in a plastic retrieval bag (Endocatch II; US Surgical, USA) and extracted through the umbilical incision, with more 30-mm extension of the intraumbilical vertical skin incision.

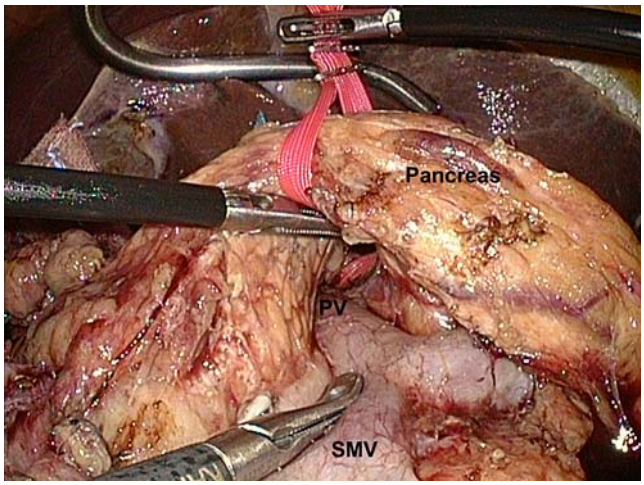

Fig. 2 Separation of the neck of the pancreas from the anterior walls of the portal and superior mesenteric veins. *PV*, portal vein; *SMV*, superior mesenteric vein

Following an *en bloc* resection of the pancreatic head and duodenum and the distal stomach, intracorporeal anastomosis was accomplished by Child's method of the reconstruction, which included a two-layered end-to-side pancreaticojejunostomy, an end-to-side choledochojejunostomy, and a side-to-side gastrojejunostomy. At first, with the external pancreatic drainage tube kept in place, the anastomosis of the pancreatic duct to all the coats of the jejunum was performed with two interrupted 5-0 absorbable sutures (Fig. 4a), and an approximation of the jejunal seromuscular layer and the pancreas parenchyma was performed using four interrupted 4-0 nonabsorbable sutures (Fig. 4b). Next, after intubation of bile duct with a 6 F cuffed tube, a single-layer end-to-side choledochojejunostomy was performed with interrupted 3-0 absorbable sutures. Finally, a side-to-side gastrojejunostomy anastomosis was made at 20 cm below the choledochojejunostomy, using ETS 45. Surgical soft drains were placed in the

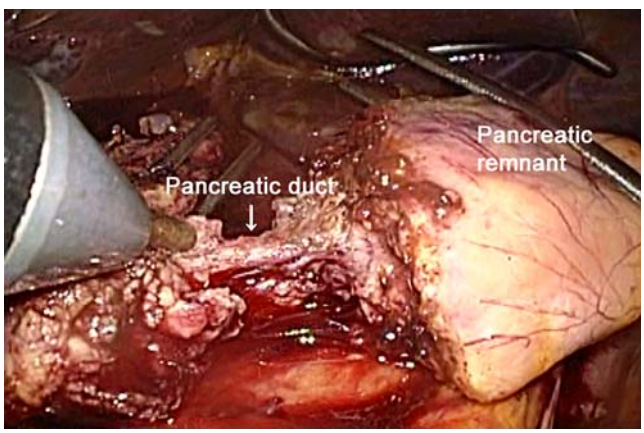

Fig. 3 Exposing of the pancreatic duct 1 cm long from the pancreatic stump using ultrasonic dissector

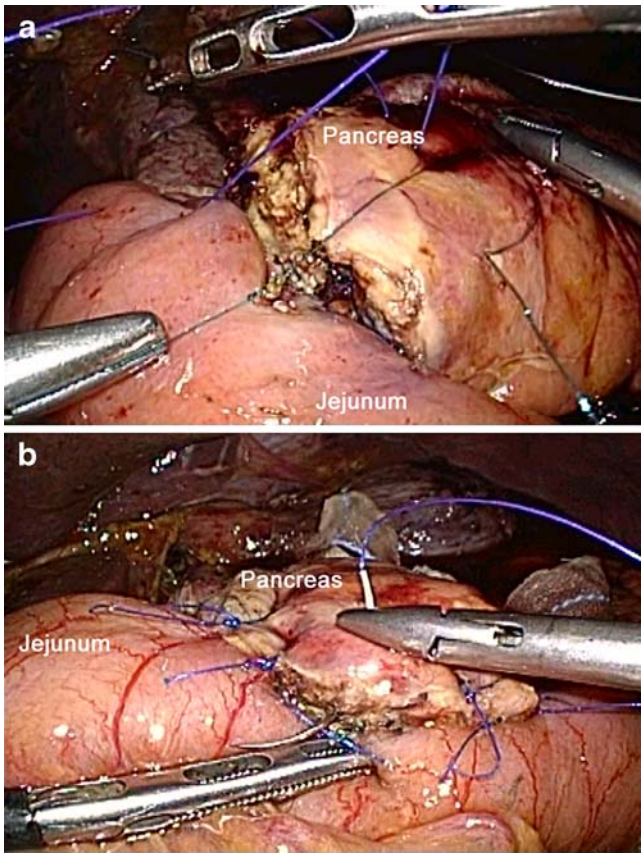

Fig. 4 Completion of pancreaticojejunostomy. **a** Duct-to-whole-layer anastomosis with an external drainage tube. **b** Approximation between the pancreas stump and the jejunal wall

left subphrenic space and at the area of the pancreaticojejunostomy and the choledochojejunostomy in all patients.

Results

The three patients underwent entirely laparoscopic procedures without any intraoperative complications. The operative time was 913, 764, and 536 min, and the blood loss was 1,660, 642, and 130 ml, and the number of retrieved lymph nodes was 58, 60, and 44, respectively. All patients received broad-spectrum antibiotics for 48 h and histamine H2 receptor antagonists during their postoperative hospitalization. No prophylactic somatostatin or Octreotide was used. The time to postoperative ambulation was 4, 3, and 4 days, and oral feeding was instituted on the 5th, 7th, and 13th postoperative day. The postoperative courses were uneventful in two patients. One patient (case 3) experienced postoperative mild colitis that was medically managed. An external drainage tube of the pancreatic duct was removed about 3 weeks after operation, and they were discharged on the 25th, 29th, and 30th postoperative day. Histopathological examinations are shown in Table 1. Microscopically,

Table 1 Patient demographics

Case no.	Sex	Age (year)	Symptoms	Pancreatic duct size (mm)	Pathological stage[a]	Tumor size (cm)
1	M	67	Abdominal distension due to antral stenosis	3	T3N3H0P0CY0: stage IV	8.7×5.6
2	M	75	Epigastric discomfort	2	T4N2H0P0CY0: stage IV	4.5×2.8
3	F	61	Epigastric pain	3	T4N2H0P0CY0: stage IV	4.3×3.2

[a] According to the UICC staging [16]

there were no tumor cells on the surgical margins of the resected specimens. All of the patients were treated with postoperative adjuvant chemotherapy.

Discussion

We described three TLPDs for advanced gastric cancer with suspected pancreatic head invasion and favorable short-term outcomes of this procedure. There have been several reports describing laparoscopic pancreaticoduodenectomy for various diseases such as pancreatic adenocarcinoma, ampullary adenocarcinoma, neuroendocrine tumor, duodenal adenocarcinoma, metastasis of renal cell carcinoma, and chronic pancreatitis [9–12]. Advanced gastric cancer involving the duodenum and/or the pancreatic head occasionally necessitates an extensive gastrectomy including PD to achieve negative surgical margins [1–3]. To the best our knowledge, this is the first series on TLPD for advanced gastric cancer reported to date.

Several studies have shown favorable short-term surgical outcomes and acceptable long-term oncologic safety of laparoscopic resection of early gastric cancer [4, 5]; however, the indication or necessity of laparoscopic gastrectomy for advanced gastric cancer remains controversial [6–8]. There are several concerns about the technical feasibility and safety of laparoscopic D2 gastrectomy, insufficient elucidation of port site recurrences, and the lack of long-term results from any controlled studies. Actually, since the first report of our experience of laparoscopic D2 gastrectomy in 1999 [8], we performed more than 200 cases of laparoscopic D2 gastrectomy in patients with advanced gastric cancer. There are minimum mortality and acceptable morbidity and no port site recurrences after a mean follow-up period of 46 months (K. Inaba et al., unpublished results). Given these encouraging initial results, we have approached most cases of gastric cancer by laparoscopy since 2007. As in open resections, the indication for PD in patients with advanced gastric cancer remains debatable. However, curative surgical resection brings some hope of long-term survival. So we believe that TLPD may be considered a viable choice for treatment of patients with advanced gastric cancer without increased morbidity or mortality.

Soft pancreas with nondilated pancreatic duct was one of the most important risk factors for pancreatic fistula-related postoperative complications [13]. In open series of PD for advanced gastric cancer, the morbidity rate was reported to be 38–74% with a high prevalence of pancreatic complication [1–3]. In our series, all of the patients were with a soft and friable pancreatic parenchyma, and the mean size of pancreatic duct was <3 mm in diameter. However, the morbidity relating to the pancreatic fistula was nil. Although a better technique for pancreaticojejunal anastomosis still remains to be validated especially for such a soft pancreas, several authors suggest that both external drainage and invagination may reduce the rate of pancreatic fistula [14, 15]. We feel that the high quality of laparoscopic view with a well-lighted and magnificent visualization would help the surgeons to safely insert the drainage tube into the nondilated pancreatic duct and obtain appropriate approximation between the pancreas stumps.

Operation time in our initial experience of TLPD was quite longer than expected, while mean estimated blood loss during surgery was favorably comparable with open series [1–3]. In our series, two patients had hepatic artery anomalies; thereby, it took time to dissect the second tier of lymph nodes and separate the uncinate process with keeping the integrity of the hepatic artery blood supply. Since this is the first report on the outcomes of TLPD for advanced gastric cancer, we expect that this problem would be solved in the future by improvements in laparoscopic devices and techniques. The median hospital stay in our series was 27 days, which was shorter than those described in several series of conventional open PD for gastric cancer [1–3], but longer than in other series of laparoscopic pancreatic surgery [9–11]. This longer hospital stay may be due to: (1) our policy to continue external drainage of the pancreatic juices until 3 weeks after operation; and (2) in Japan, subacute care, such as that given in nursing facilities or rehabilitation centers is not well developed, and most patients hope to stay in the hospital before being free from external drainage.

In conclusion, we described our technique of TLPD for locally advanced gastric cancer with suspected invasion to the pancreas head and surrounding structures; TLPD was successfully performed without perioperative adverse events.

Although the limited number of patients in the present series did not permit any definitive conclusions concerning the role of TLPD in the management of advanced gastric cancer, this procedure is technically feasible and safe in the hands of experienced surgeons. Long-term follow-up is mandatory to validate oncological outcome.

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