Case Report

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Laparoscopic Whipple's Operation for Locally Advanced Gastric Cancer Invading the Pancreas and Duodenum: a Case Report

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OPEN ACCESS

Received: Mar 18, 2019 Revised: Jun 24, 2019 Accepted: Jul 10, 2019

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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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ABSTRACT

Few surgeons have adopted pancreaticoduodenectomy (PD) for the treatment of advanced gastric cancer (AGC) invading the pancreas or duodenum because it remains controversial whether its prognostic benefits outweigh the high morbidity rates in such advanced cases. However, recent technical advances have revived diverse surgical procedures in minimally invasive approaches. Inspired by this trend, laparoscopic PD procedures have been performed for AGC in our institute since 2014. We recently performed a laparoscopic Whipple's operation in a case of cT4b gastric cancer with invasion of the pancreatic head and duodenum.

Keywords: Gastric cancer; Laparoscopic; Pancreaticoduodenectomy

INTRODUCTION

R0 resection is an important strategy for achieving survival in patients with gastric adenocarcinoma. This principle should be considered a significant goal in locally advanced cases; therefore, combined resection has been associated with surgical treatment for T4b gastric cancer [1-3], and several studies have reported favorable outcomes of combined resection [2,4,5].

Up to 50% of the organs involved in advanced gastric cancer (AGC) include the pancreas [6,7], which is occasionally resected to achieve R0 surgery for gastric adenocarcinoma. Compared to other T4b diseases, pancreas-involving gastric cancer is more controversial in terms of combined resection. In advanced cases with incurable features, palliative chemotherapy or bypass surgery is often considered rather than combined resection [7]. However, in cases in which pancreaticoduodenectomy (PD) is required to achieve R0 surgery, combined resection is not widely considered to be acceptable. The reasons why PD remains controversial in the treatment of gastric cancer may include the high morbidity rate and the prognostic uncertainty of the procedure. Moreover, the high morbidity rate is correlated with poor oncological outcomes since postoperative complications could delay the initiation of chemotherapy. Therefore, most physicians generally avoid PD in patients with T4b AGC.

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However, a recent systemic review reported a pooled incidence of pancreatic leakage of 24.5% in patients who underwent PD for AGC [8]. In other words, more than two-thirds of patients who underwent R0 surgery were free from pancreatic fistulas that are commonly associated with delayed administration of adjuvant chemotherapy. Therefore, considering the oncological outcomes of well-treated cases, in which both R0 resection and chemotherapy were performed in a timely manner, it may be inappropriate to insist on palliative treatment in cases of AGC without incurable factors. Moreover, PD is a standard procedure in other malignancies involving the pancreatic head and peripancreatic area [9] in which PD does not guarantee favorable outcomes compared to those of gastric cancer [10-15].

For these reasons, we have performed Whipple's operation in our institute for AGC cases in which R0 resection can be achieved by PD. Moreover, based on our expertise in PD for AGC, we considered converting to laparoscopic PD techniques. We believed that PD could be oncologically beneficial for AGC invading the pancreas; therefore, the features of laparoscopic surgery were expected to boost the prognostic benefit. In other words, the early recovery due to a smaller wound, a characteristic of the laparoscopic approach, might provide a good prognosis by allowing an earlier initiation of adjuvant chemotherapy. Furthermore, the following points were advantageous in realizing laparoscopic PD for AGC: first, we were accustomed to the anatomical orientations of laparoscopic PD as laparoscopic procedures for AGC had been established. In addition, recent advances in surgical instruments (e.g., energy devices and surgical staplers or clips) could simplify the challenging procedures of PD. Therefore, we have prepared for laparoscopic combined resection of T4b disease involving the pancreas since 2014.

We recently performed a laparoscopic Whipple's operation for T4b gastric cancer with gastric outlet obstruction. Herein, we described the details of the surgical techniques and postoperative outcomes of this case.

CASE REPORT

A 50-year-old man was referred for gastric outlet obstruction. He manifested with abdominal distension and vomiting for one month. A gastric signet ring cell carcinoma was diagnosed via gastrofiberscopy, in which the gastroscopic fiber could not pass through the gastric antrum encircled by the ulcerofungating tumor. Computed tomography showed that the gastric tumor involved the duodenum and pancreas (head portion) but did not reveal distant metastases or peritoneal carcinomatosis. His body mass index was 16.7 kg/m². The patient did not have any comorbid conditions or a history of previous abdominal surgery.

We planned to perform a laparoscopic curative surgery unless an incurable finding was noted in the diagnostic laparoscopy. PD was preoperatively considered for tumor involvement in the duodenum and pancreas. The details of our procedure were as follows.

Preparative procedures

In the operating room, the patient was placed on a bed with both legs abducted under general anesthesia. The bed was adjusted to create a reverse Trendelenburg position for the patient. The operator stood on the patient's right side. The scopist was positioned between the patient's legs. The assistant stood on the opposite side of the patient.



A trocar was inserted through an infra-umbilical incision using Hasson's method [16]. After a pneumoperitoneum was formed with carbon dioxide at a pressure of 15 mmHg, a flexible scope was inserted through the umbilical port. After two working ports were established under the guidance of the scope, we performed peritoneal washing cytology. Then, the falciform ligament and the left lobe of the liver were raised in the cephalad direction by combined suture retraction [17]. We found no evidence of incurable findings in the laparoscopic view and therefore continued to perform laparoscopic curative surgery.

Lymph node dissection (LND) for gastric cancer

D2 lymphadenectomy was performed based on the 2014 Japanese Gastric Cancer Treatment Guidelines (ver. 4) [18]. A Harmonic[™] Scalpel (Ethicon Endo-Surgery Inc., Cincinnati, OH, USA) and LigaSure[™] Maryland Jaw 37 cm Laparoscopic Instrument (Medtronics, Minneapolis, MN, USA) were used to facilitate LND.

- The total omentectomy began with the division of the avascular plane between the greater omentum and transverse colon to include lymph node (LN) station 4d. The left gastroepiploic vessels were ligated and divided at the roots to dissect LN station 4sb (Fig. 1A). Then, the greater curvature of the stomach was cleared by the ligation and division of the left gastroepiploic arcade.
- 2) The greater omentum was then divided to mobilize the distal stomach. The right gastroepiploic vessels were ligated and divided to include LN station 6. During this procedure, we confirmed the tumor involvement of the pancreas (**Fig. 1B**).
- 3) With the stomach elevated, suprapancreatic LND was performed to clear LN stations 7, 9, and 11p. During this procedure, the left gastric vessels were ligated and divided (**Fig. 1C**).



Fig. 1. The procedures during lymph node dissection. (A) Ligation and division of the left gastroepiploic vessels. (B) Confirmation of the pancreas invasion. (C) Ligation and division of the left gastric vessels. (D) Division of the stomach using laparoscopic linear stapler.



- 4) The lesser omentum was divided to expose the right crus. After complete dissection of LN station 9, the lesser curvature of the stomach was cleared.
- 5) The stomach was divided using a laparoscopic linear stapler (ECHELON FLEX[™] Powered ENDOPATH[®] Stapler; Ethicon Endo-Surgery Inc.) (**Fig. 1D**).
- 6) LN station 8a was dissected until the common hepatic artery was completely exposed. After this procedure, the gastroduodenal artery was ligated and divided at the branching point from the common hepatic artery.

Pancreaticoduodenal resection

- 1) The body of the pancreas was mobilized to establish the pancreatic division line. Then, the proximal and distal portions of the division line were ligated using nylon tape. The pancreas was divided using the Harmonic[™] Scalpel (Ethicon Endo-Surgery Inc.) (**Fig. 2A**). Hemostasis of the pancreatic division line was facilitated by electrocautery.
- 2) Kocher's maneuver was used for mobilization of the duodenum (Fig. 2B).
- 3) Cholecystectomy was performed. Then, the extra-hepatic biliary tree was meticulously dissected and the bile duct was divided at the proximal level of the branching cystic duct.
- 4) The proximal jejunum was divided using a laparoscopic linear stapler (Ethicon Endo-Surgery Inc.). From this division point, the proximal jejunum was devascularized by clipping and dividing the supplying vessels (**Fig. 2C**).
- 5) The duodenum and pancreas (including the uncinate process) were meticulously mobilized, with attention paid to the division of the branching vessels from the superior mesenteric artery (SMA), superior mesenteric vein (SMV), and portal vein (PV) (Fig. 2D).



Fig. 2. The procedures during pancreaticoduodenal resection. (A) Division of the pancreas using the ultrasonic energy device. (B) Kocher's maneuver for mobilization of the duodenum. (C) Mobilization of the proximal jejunum using the bipolar vessel-sealing device. (D) The branching vessels from the superior mesenteric vein and portal vein were meticulously dissected to separate the specimen.

CHA, common hepatic artery; PV, portal vein; SMV, superior mesenteric vein; SV, splenic vein.



Reconstruction

Child's method was adopted for reconstruction [19]. After completing pancreaticoduodenal resection, a 5-cm vertical incision was made on the epigastrium.

Pancreaticojejunostomy (PJ)

Extracorporeal PJ anastomosis was performed through mini-laparotomy. For pancreaticoenteric anastomosis, the divided jejunum was lifted through the mesocolon of the transverse colon (retrocolic approach). We adopted a duct-to-mucosa anastomosis for PJ. First, to reinforce the strength of the posterior outer layer, six absorbable continuous sutures (V-Loc[™], 3-0; Medtronics) were placed between the posterior surface of the pancreas and the seromuscular layer of the jejunum. After making a small incision in the jejunum, four nonabsorbable interrupted sutures (Prolene, 6-0; Ethicon Inc., Somerville, NJ, USA) were placed between the pancreatic duct and the jejunal mucosa in an end-to-side fashion. As for duct-tomucosa anastomosis, a poly-vinyl chloride (PVC) stent was inserted into the jejunal opening and pancreatic duct to stabilize the inner strength of the pancreaticoenteric anastomosis. Then, the anterior surface of the pancreas and seromuscular layer of the jejunum were approximated in the same manner as performed for the posterior outer layer.

Choledochojejunostomy (CJ)

CJ anastomosis was also performed through mini-laparotomy. Eight non-absorbable interrupted sutures (Prolene, 5-0; Ethicon Inc.) were placed between the bile duct and jejunum (distal from the PJ) in an end-to-side fashion. A PVC drain tube was transhepatically inserted into the bile duct and jejunum to stabilize the inner strength of CJ and PJ anastomoses [9,20].

Gastrointestinal reconstruction

To restore the gastrointestinal continuity, Billroth II reconstruction was performed using a linear stapler (Ethicon Endo-Surgery Inc.). To facilitate drainage of the afferent loop, jejunojejunostomy was performed using a linear stapler (Ethicon Endo-Surgery Inc.).

Drainage

Closed suction drainage was established for the pancreaticoenteric and choledochoenteric anastomoses.

Clinical outcomes

The total operation time was 650 minutes. The patient started drinking water on postoperative day seven. A semi-bland diet was provided on postoperative day nine. The patient showed some signs of infection (fever, chill, and leukocytosis) on postoperative day 11; abdominal computed tomography revealed complicated fluid collection around the left lateral section of the liver but the patient was treated using only intravenous antibiotics (Clavien-Dindo grade II). After leukocytosis disappeared in laboratory examinations, the patient was discharged on postoperative day 34. The final pathological report revealed that the tumor had invaded the pancreatic head and second portion of the duodenum. There was one LN metastasis (LN station 6) among the 50 LNs that had been dissected (pT4bN1, stage IB, according to the American Joint Committee on Cancer 7th ed.) [21]. Lymphovascular invasion was also noted. Peritoneal washing cytology revealed a negative finding (CY0).

The patient returned for a follow-up appointment on postoperative day 42. We did not find any evidence of late complications or dietary problems. Since then, the patient has



undergone adjuvant chemotherapy using the XELOX regimen and a total of eight cycles have been completed without dose reduction. We did not find any evidence of recurrence at 20 months after surgery.

DISCUSSION

Unlike concomitant resection for double primary malignancies, combined resection for T4b gastric cancer should be organized so that the main procedures cannot be distributed to each surgeon of the multidisciplinary team. Therefore, surgeons who deal with AGC usually take the responsibility for en bloc resection, in which open procedures are preferred over laparoscopic approaches due to their familiar access to the operation field.

These features also deserve combined resection for AGC invading the pancreatic head. Several vessels (i.e., the SMA, SMV, and PV) are located around the pancreas and duodenum. In T4b cases, it is difficult to localize these vessels because the surgical planes may be ambiguous due to desmoplastic reaction around the tumor. Moreover, as described above, most gastrointestinal surgeons who perform gastric cancer surgery are not familiar with PD. Although several reports have described the outcome of PD for AGC [22-28], there are few references on laparoscopic Whipple's operation for gastric cancer [29-32].

Therefore, we adopted a strategy to overcome our unfamiliarity with the PD procedure. For one year, we discussed the technical details of laparoscopic PD at several multidisciplinary conferences. As a result of these efforts, we recently performed laparoscopic Whipple's operation in a patient with AGC who was able to start adjuvant chemotherapy within six weeks.

During laparoscopic PD for AGC, we encountered several significant considerations. First, the stomach was more resected during PD for AGC than for other malignancies (**Fig. 1D**). Therefore, to achieve en bloc tumor resection, we should bear the bulky specimen throughout the operation. This condition necessitated intensive attention in every procedure after gastrectomy and was correlated with the long operation time. Although we aspirated gastric contents that had accumulated due to gastric outlet obstruction, the heavy burden of the gastric tumor did not disappear.

Second, a bipolar vessel sealing device was advantageous in the laparoscopic mobilization of the pancreas and duodenum. The pancreas and duodenum are supplied or drained by many branching vessels from the SMA, SMV, and PV; therefore, the mobilization of these organs is accompanied by considerable surgical ligation times in open surgery. Even for hepatobiliary surgeons, it is technically demanding to separate the uncinate process from the SMA and SMV. However, surgical ligation of the branching vessel is nearly impossible during laparoscopic PD. Furthermore, it is difficult to ligate these vessels by laparoscopic clipping between the complex structures. Therefore, we used a Maryland jaw type bipolar vesselsealing device (LigaSure[™] Maryland Jaw 37 cm Laparoscopic Instrument; Medtronics). As this device was designed for delicate dissection as well as powerful hemostasis [33], it was useful for the mobilization of the pancreas and duodenum.

Third, minimally invasive procedures might be associated with mistakenly performed PD in patients with AGC. This is an important issue that may be correlated with oncologic outcomes. Currently, PD cannot be justified in AGC cases with any incurable factor (i.e.,



peritoneal seeding or distant metastasis) since this procedure has a high risk of surgical complications. However, even in patients without incurable factors, PD should be carefully considered. The magnified view of laparoscopic imaging systems can exaggerate desmoplastic reactions around the duodenum. In other words, performing only gastrectomy might be more beneficial than PD in terms of long-term results, when AGC leads to perigastric LN enlargement or desmoplastic adhesions around the duodenum or pancreas. In our case, the final pathologic report showed pancreatic invasion by AGC.

Despite this pitfall, the minimally invasive approach shows promise for PD in patients with AGC. Currently, PD lacks a survival benefit in the treatment for AGC invading the pancreatic head [34]. Such dismal outcomes might be due to the difficulties of the delicate lymphadenectomy around the major vascular structures affected by pancreatic invasion. Our case required a long operation time to follow the surgical planes around named vessels covered with desmoplastic adhesions. However, the well-lighted and magnified view provided by the laparoscopic system might enable us to skeletonize the major vessels around the pancreas (**Fig. 2D**). Shinohara et al. [29] also reported that their PD procedures were enhanced by the high quality of the laparoscopic view. Therefore, laparoscopic imaging systems are key to improving the short- and long-term outcomes of PD for AGC and are continuously evolving to enhance surgeons' vision.

In summary, few surgeons have adopted PD for the treatment of AGC invading the pancreas or duodenum because it remains controversial whether the prognostic benefit outweighs the high morbidity rate in advanced cases. However, recent technical advances have revived diverse surgical procedures in minimally invasive approaches and the paradigm of cancer surgery has changed with the reduction of surgical stress. This trend corresponds with our experience of laparoscopic Whipple's operation in a patient with AGC invading the pancreas and duodenum.

ACKNOWLEDGMENTS

The authors thank Young Ki Kim (Assistant Professor, Department of Surgery, Inje University Seoul Paik Hospital) for providing the technical details of laparoscopic pancreaticoduodenectomy.

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