Laparoscopic Pancreaticoduodenectomy for Pancreatic Ductal Adenocarcinoma

Tamotsu Kuroki, MD, PhD*, and Susumu Eguchi, MD, PhD

Abstract—In recent years laparoscopic pancreatic procedures have developed rapidly, and reports of laparoscopic pancreatic resection including laparoscopic pancreaticoduodenectomy (LPD) have increased in number. Although most of the uses of laparoscopic distal pancreatectomy (LDP) were indicated mainly for benign disease and low-grade malignancy at the initial period, most LPDs were indicated for malignant tumors including pancreatic ductal adenocarcinoma (PDAC) of the pancreatic head. However, the benefits of LPD for PDAC are unclear. In the following review of the literature, we note that LPD is a technically feasible and safe surgical procedure in selected patients that provides the advantages expected from a minimally invasive surgery, including less blood loss. In addition, LPD can achieve the level of short-term oncologic outcome of open PD such as retrieved lymph nodes and adequacy of resection margin for PDAC. Large randomized and controlled prospective studies are needed for the determination of the clinical advantages of LPD for periampullary malignant tumors including PDAC.

Keywords — laparoscopic, pancreaticoduodenectomy, pancreatic cancer.

I. INTRODUCTION

Laparoscopic surgical techniques for benign pancreatic disease provide clear advantages compared to conventional open surgery, including less postoperative pain, a shorter hospital stay, and a better cosmetic outcome (1–6). Two studies demonstrated that laparoscopic distal pancreatectomy (LDP) was an acceptable approach for the resection of pancreatic ductal adenocarcinoma (PDAC) of the left-side pancreas in selected patients (7,8). LDP for PDAC has been shown to be safe and readily feasible, and it provides similar oncologic outcomes compared with open distal pancreatectomy. However, the recent development of various laparoscopic instruments, surgical techniques, and the knowledge of surgical anatomy has enabled laparoscopic pancreatic surgery, not only for LDP but also laparoscopic pancreaticoduodenectomy (LPD). We and others have found that LPD is a safe and feasible surgical procedure (9–14). In our previous study, we compared a group of patients who underwent LPD with a group that underwent open PD, and we observed that although there were no significant differences in the operative time or the occurrence of postoperative complications between the two groups, the blood loss in the LPD group was significantly less than that in the open PD group (14). However, the benefits of LPD for PDAC are less clear. In this report, we review the surgical techniques and practical benefits of LPD, and we discuss the existing problems and future prospects of LPD for PDAC.

II. OPERATIVE TECHNIQUE

Pancreatectoduodenectomy (PD) with lymphadenectomy is the standard surgery for PDAC. The dissection of connective tissue and nerve plexuses of the pancreatic head is the important point to achieve microscopically negative margin (R0) in patients who undergo LPD for PDAC (15). LPD remains challenging, and the performance of successful LPD has been limited because the procedure is technically difficult due to the complicated reconstructions, fragile pancreatic parenchyma, and complexity of the surrounding organs. In addition, laparoscopic surgery requires a high degree of technical skill and dexterity such as eye/hand coordination. Therefore, several surgical techniques and new laparoscopic instruments have been proposed for LPD.

One of the most important techniques for the safe and feasible LPD is to expose the optimal laparoscopic view and obtain a sufficient working space. The particularly difficult procedure in LPD for PDAC is ensuring a suitable laparoscopic surgical view for the dissection of the uncinate process of the pancreas with connective tissue and nerve plexuses of the pancreatic head from the right aspect of the portal vein (PV), the superior mesenteric vein (SMV), and the superior mesenteric artery (SMA). In our previous report, we proposed a “pancreas-hanging maneuver” for ensuring a suitable surgical field and laparoscopic view for the resection of the pancreatic head with connective tissue and nerve plexuses from the mesenteric vessels during LPD (16).

The pancreas-hanging maneuver is as follows: the uncinate process is dissected off along the right lateral aspect of the
SMV-PV. A plastic tape is placed under the pancreas head. The plastic tape is tightened lightly at the left edge of the pancreas parenchyma; this tape can be grasped by the laparoscopic forceps. Traction on the specimen with the plastic tape to the right side opens a plane to make the planned isolation line visible with a sufficient laparoscopic view.

In another approach, Honda et al. (17) described taking advantage of the unique view from the caudal side for the safe and clear dissection of the pancreatic head from the mesenteric vessels. Taking advantage of the unique view from the caudal side, the posterior aspect of the SMA enveloped with a nerve plexus beside the pancreatic uncinate process is exposed by dividing the fat tissue behind the SMA through a hole opened in the ligament of Treitz.

In the conventional open PD, resection of the PV/SMV may provide an acceptable survival benefit to patients with PDAC of the pancreatic head, which involves the PV/SMV without additional mortality and morbidity. However, the benefits and feasibility of resection of the PV/SMV using the laparoscopic approach are not yet clear. The resection and reconstruction of the PV/SMV during LPD is a technically challenging operation that must be performed by expert laparoscopic surgeons and requires an advanced degree of laparoscopic skills. Kendrick et al. (18) reported 11 successful resections of the PV/SMV during LPD. An R0 resection was obtained in eight patients of nine patients with PDAC. Post-operative imaging was available in 10 patients with 100% patency at the PV/SMV reconstruction site. Kendrick et al. concluded that laparoscopic major venous resection during LPD is feasible in selected patients, and they recommended that surgeons acquire considerable experience in both open PD with and without vascular resection and LPD without vascular reconstruction before attempting laparoscopic resection and reconstruction of the PV/SMV.

### III. PERIOPERATIVE OUTCOMES

The main published series of LPD are listed in Table 1. Pancreatic fistula is the most problematic complication of PD in both open and laparoscopic strategy. Only a few studies in which LPD is directly compared to open PD are available. Our previous study indicated that there was no significant difference in the incidence of pancreatic B-C fistula between open PD and LPD (16% vs. 15%) (14). Other groups also found no significant difference in the incidence of pancreatic B-C fistula between open PD and LPD (19–21).

Laparoscopic approaches using a magnified view of the PDAC have a potential advantage in that there is improved visualization of the anatomy for the resection of complex vessels or lymphadenectomy along appropriate planes. Therefore, LPD has better visualization, and low estimated blood loss is fundamental for minimally invasive surgery. In a study by Asbun et al., 53 patients who underwent LPD were compared with 215 patients who underwent open PD; there was a significant decrease in estimated blood loss in the LPD group (195 mL vs. 1,032 mL) (22). In our previous study, estimated blood loss and red blood cell transfusion requirements were significantly less in the LPD group (14).

Several reports described that perioperative blood transfusion in PDAC has been linked to decreased patient survival (23, 24). LPD may thus lead to better outcomes for PDAC.

Several studies described that LPD was associated with operative times that were substantially longer than those of open PD (14, 22). However, Kim et al. (25) recently showed a reduction in the median operation time, from 9.8 h for the first 33 patients to 6.6 h for the last 40 patients, a statistically significant improvement. In their early experience with LPD, Kendrick et al. (26) reported a median operative time of 6.1 h, a decrease from a mean of 7.7 h for the first ten patients to 5.3 h for the last ten patients. These findings suggest that LPD is a
feasible and safe surgical procedure with a steep learning curve when performed by a surgeon who is experienced at performing open PD. The learning curve for LPD depends on several factors including the procedure complexity, the manual dexterity of the individual surgeon, his or her surgical aptitude, and the surgical training environment. Based on our experience (including that described in our previous study), we suggest that standardizing the complex surgical procedure for LPD may help shorten the LPD operative times.

IV. ONCOLOGIC OUTCOMES

Randomized controlled trials are needed to evaluate and clarify the benefits of LPD for the oncologic outcome. However, to the best of our knowledge there has been no randomized study comparing LPD and open PD for the oncologic outcomes of periampullary malignant tumors including PDAC. Palanivelu et al. (9) described the first large series of LPD of 42 cases in 2007. They reported a mean of 13 lymph nodes harvested with R0 resection for all patients including 40 periampullary malignant tumors and a five-year survival rate of 19.1% for nine patients with PDAC of the pancreatic head. Kendrick et al. (26) reported 65 patients including 31 with PDAC who underwent LPD. The median number of lymph nodes harvested was 15 and the R0 resection rate was 89%; however, long-term survival outcomes were not described because this was an early experience with LPD.

Port-site recurrence is one of the most serious problems of laparoscopic surgery for intra-abdominal malignancies. In fact, Ziprin et al. (27) reviewed the cases of 3,942 patients in 27 studies who underwent laparoscopic colorectal operations, and they found that the overall incidence of port-site recurrence was 0.71%. Although the exact etiology of port-site recurrence is unclear, various factors related to laparoscopic surgery have been revealed including as pneumoperitoneum with carbon dioxide, high intra-abdominal pressure, aerosolization, and surgical technique (28). Young et al. (29) reported the first case of a port-site recurrence of PDAC following LPD. Although the exact incidence of port-site recurrence is difficult to document, the prevention of port-site recurrence of PDAC requires that the surgeon performing LPD should have adequate training and experience.

V. SURVIVAL OUTCOME

Although the laparoscopic technical skills, feasibility, perioperative results, and short-term oncologic outcome of LPD for PDAC have matured, the survival outcome of patients who have undergone LPD for PDAC has not been established in sufficient detail. Palanivelu et al. (9) reported that the five-year actual survival rate following LPD for 40 periampullary malignant tumors was 30.4%. Of these, the five-year survival rate of the nine patients who underwent LPD for PDAC was 19.1%. All five-year survivors were node-negative and included cases of ampullary carcinoma, cholangiocarcinoma, pancreatic cystadenocarcinoma, and PDAC.

VI. CONCLUSIONS

We recommend that LPD be performed by highly skilled laparoscopic pancreatic surgeons in high-volume pancreatic surgery centers. In Lee future, the precise evaluation of the pancreatic lesions and the careful selection of patients are important for achieving the best outcomes. Large randomized controlled prospective studies are needed for the investigation of the clinical advantages of LPD. Recently, Zureikat et al. (30) reported 132 robotic-assisted PD including PDAC. In the near future, robotic-assisted PD will also be required in addition to LPD.

REFERENCES


