Laparoscopic Radical Antegrade Modular Pancreatosplenectomy: Preliminary Experience with 10 Cases

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Abstract

Background

The radical antegrade modular pancreatosplenectomy (RAMPS) which is a reasonable surgical approach for left-sided pancreatic cancer is emphasis on the complete resection of regional lymph nodes and tumor-free margin resection. Laparoscopic radical antegrade modular pancreatosplenectomy(LRAMPS) has been rarely performed, with only 49 cases indexed on PubMed. In this study, we present our experience of LRAMPS.

Methods

From December 2018 to February 2020, 10 patients underwent LRAMPS for pancreatic cancer at our department. The data of the patient demographics, intraoperative variables, postoperative hospital stay, morbidity, mortality, pathologic findings and follow-up were collected.

Results

LRAMPS was performed successfully in all the patients. The median operative time was 235 minutes (range, 212–270 min), with an EBL of 120 ml(range,100–200 ml). Postoperative complications occurred in 5 (50.0%) patients. Three patients developed a grade B pancreatic fistula. There was no postoperative 30-day mortality and reoperation. The median postoperative hospital stay was 14 days (range, 9- 24d).The median count of retrieved lymph nodes was 15 (range, 13–21), and four patients (40%) had malignant-positive lymph nodes. All cases achieved a negative tangential margin and R0 resection. Median follow-up time was 11 months (range, 3–14 m). Two patients developed disease recurrence(pancreatic bed recurrence and liver metastasis) 9 months,10 months after surgery,respectively. Others survived without tumor recurrence or metastasis.

Conclusions

LRAMPS is technically safe and feasible procedure in well-selected patients with pancreatic cancer in the distal pancreas. The oncologically outcomes need to be further validated based on additional large-volume studies.

Introduction

The radical antegrade modular pancreatosplenectomy (RAMPS) for left-sided pancreatic cancer(PC) was initially described by Strasberg[1] et al in 2003. This procedure was emphasis on the complete removal of regional lymph nodes and tumor-free margin resection[1]. RAMPS was expect to obtain high negative tangential margins rate and a favorable survival rate[1–4]. Laparoscopic pancreatic surgery has been gaining popularity in the last two decade due to recent technological developments in laparoscopic technique and instruments. However, Laparoscopic radical antegrade modular pancreatosplenectomy(LRAMPS) has been rarely performed, with only 49 cases indexed on PubMed[5–14].

There are still some concerns about the feasibility and safety of this technique. The proper indications for LRAMPS is still being debated. The best surgical procedure of LRAMPS is not yet established. The aim of this paper was to present our experience of 10 cases of LRAMPS .

Materials And Methods

From December 2018 to February 2020, 10 patients underwent LRAMPS for pancreatic cancer at the our institute. All patients underwent preoperative assessment including laboratory examination, ultrasonography, computed tomography, and magnetic resonance imaging for characterization and localization of the lesions.

The data studied were the patient demographics, intraoperative variables (operative time, estimated blood loss (EBL), conversion to open operation, blood transfusion requirement), postoperative hospital stay, morbidity , mortality (within 30 days from surgery),pathologic findings(tumor size, count of retrieved lymph nodes, margin status) and follow-up.

Pancreatic fistula (PF) was assessed according to the International Study Group on Pancreatic Fistula recommendations [15]. PF grade A was considered an asymptomatic biochemical leak and not counted as a complication, according to the modifications of the

International Study Group definition of PF[16].

Patients were followed up via out-patient examination. The final follow-up was taken in February 2020.Recurrence or distant metastasis was diagnosed pathologically by surgical resection, biopsy, or cytology and/or radiological examination.

The Institutional Review Board of Zhejiang provincial people's Hospital and The First people's Hospital of Jiashan approved this study. The written informed consent was obtained from the patients before inclusion in the study.

Operative technique

Patients were placed in supine position with the head slightly elevated. The surgeon and the second assistant who held the laparoscope stood on the right side of the patient and the first assistant stood on the left. One initial 10-mm trocar was placed for laparoscopy below the umbilicus. A 30-degree telescope was inserted to examine the peritoneal cavity to rule out metastatic disease. After general exploration, the other four trocars (one 12 mm, three 5 mm) were inserted into the left upper flank, left flank, right upper flank, and right flank quadrants; the five trocars were arranged in a V shape.

The gastrocolonic ligament was divided for entrance to the lesser sac with harmonic scalpel (Harmonic Ace scalpel, Ethicon Endo-Surgery, Inc, Cincinnati, OH, United States). The mobilization of the pancreas began at the inferior border to visualize the superior mesenteric vein(SMV), the splenomesenteric confluence and the portal vein(PV). The lymph nodes along the common hepatic artery (CHA) and gastroduodenal artery were removed after sufficient mobilization of the pancreas through dissecting the tissue around the upper border of the pancreas. After creating a tunnel behind the neck of the pancreas, the pancreas neck was transected with an endoscopic linear stapler (Endocutter 60 staple, white or blue cartridge; Ethicon Endo-Surgery, Inc, Cincinnati, OH, United States).Lymph nodes around the celiac axis were dissected to expose the origin of the splenic artery(SA). Then the SA and splenic vein (SV) were divided . The lymph nodes anterior to the aorta between the celiac artery(CA) and superior mesenteric artery(SMA) and those anterior and to the left of the superior mesenteric artery were dissected. The distal pancreas was dissected with soft tissue of retroperitoneum in a medial-to-lateral fashion and the resection range was up to the diaphragmatic crus, down to the left renal vein, and to the left lateral portion of the aorta on the posterior side. Either the anterior or posterior RAMPS procedure was based on the principles emphasized by Strasberg et al[1].After completely resecting the distal pancreas and spleen with en bloc lymph node dissection, the specimen was bagged and retrieved through enlarged umbilical incision. One drainage tubes was left close to the proximal pancreatic remnant.Drainage tubes were routinely removed on postoperative day 3, when amylase of drain fluid was less than 3 times the upper normal serum value. In patients with any measurable volume of drain fluid of amylase-rich (>3 times the upper normal serum value), drainage tubes were kept in place and removed individually, depending on the enzyme levels.

Results

We performed 10 consecutive cases of totally LRAMPS. No robotic or hand assistance was used. All the patients underwent posterior RAMPS. No patient required conversion and transfusion. The median operative times was 235 minutes (range, 212–270 min), with an EBL of 120 ml(range,100–200 ml). Postoperative complications occurred in 5 (50.0%) patients. Three patients developed a grade B pancreatic fistula requiring persistent drainage longer than 3 weeks. One patient experienced gastric empty delay that was managed conservatively and ultimately cured. One patient developed retroperitoneal infection; he underwent percutaneous drainage. There was no postoperative 30-day mortality and reoperation. The median postoperative hospital stay was 14 days(range,9- 24d).

Nine patients were diagnosed with pancreatic ductal adenocarcinoma, one with pancreatic mucinous cystoadenocarcinoma. Median tumor size was 3.5 cm (range, 2–12.5 cm). The median count of retrieved lymph nodes was 15 (range, 13–21), and four patients (40%) had malignant-positive lymph nodes. All of these cases achieved a negative tangential margin and R0 resection.

Median follow-up times were 11 months (range, 3–14 m). Two patients developed disease recurrence(pancreatic bed recurrence and liver metastasis) 9 months, 10 months after surgery,respectively. Others survived without tumor recurrence or metastasis.

Discussion

Laparoscopic distal pancreatectomy(LDP) has been recognized as a standard technique for benign or borderline malignant neoplasms. The findings that LDP is associated with lower estimated blood loss, faster recovery than open distal pancreatectomy have increased interest in the procedure[17, 18]. Due to recent technological developments, LDP has been expanded to treat PC by

LRAMPS. But the safety and feasibility of LRAMS for PC remains controversial. This study clarified that LRAMPS is technically safe and feasible procedure in well-selected patients with PC in the distal pancreas.

The morbidity rates of LRAMPS reported in literatures varied greatly from 13.3–66.7% (Table 1) [5–11]. PF was the most frequent complication after LRAMPS. The PF rates of LRAMPS varied greatly from 0 to 66.7% (Table 1) [5–11]. Lee et al[6]reported that laparoscopic or robotic RAMPS had comparable rate of morbidity (25% vs. 37.2%, p = 0.412) and PF (grades B and C; 19.2 vs. 35.7%, p = 0.251) in relation to conventional open distal pancreatosplenectomy (DPS). Compared to conventional open DPS, laparoscopic or robotic RAMPS is associated with faster recovery, shorter length of hospital stay(12.3 ± 6.8 vs. 22.4 ± 21.6 days, p = 0.002)[6]. The morbidity rates and PF rates of laparoscopic conventional radical distal pancreatectomy for PC reported in literatures varied greatly from 13.6–52.9%[19].Our series with 10 cases showed a morbidity rate of 50.0%, and the PF rate of 30.0%, similar to what have been reported in the literature[5–11].Even the operation more complicated, the LRAMPS didn't increase the risk of complications but with the advantages related to minimal-access surgery, such as less intraoperative blood loss, faster recovery.

Table 1
Main Published Series of Laparoscopic radical antegrade modular pancreatosplenectomy (Surgical Outcomes)

Author(Year)	N	Operative Time (min)	EBL (ml)	Conversion	Morbidity	Pancreatic Fistula	Reoperation	Mortality	Postoperative hospital stay (days)
Sunagawa et al[5] (2014)	3	431.0 [A]	175[A]	0	1(33.3%)	1(33.3%)	0	0	17.3[A]
Lee et al[6] (2014)	12	324.3[A]	445.8[A]	0	3 (25%)	2 (16.6%)	0	0	12.3[A]
Kim et al[7] (2017)	15	219[A]	250[A]	0	2(13.3%)	0	0	0	6.1[A]
Ome et al[8] (2017)	3	358[B]	minimal to 1 ml	0	1(33.3%)	1(33.3%)	0	0	14[B]
Yamamoto et al[9] (2017)	3	421[B]	75[B]	0	1(33.3%)	1(33.3%)	0	0	15[B]
Xu et al[10] (2018)	12	250[B]	150[B]	0	8(66.7%)	8(66.7%)	1(8.3%)	0	9[B]
Kim et al[11] (2019)	1	220	200	0	0	0	0	0	7
This study	10	235[B]	120[B]	0	5(50.0%)	3(30.0%)	0	0	14[B]
EBL, estimated blood loss; A = mean; B = median; NA = not available									

RAMPS was designed to increase the rate of R0 resection and lymph node yield for PC in the body or tail[1, 2]. Chun et al [20] performed a systematic literature review that mean lymph node counts of RAMPS was as high as 24, and negative margin rates between 81% and 100%. Tangential margins are reportedly negative in 94% of patients undergoing RAMPS[20]. Studies comparing RAMPS with standard DPS demonstrate significantly higher lymph node counts[21–23]. The lymph node counts of LRAMPS reported in literatures varied greatly from 10.5 to 43 (Table 2) [5–11]. The mean count of retrieved lymph nodes was 18.1 ± 9.5, and 18 patients had malignant-positive lymph nodes[5–11]. Lee et al[6]reported that laparoscopic or robotic RAMPS had comparable number of retrieved lymph nodes (10.5 ± 7.1 vs. 13.8 ± 11.1, p = 0.313) and R0 resection (100% vs. 85.9%, p = 0.381) in relation to conventional open DPS. The lymph nodes harvested and negative surgical margin of laparoscopic conventional radical distal pancreatectomy for

PC reported in literatures varied greatly from 9 to 25.9 and 64.1–95.5%,respectively[19]. Our series with 10 cases showed a count of retrieved lymph nodes of 15 (range, 13–21),and the R0 resection rate of 100.0%, similar to what have been reported in the literature[5–11].So whether LRAMPS could achieve better oncological outcomes than laparoscopic conventional DPS or similar oncological outcomes as open RAMPS need more randomized controlled test to confirm.

Table 2. Main Published Series of Laparoscopic radical antegrade modular pancreatosplenectomy(Pathologic characteristics&Follow-up Data)

Author(Year)	N	Tumor size (cm)	Count of retrieved lymph nodes	Margin status, RO(%)	Follow-Up (months)	Recurrence
Sunagawa et al[5] (2014)	3	NA	43[A]	NA	NA	NA
Lee et al[6] (2014)	12	2.8[A]	10.5[A]	100	39[B]	5 (41.7%)
Kim et al[7] (2017)	15	3.8[A]	18.1[B]	100	46[B]	4(26.7%)
Ome et al[8] (2017)	3	NA	NA	NA	NA	NA
Yamamoto et al[9] (2017)	3	NA	37[B]	100	NA	NA
Xu et al[10] (2018)	12	3.4[B]	16[B]	100	10[B]	2(16.7%)
Kim et al[11] (2019)	1	2	21	100	NA	NA
This study	10	3.5[B]	15[B]	100	11[B]	2(20.0%)

A = mean;B = median; NA = not available

No study to date has shown improved overall survival between RAMPS and standard DP[21–23]. Abe et al[23] reported that median overall survival rates were not significantly different between patients undergoing RAMPS versus standard DP(47 months vs. 34 months; p = 0.19). In a study of Park et al[22],on univariate analysis ,conventional resection was associated with a worse 5-year overall survival of 12%, compared with 40% after RAMPS (p = 0.014). However, on multivariate analysis, adjuvant chemoradiation and negative margins were the sole factors associated with improved overall survival[22]. Lee et al[6]reported that there were no significant differences in median overall survival between laparoscopic or robotic RAMPS and conventional open DPS within the Yonsei criteria (60.00 vs. 60.72 months, p = 0.616).So whether the patients could benefit the better survival outcomes after LRAMPS need to be further validated based on additional large-volume studies

Potential indications for LRAMPS is still being debated. Generally acceptable potential indications(Yonsei criteria) for patients best suited for LRAMPS were as follows: (1) pancreas-confined tumors; (2) intact fascia layer between the distal pancreas and left adrenal gland and kidney; and (3) tumor located at least 1–2 cm away from the celiac axis[6, 24]. Kang et al[24]and Lee et al[6] considered that it would be wise to limit the LRAMPS procedure to anterior RMAPS alone. The indication proposed by Ome et al[8] for LRAMPS is left-sided PC located ≥ 1 cm away from the origin of the SA without invasion of the SMA, CA, CHA, or PV. Kim et al[7] performed LRAMPS for the left-sided PC that was less than stage T3 without distant metastasis or unable to secure a safety margin from a major vessel, such as the SMA or PV or CA. But from the literature review[5–11],more patients underwent posterior RAMPS even with

combined resection of the transverse colon with the safe and effective outcomes. With the technical evolution and clinical experience accumulating, the indication of LRAMPS will be expanded.

There are several approaches in LRAMPS. Sunagawa at al[5]and Ome et al[8] performed a LRAMPS by starting from the resecting the ligament of Treitz and entered the anterior space of the aorta and inferior vena cava. They confirmed that it could be easily to proceed from neck of the pancreas to the level of aorta and easily to avoid causing any damage to the retropancreatic organs, including the left renal vein [5, 8]. Yamamoto et al[9] developed the artery-first approach LRAMPS for left-sided pancreatic cancer. The artery-first approach means that middle segment of the pancreas was initially separated from both the left renal vein and the SMA with the advantage of early detection of no tumor infiltration into the SMA and the early determination of posterior dissection plane[9]. But in most centers, the dissection plane proceeded vertically during LRAMPS, thereby exposing the left side of the CA and SMA down to the level of the aorta after the division of the neck of the pancreas[6, 7, 10]. We also performed LRAMPS in this manner. In our experience, preoperative accuracy assessment of tumor by CT and MRI and fine operation were the key points of the this manner of LRAMPS.

Whether LRAMPS is the ideal approach for the left-sided PC? Only one retrospective control study of LRAMPS compared with conventional open surgery was indexed on Pubmed[6]. No literature of LRAMPS compared with laparoscopic standard distal pancreatectomy was published. Therefore, a randomized controlled test should be performed to test whether the LRAMPS procedure is superior to open RAMPS or standard distal pancreatectomy. But it was difficult to accomplish owing to the infrequent procedure of LRAMPS[3].

Conclusions

LRAMPS is technically safe and feasible procedure in well-selected patients with pancreatic cancer in the distal pancreas. The oncologically outcomes need to be further validated based on additional large-volume studies.

Abbreviations

CA: Celiac arteryc; CHA: Common hepatic artery; DPS:Distal pancreatosplenectomy; EBL: estimated blood loss; LDP :Laparoscopic distal pancreatectomyy; LRAMPS: Laparoscopic radical antegrade modular pancreatosplenectomy; PC:Pancreatic cancer; PF :Pancreatic fistula; PV:Portal vein; RAMPS: Radical antegrade modular pancreatosplenectomy ; SA :Splenic artery; SMA: Superior mesenteric artery;SMV: Superior mesenteric vein;SV:Splenic vein.

Declarations

Ethics approval and consent to participate

The Institutional Review Board of Zhejiang provincial people's Hospital and The First people's Hospital of Jiashan approved this study. The written informed consent was obtained from the patients before inclusion in the study.

Consent for publication

All the authors express the consent for publication on BMC Surgery.

Availability of data and materials

All data generated or analysed during this study are included in this published article.

Competing interests

Ren-Chao Zhang, Xin-Jun Gan, Wei Song, Song-Tao Shi, Hui-Fang Yu, and Yi-Ping Mou have no conflict of interest or financial ties to disclose.

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Authors' contributions

ZRC and MYP conceived and designed the study. ZRC, GXJ and MYP performed the operation. SW, SST and YHF collected and analyzed data. ZRC drafted the manuscript. GXJ revised the manuscript. All authors read and approved the final manuscript.

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