Review Article

Laparoscopic pancreaticoduodenectomy

Guolin Li, Jun Min, Haoming Lin, Jun Cao, Jinxing Wei, Zehua Huang, Qing He, Shuling Peng, Qingfang Han, Rufu Chen

Sun Yat-Sen Memorial Hospital, Sun Yat-Sen University, Guangzhou 510235, China

Contributions: (I) Conception and design: J Min, G Li, H Lin, J Cao, Z Huang; (II) Administrative support: J Min, Z Huang, Q He, S Peng, R Chen; (III) Provision of study materials or patients: J Min, H Lin, J Cao, Z Huang, R Chen; (IV) Collection and assembly of data: Li Guolin, H Lin, J Wei, Q Han; (V) Data analysis and interpretation: Li Guolin, H Lin, J Cao, J Wei, Q Han; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Jun Min. Sun Yat-Sen Memorial Hospital, Sun Yat-Sen University, Guangzhou 510235, China. Email: drminj@qq.com.

Abstract: Laparoscopic procedures have become an important part of minimally invasive surgery for pancreatic disease. However, due to the complex anatomic location and numerous reconstructions, laparoscopic pancreaticoduodenectomy (LPD) still remains one of the most challenging procedures even for the experienced laparoscopic surgeons. Owing to the evolution in laparoscopic technology and instrumentation within the past decade, LPD is beginning to gain wider acceptance. In contrast to the traditional open procedures, LPD has been showed to improve perioperative outcomes, such as less blood loss, decreased postoperative pain, shorter hospital stay and faster recovery. According to our experience, LPD has the same indications as the open procedures, including the cases with SMV or PV been invaded. However, abundant experience in open surgery and strict laparoscopic technique training are still play an important role in this procedure. Here we propose the posterior approach, and sum up the dissection processes as "Three axis and four visual fields". In order to shorter the operative time, vessels should be taken as the axis, dissection should be performed from the distant towards the portal and every visual field should be made full use of. However, prospective RCTs of LPD are still absence. We are looking forward to adding more surgeons to promote LPD, working together to identify its superiority and long-term advantages over the open counterpart and making it become the gold standard for the treatment of periampullary diseases.

Keywords: Laparoscopic pancreaticoduodenectomy (LPD)

Received: 18 September 2016; Accepted: 10 October 2016; Published: 23 November 2016.

doi: 10.21037/ales.2016.11.01

View this article at: http://dx.doi.org/10.21037/ales.2016.11.01

Introduction

Laparoscopic procedures have advanced to represent the new gold standard in many surgical fields, also it has become an important part in minimally invasive surgery for pancreatic disease. Laparoscopic pancreaticoduodenectomy (LPD) was first described by Gagner and Pomp in 1994 (1), and more series began to describe this new technique in the following years (2-10). However, due to the complexity of the procedure, such as the retroperitoneal location of the pancreas, close relationship with blood vessels [superior mesenteric artery and vein, portal vein (PV), hepatic artery (HA), etc.] and the technical difficulty of three reconstructions, LPD remains to be one of the most challenging procedures even for the experienced laparoscopic surgeons.

Fortunately, owing to the evolution in laparoscopic technology and instrumentation within the past decade, LPD is beginning to gain wider acceptance. As reported in the literatures (11-13), compare to the traditional open counterpart, LPD has been showed to improve perioperative outcomes, such as less blood loss, decreased postoperative pain, shorter hospital stay and faster recovery. But there still some problems blocking the popularization of this technique, including longer operation time, higher

expense, uncertain of the long-term advantages and so on.

Definitely, LPD is an attractive and also challenging procedure to surgeons. Abundant experience in open pancreaticoduodenectomy and strict laparoscopic technique training are the foundation to promote the process, and covering the learning curve is the only way to master this complex procedure.

According to our experience, we propose the posterior approach, and sum up the dissection processes as "Three axis and four visual fields". They are, common hepatic artery (CHA)-HA [gastroduodenal artery (GDA)] axis, superior mesenteric vein (SMV)-PV axis, superior mesenteric artery (from far and near) axis and distal gastric and pancreatic neck region, Treitz ligament region, descending duodenum region, hepatoduodenal ligament region. In order to shorten the operative time, vessels should be taken as the axis, dissection should be performed from the distant towards the portal and every visual field should be made full use of.

However, prospective RCTs of LPD are still absence. We are looking forward to adding more surgeons to promote LPD, working together to identify its superiority and long-term advantages over the open counterpart and making it become the gold standard for the treatment of periampullary diseases.

In the following sections, we will share our experience about LPD in detail, including the managements throughout the perioperative period.

Patient selection and workup

According to our experience, LPD has the same indications as the open procedures, including benign periampullary diseases, distal common bile duct cancer, ampullary carcinoma, duodenal carcinoma, pancreatic head carcinoma, and even the cases with SMV or PV been invaded, but at the very beginning period, patient selection should be very cautious, and distal common bile duct or ampullary diseases seemed to be more appropriate.

Most of the time, the cases easy to resect are always difficult to reconstruct, such as the small tumor in the pancreatic head. On the other hand, the cases difficult to resect are always easy to reconstruct, such as the obvious obstructive jaundice case with dilation in both bile duct and pancreatic duct. Sometimes the patient of ampullary carcinoma might be both easy to resect and reconstruct as well. Of course, the case of pancreatic head carcinoma with vessel invasion would be difficult to resect or reconstruct.

Before the operation, routinely blood tests (CA19-9, CEA and AFP, liver function, IgG4, etc.) are performed, which would be initially helpful to understand the general situation, identify benign or malignant mass, and determine whether preoperative biliary drainage is needed or not.

A variety of imaging modalities are used to assess the resectability of the tumor, such as CTA and MRCP, which would help to estimate the relationship of the tumor with the major vessels, dilation of bile duct and pancreatic duct. More attentions should be paid to vascular variation, especially allotropic hepatic right artery originated from superior mesenteric artery. Endoscopic ultrasonography (EUS) would be needed in some of the complex cases. Also PET-CT would be useful in finding the metastasis.

Pre-operative preparation

Perform the biliary drainage pre-operation for 10–14 days if total bilirubin is higher than 300 μmol/L, which might greatly reduce the intraoperative tissue edema and wound exudation when total bilirubin is reduce to below 100 μmol/L).

Intestinal preparation would be needed before the operation.

Other pre-operative preparations are in accordance with the other abdominal surgeries.

Equipment preference card

We are in favor of harmonic scalpel, LigaSure combined with bipolar coagulation to implement most of the processes.

Laparoscopic ultrasound would be of great help in locating the small lesion and determining the surgical margins.

Other frequently used equipments and instruments include energy platform, golden finger hook, Endo-GIA, etc.

Procedure

After successful general anesthesia with tracheal intubation, disinfect the surgical area and spread aseptic towel routinely.

Place the patient in a supine, straddle and reverse Trendelenburg position. Usually five trocars are needed for this complex procedure. The surgeon stands between the patient's legs, two assistants stand on each lateral side of the patient and take turns to hold the laparoscope.

Enter the abdomen through an infraumbilical approach

and then thoroughly explore the abdomen to exclude metastasis. Sometimes intraoperative ultrasonography is performed to locate the small tumor and assess its resectability. And most of the time, suspension of the ligamentum teres hepatis is helpful for surgical exposure.

Then, create an opening in the gastrocolic omentum using technique of choice (harmonic scalpel, or LigaSure.), continue the division proximal and distal along the surface of the transverse colon until a sufficiently large window has been developed. After confirming the resectability of the tumor, divide the stomach with the laparoscopic linear stapler and expose the pancreas and CHA. Mobilize upper margin of the pancreas (harmonic scalpel, or unipolar electric coagulation hook), encircle and tape CHA and dissect the lymph nodes around (No. 8), then divide and cut GDA. Continue to encircle and tape HA towards the hilar, dissect the lymph nodes (No. 12) and identify PV just under HA.

After mobilizing the inferior margin of pancreas and identifying SMV by following the middle colic vein and the gastrocolic trunk as they drain directly into the SMV in close proximity, encircle and tape SMV and carefully protect the transverse mesocolon throughout the operation when dissecting the inferior border of the pancreas. Enter the avascular plane between the neck of pancreas and the SMV, bluntly mobilize and create a post-pancreatic tunnel upwards until the upper margin of the pancreas. There should not be any collateral veins entering the anterior surface of the SMV from the substance of the pancreas. Tape the pancreas to avoid injury to the vessels in the following process.

Next, reflect the transverse colon cephalad, identify and fully divided the Treitz ligament on the left side until the inferior vane cava (IVC) is coming into view. Then divide the upper portion of the jejunum about 10 cm away from Treitz ligament with a linear stapler, and separate the proximal jejunum from the mesojejunum with LigaSure or harmonic scalpel. The horizontal part of duodenum should be mobilized as much as possible from the left side of the abdomen, which would be of much help to the following procedures.

Mobilize the hepatic flexure downward to expose the duodenum, perform a Kocher maneuver, by incising the peritoneum lateral to the duodenum in the avascular plane. Reflect the duodenum and head of the pancreas medially so as to expose inferior vena cava, left renal vein and the origin of superior mesenteric artery.

Traverse the pancreas slowly by using harmonic scalpel or electrocoagulation. It is important to identify the pancreatic duct and cut it with a sharp scissors. Complete hemostasis of pancreatic stump would be helpful in preventing postoperative bleeding.

Pass the divided jejunum to the right side and begin to separate the pancreatic uncinate process from SMV and SMA. Here three layers should be dissected in turn. The first layer is composed of loose tissue, where a branch of uncinate process from SMV could be separated and cut, remember to preserve the gross first jejunal branch if possible. The second layer is a dense fibrous tissue, in which inferior pancreaticoduodenal artery should be handled, and allotropic hepatic right artery may be found in this layer too. Finally there is also a loose tissue of the mesentery of uncinate process. It is important to identify the origin and termination of any anomalous vessel here before division, because an aberrant right HA may occasionally arise from SMA. And then continue dissection along the sheath of SMA, upwards to the posterior of hepatoduodenal ligament (No. 12).

After fully skeletonization of the hepatoduodenal ligament, separate the gallbladder from the liver and divide the bile duct on hepatic duct level, remove the whole specimen and finish the resection processes.

Use either a transverse incision just above the synchondroses pubis or a middle incision in the upper abdomen to take out the specimen is feasible. Close the incision, irrigate the abdomen and get ready for reconstruction.

Pull the proximal jejunum to the right side through the rear part of the mesenteric vessels. Duct to mucosa anastomosis is the most traditional method used for the pancreaticojejunostomy, usually 4-0 prolene is chosen for the suture of posterior layer (continuous or interrupted), but for the especially brittle and soft pancreas, interrupted sutures maybe more suitable. A pancreatic stent is inserted and the duct to mucosa anastomosis is fashioned with 5-0 prolene sutures. Then the anterior layer is completed with the 4-0 prolene or barbed sutures, either continuous or interrupted suture is OK.

Make an end-to-side hepaticojejunostomy distal to the pancreaticojejunostomy, and make sure that there is no tension between the two anastomoses. In most cases, 5-0 PDS or 4-0 barbed suture is used for the running suture, but sometimes biliary stent and interrupted suture might be needed if the bile duct is too small (D <5 mm).

Gastrojejunostomy is performed using a laparoscopic linear stapler or running suture with 3-0 barbed sutures, but for the pylorus-preserving procedure, the stapler is

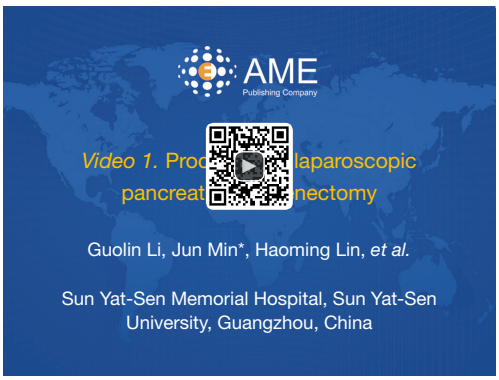

Figure 1 Procedure of laparoscopic pancreaticoduodenectomy (14). Available online: http://www.asvide.com/articles/1220

obviously not an ideal choice according to our experience.

After the reconstructions, two double-lumen drainages are emplaced, one in the hepatorenal recess, just posterior to the hepaticojejunostomy, and the other posterior to the pancreaticojejunostomy. The tips of the two drainages cross each other might be very useful in case of any postoperative leakage.

If you want to know more about the detail procedures of LPD, please pay attention to *Figure 1*.

Role of team members

(I) Jun Min (surgeon);
(II) Rufu Chen (surgeon);
(III) Guolin Li (surgeon);
(IV) Haoming Lin (surgeon);
(V) Jun Cao (surgeon);
(VI) Jinxing Wei (surgeon);
(VII) Zehua Huang (theatre nurse);
(VIII) Qing He (physician of ICU);
(IX) Shuling Peng (anesthetist);
(X) Qingfang Han (trainee).

Post-operative management

Reasonable analgesia is especially important for postoperative recovery, and it is better to "Be on time" than "Be on demand".

Maintaining unobstructed drainage and preventing localized hydrops would be the most important things for the pancreatic surgery after operation, and perform Ultrasound examination at any time if needed.

Conventionally check the amylase of each drainage daily for at least three days after the surgery. If the result is obviously abnormal, have a double check or prolong the time for testing until it return to normal.

The drainages will stay for four or five days, remember to confirm the drainages are unobstructed and there is few hydrops in the abdomen before removing them.

Gastric tube would be taken out 3–5 days after the surgery when gastrointestinal function gradually recovers, it is better to clamp the tube for a couple of hours before taking out.

Finally, pay more attention to perioperative nutritional support and maintain body weight stable and body fluid balanced would help to faster recovery. Do not forget to use somatostatin through intravenous pumping for 3–5 days.

Tips, tricks and pitfalls

(I) Vessels should be taken as the axis, dissection should be performed from the distant towards the portal, which is more conducive to grasp the anatomical planes and at the same time simplify the dissection of hepatoduodenal ligament.
(II) Made full use of every visual field, and avoid repeated exposure or manipulation.
(III) Suspension of the ligamentum teres hepatis is helpful for surgical exposure.
(IV) Familiar with the anatomy and blood supply of the pancreatic head and duodenum.
(V) Pay more attention to vascular variation, especially allotropic hepatic right artery originated superior mesenteric artery.
(VI) The horizontal part of duodenum should be mobilized as much as possible from the left side of the abdomen, until reaching the right side of the inferior vena cava, which would help to perform the Kocher maneuver.
(VII) Management of uncinate process is the most critical technology in LPD, during which the following three layers should be showed: (i) loose tissue containing branch of uncinate process from SMV; (ii) dense fibrous tissue in which inferior pancreaticoduodenal artery and allotropic hepatic right artery may be found; (iii) loose mesentery of uncinate process.
(VIII) Reverse-stitch technique would be helpful for the reconstruction of hepaticojejunostomy.
(IX) Tension and lack of blood supply will always contribute to the leakage.

(X) Remember that the knot too tight may increase the risk of pancreatic fistula.
(XI) It is harmful to stay the tubes too long; and it is also not a good idea to place as much tubes as possible.

Acknowledgments

Funding: None.

Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/ales.2016.11.01). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Gagner M, Pomp A. Laparoscopic pylorus-preserving pancreatoduodenectomy. Surg Endosc 1994;8:408-10.
2. Dulucq JL, Wintringer P, Mahajna A. Laparoscopic pancreaticoduodenectomy for benign and malignant diseases. Surg Endosc 2006;20:1045-50.
3. Pugliese R, Scandroglio I, Sansonna F, et al. Laparoscopic pancreaticoduodenectomy: a retrospective review of 19 cases. Surg Laparosc Endosc Percutan Tech 2008;18:13-8.
4. Palanivelu C, Rajan PS, Rangarajan M, et al. Evolution in techniques of laparoscopic pancreaticoduodenectomy: a decade long experience from a tertiary center. J Hepatobiliary Pancreat Surg 2009;16:731-40.
5. Kendrick ML, Cusati D. Total laparoscopic pancreaticoduodenectomy: feasibility and outcome in an early experience. Arch Surg 2010;145:19-23.
6. Asbun HJ, Stauffer JA. Laparoscopic vs open pancreaticoduodenectomy: overall outcomes and severity of complications using the Accordion Severity Grading System. J Am Coll Surg 2012;215:810-9.
7. Kim SC, Song KB, Jung YS, et al. Short-term clinical outcomes for 100 consecutive cases of laparoscopic pylorus-preserving pancreatoduodenectomy: improvement with surgical experience. Surg Endosc 2013;27:95-103.
8. Nakamura M, Nakashima H. Laparoscopic distal pancreatectomy and pancreatoduodenectomy: is it worthwhile? A meta-analysis of laparoscopic pancreatectomy. J Hepatobiliary Pancreat Sci 2013;20:421-8.
9. Correa-Gallego C, Dinkelspiel HE, Sulimanoff I, et al. Minimally-invasive vs open pancreaticoduodenectomy: systematic review and meta-analysis. J Am Coll Surg 2014;218:129-39.
10. Subar D, Gobardhan PD, Gayet B. Laparoscopic pancreatic surgery: An overview of the literature and experiences of a single center. Best Pract Res Clin Gastroenterol 2014;28:123-32.
11. Fernández-Cruz L, Cesar-Borges G, López-Boado MA, et al. Minimally invasive surgery of the pancreas in progress. Langenbecks Arch Surg 2005;390:342-54.
12. Nappo G, Perinel J, El Bechwaty M, et al. Minimally Invasive Pancreatic Resection: Is It Really the Future? Dig Surg 2016;33:284-9.
13. Alsfasser G, Hermeneit S, Rau BM, et al. Minimally Invasive Surgery for Pancreatic Disease - Current Status. Dig Surg 2016;33:276-83.
14. Li G, Min J, Lin H, et al. Procedure of laparoscopic pancreaticoduodenectomy. Asvide 2016;3:447. Available online: http://www.asvide.com/articles/1220

doi: 10.21037/ales.2016.11.01
Cite this article as: Li G, Min J, Lin H, Cao J, Wei J, Huang Z, He Q, Peng S, Han Q, Chen R. Laparoscopic pancreaticoduodenectomy. Ann Laparosc Endosc Surg 2016;1:31.