

Totally Laparoscopic Pancreaticoduodenectomy: Technical Notes

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Rezumat

Duodenopancreatectomia laparoscopică totală: note tehnice

Introducere: Duodenopancreatectomia laparoscopică este încă rar adoptată datorită complexității sale inerente. Acest articol prezintă experiența noastră de duodenopancreatectomie laparoscopică axată pe note tehnice.

Descrierea tehnică: Se folosește o tehnică cu 5 trocare. Vizibilitatea este asigurată de un telescop optic 30° cu tehnologie 4K pentru rezecție și 3D pentru faza reconstructivă. Flexura colică dreaptă este mobilizată și se efectuează manevra Kocher extinsă care expune vena cava inferioară și vena renală stângă. Antrul gastric este rezecat cu un capsator mecanic. Artera hepatică comună este identificată în spatele marginii pancreatice superioare; limfadenectomia stațiilor 7, 8, 9, 12 a și b este efectuată, până când artera gastroduodenală este curățată de țesutul limfatic; o pensă bulldog este folosită pentru a întrerupe fluxul arterial prin artera gastroduodenală, pentru a exclude vascularizarea arterelor aberante ale ficatului din artera mezenterică superioară. Ductul hepatic comun este secționat chiar deasupra canalului chistic. Pancreasul este secționat prin electrochirurgie monopolară, împărțind canalul pancreatic principal la 2-3 mm distal de secțiunea transversală prin parenchim cu foarfece reci, pentru a lăsa un ciot care va facilita anastomoza ducto-mucoasă, apoi se secționează prima buclă jejunală. Se realizează o disecție completă a mezopancreasului, de la coadă la cap. Înainte de a efectua anastomoza pancreatico-jejunală, se evaluează un scor de risc al fistulei bazat pe textura parenchimului pancreatic, tipul tumorii, diametrul ductului Wirsung, pierderea de sânge intraoperator.

Received: 10.05.2020
Accepted: 15.06.2020

Anastomoza pancreatico-jejunală se realizează folosind fire din prolene și PDS. Hepaticojejunostomia termino-laterală se efectuează la aproximativ 10 cm de pancreatico-jejunostomie. Gastrojejunostomia laterală se realizează cu ajutorul unui capsator liniar de 60 mm.

Concluzie: Duodenopancreatectomia laparoscopică este o procedură dificilă afectată de rate mari de morbiditate. Standardizarea tehnicii ar putea duce la reducerea acestor rate și la favorizarea adoptării acesteia.

Cuvinte cheie: duodenopancreatectomie laparoscopică totală, duodenopancreatectomie laparoscopică, intervenție chirurgicală minim invazivă, chirurgie pancreatică, cancer pancreatic

Abstract

Introduction: Laparoscopic pancreaticoduodenectomy is still rarely adopted due to its inherent complexity. We hereby present our experience of laparoscopic pancreaticoduodenectomy focused on technical notes.

Technical description: A 5 trocars technique is used. Vision is provided by a 30° scope with 4K technology for the demolitive phase and 3D for the reconstructive phase. The right colic flexure is mobilized and an extensive Kocher maneuver is carried out exposing the inferior vena cava and left renal vein. The gastric antrum is resected with a mechanical stapler. The common hepatic artery is identified behind the superior pancreatic margin; lymphadenectomy of stations 7, 8, 9, 12 a and b is performed, until the gastroduodenal artery is cleared from the lymphatic tissue; a bull-dog clamp is placed to interrupt the arterial flow through the gastroduodenal artery, in order to exclude aberrant vascularization of the liver from the SMA. The common hepatic duct is transected just above the cystic duct. The pancreas is sectioned with monopolar energy, dividing the main pancreatic duct 2-3 mm distal to the parenchymal transection line with cold scissors, as to leave a stump that will facilitate the duct-to-mucosa anastomosis then the first jejunal loop is sectioned. A complete dissection of the mesopancreas is performed, moving from a caudal to cephalad fashion. Prior to perform the pancreatico-jejunal anastomosis, a fistula risk score based on pancreatic parenchymal texture, tumor type, Wirsung diameter, intraoperative blood loss is assessed. The pancreatico-jejunal anastomosis is carried out using prolene and pds sutures. The end-to-side hepaticojejunostomy is performed about 10 cm distant from the pancreaticojejunostomy. The side-to-side gastrojejunostomy is performed using a 60 mm linear stapler.

Conclusion: Laparoscopic pancreaticoduodenectomy is a demanding procedure affected by high morbidity rates. The standardization of the technique could lead the way to reduce such rates and favor its adoption.

Key words: total laparoscopic pancreaticoduodenectomy, laparoscopic pancreaticoduodenectomy, advanced minimally invasive surgery, pancreatic surgery, pancreatic cancer

Introduction

Initial experiences of minimally invasive surgery applied to pancreatic diseases were limited to the diagnostic and stadiative phases or palliative procedures (1,2). During

the last decades, the technological and surgical progress has resulted into a wider spectrum of minimally invasive operations in the field of pancreatic surgery, for the treatment of both benign and malignant neoplasms (3). In this scenario, laparoscopic distal

pancreatectomy has already achieved acceptance worldwide (4). This operation does not require any anastomosis, and it is considered feasible and safe (3). On the other hand, laparoscopic pancreaticoduodenectomy (LPD) is still questioned to be as safe and reproducible, due to its technical complexity and long operative time (3,5). Although the first LPD was performed more than 20 years ago (6), the adoption rate has been very low (7), especially when compared to other fields of surgical oncology for which laparoscopy is routinely applied (3). The technical complexity, especially related to the dissection close to the vascular structures and to the difficulty of creating multiple anastomoses, represents the main reason that limits the adoption of LPD (8).

Recent retrospective series have reported multiple advantages in short term outcomes for LPD compared to open PD (9-11). Considering its potential benefits, efforts should be made to improve the diffusion and standardization of LPD technique worldwide.

We hereby present our experience of LPD with regards to the operatory phases and technical aspects.

Surgical Technique

Patient's Preparation and Positioning

The patient receives low molecular weight heparin starting the evening before the

surgery. Cefazolin 2 g is administered as antibiotic prophylaxis 15 minutes prior the skin incision.

Intermittent pneumatic compression devices are positioned on the lower extremities to prevent thromboembolic events; feet and right shoulder supports are positioned, to allow optimal bed mobilization.

The patient is placed supine, with legs apart, with the first surgeon positioned between the legs and one assistant on each side of the patient's abdomen.

Demolitive Phase

The first trocar is placed in supra-umbilical position; 2 other trocars are positioned on each side of the umbilicus (*Fig. 1*). A 30° scope is used with 4K technology. The pneumoperitoneum is insufflated at 12 mmHg. The bed is tilted in a 30° reverse Trendelenburg position. A percutaneous traction suture is placed on the round ligament to lift the liver in an upward position.

The abdominal cavity is explored to exclude the presence of macroscopic metastatic disease on the liver surface and the peritoneum. The gastrocolic ligament is then opened and dissected using a radiofrequency energy device, preserving the left gastroepiploic vessels. The right colic flexure is mobilized and an extensive Kocher maneuver is carried out exposing the inferior vena cava (IVC) and

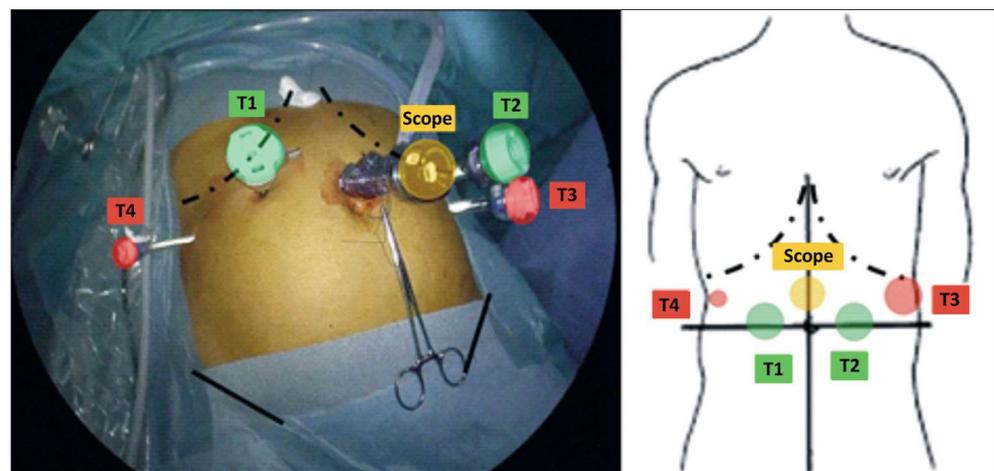


Figure 1. Trocars' position

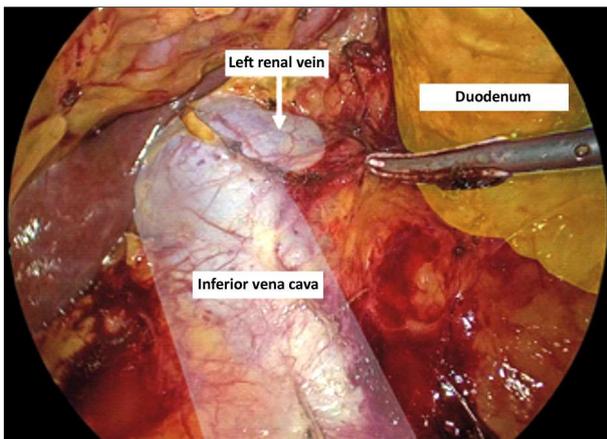


Figure 2. Kocher maneuver

left renal vein (LRV) (*Fig. 2*); the origin of the superior mesenteric artery (SMA) is identified in order to evaluate resectability. The last-third of the duodenum is separated from the transverse mesocolon with identification and partial dissection of the superior mesenteric vein (SMV) in order to rule out any neoplastic involvement. The lymph nodes of the superior mesenteric vein are excised and the right gastroepiploic vessels are sealed at trunk of Henle using clips (*Fig. 3*). The gastric antrum is resected (Whipple's procedure) with a 60 mm stapler with purple cartridge (Signia™®, Ultra Powered stapling System, Covidien).

The common hepatic artery is identified behind the superior pancreatic margin; lymphadenectomy of stations 7, 8, 9, 12 a and b is performed, until the gastroduodenal artery (GDA) is cleared from the lymphatic tissue; a bull-dog clamp is placed to interrupt the arterial flow through the GDA (*Fig. 4*), in order to exclude aberrant vascularization of the liver from the SMA. The gallbladder is dissected from the hepatic bed, sectioning the cystic artery at its origin; a careful dissection of the hepatic pedicle is performed in a caudal to cephalad fashion, and the common hepatic duct (CHD) is transected just above the cystic duct (*Fig. 5*); a frozen section of the resection margin is performed to exclude neoplastic involvement and a bile sample is obtained for microbiological purpose. The distal stump of the CHD is then closed with a running suture

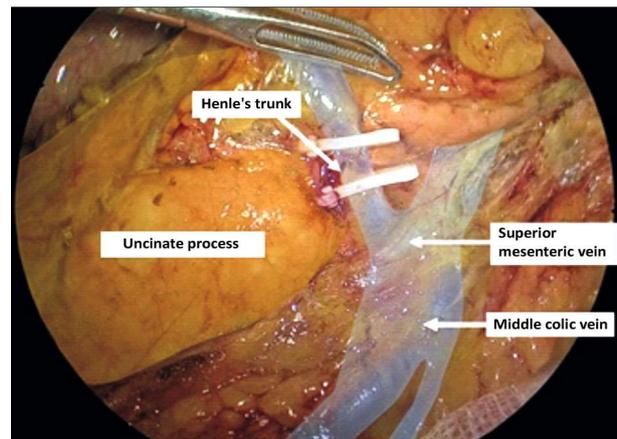


Figure 3. Henle's Trunk

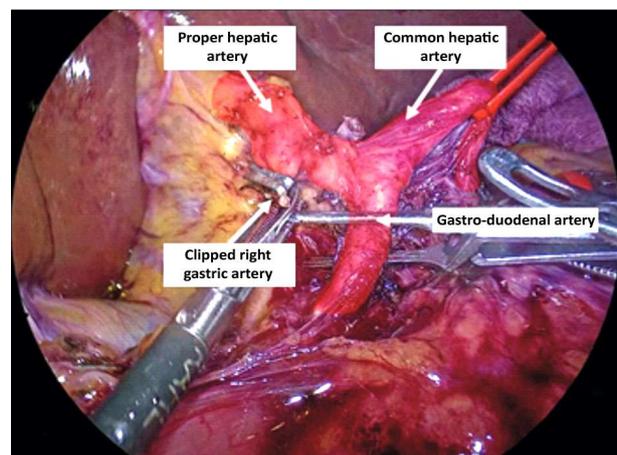


Figure 4. Gastro-duodenal artery

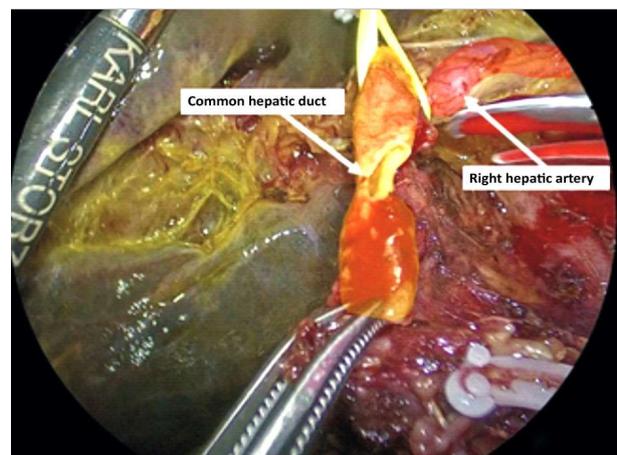


Figure 5. Biliary duct sectioned

or a clip. After assessing the correct liver and bowel perfusion, the GDA is sealed with clips or vascular stapler depending on the dimension.

The portal vein is cleared by the surrounding lymphovascular tissue in a cephalad to caudal fashion until the anterior-superior-pancreatico-duodenal vein (ASPDV) (Fig. 6). The retropancreatic tunnel is completed and the pancreatic neck is surrounded with a cloth loop. The pancreas is sectioned with monopolar energy, dividing the main pancreatic duct 2-3 mm distal to the parenchymal transection line with cold scissors, as to leave a stump that will facilitate the duct-to-mucosa anastomosis (Fig. 7). An intraoperative frozen section of the pancreatic margin is obtained to rule out neoplastic involvement.

The transverse colon is brought upwards to expose the Treitz ligament, which is dissected up to the lower edge of the pancreas; the first jejunal loop is sectioned approximately 7 cm below the Treitz with 60 mm tristaple Endo Gia (Signia™, Ultra Powered stapling System, Covidien).

The second part of the duodenum and the first jejunal loop are lifted up and pushed toward the left by the assistants' grasp showing the resection plane along the SMA (Fig. 8); a complete dissection of the mesopancreas is performed, moving from a caudal to cephalad fashion parallel to the SMA; the whole lymphovascular tissue between the uncinate process and the antero-right lateral aspect of the SMA is dissected. The vessels in the mesopancreas are sealed using 5 mm pneumatic clips (Challenger® Ti-P, B. Braun); if possible, the inferior pancreaticoduodenal artery (IPDA) should be always sealed with clips. The dissection is completed removing all the tissue between the celiac trunk and the SMA; at the end, lymphadenectomy of the station 12 b is completed.

Surgical specimen is positioned in an endobag and extracted through a Pfannenstiel mini-laparotomy (4-5 cm).

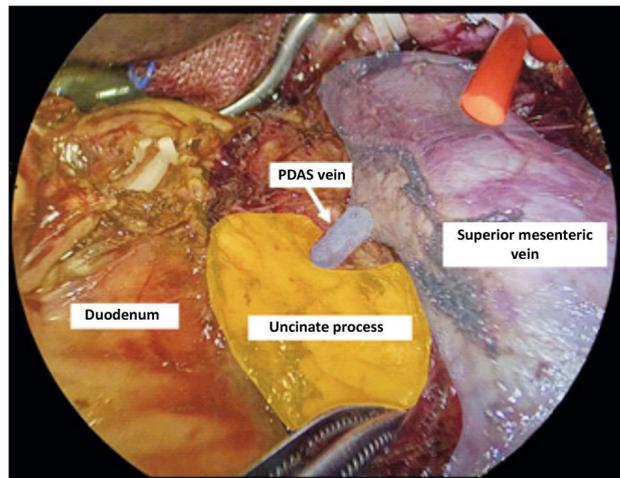


Figure 6. Pancreatic-duodenal anterior superior vein

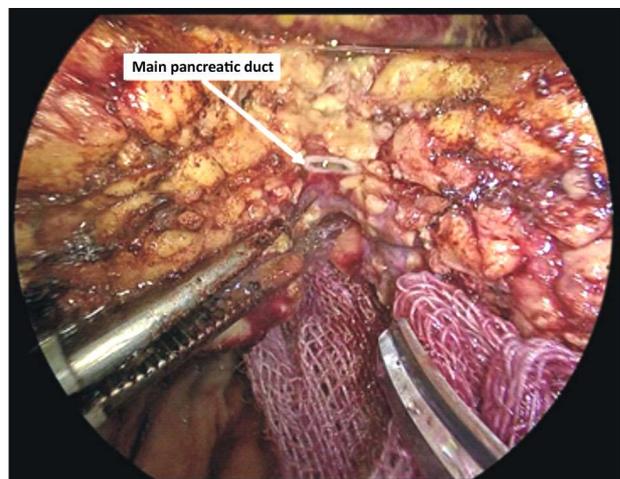


Figure 7. Main pancreatic duct

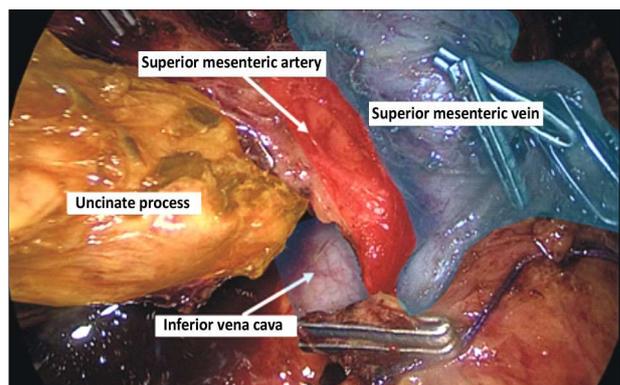


Figure 8. Identification of superior mesenteric artery

Reconstructive Phase

The 4K scope is replaced with a 30° 3D one for the reconstructive phase, performed according to Child; the jejunal loop is transposed supra-mesocolic through behind the mesenteric root.

Prior to perform the pancreatico-jejunal anastomosis, a fistula risk score based on pancreatic parenchymal texture, tumor type, Wirsung diameter, intraoperative blood loss is assessed (12).

The pancreatic remnant is mobilized for about 3-4 cm and a 2-0 absorbable polyfilament stitch (Vicryl®, Ethicon Endosurgery Inc, Cincinnati, OH) is placed on both side of the pancreas to help with traction. Six interrupted absorbable 5-0 monofilament sutures (PDS®, Ethicon Endosurgery Inc, Cincinnati, OH), with RB-1 needle, are placed in the

Wirsung (3 anterior and 3 posterior), independently from the diameter of the duct. Each suture is abandoned over the pancreatic remnant with the two extremities hold with a marked micro bull-dog (*Fig. 9*).

The posterior layer of the anastomosis is performed using interrupted non-absorbable 4-0 polypropylene (Prolene®, Ethicon Endosurgery Inc, Cincinnati, OH) with an SH needle, between the sero-muscular jejunal layer and the pancreatic capsula, from cephalad to caudal (*Fig. 10*); then an enterotomy is performed on the anastomotic jejunal loop, using the monopolar crochet, corresponding to the site and the diameter of the Wirsung duct. The duct-to-mucosa anastomosis is then fashioned, using the interrupted sutures previously placed in the Wirsung duct (*Fig. 11-12*). Finally, the

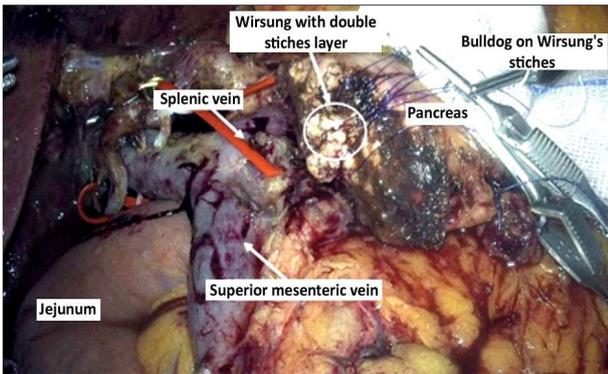


Figure 9. Stiches positioning on the Wirsung duct

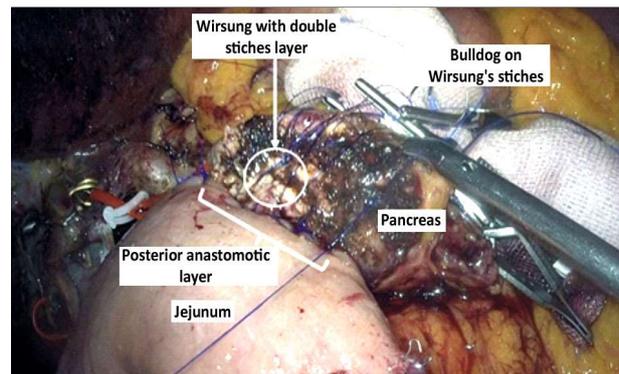


Figure 10. Posterior layer of pancreatico-jejunal anastomosis

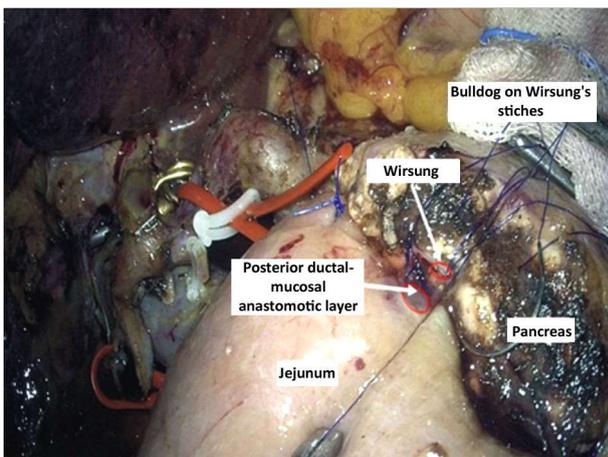


Figure 11. Duct-to-mucosal posterior layer

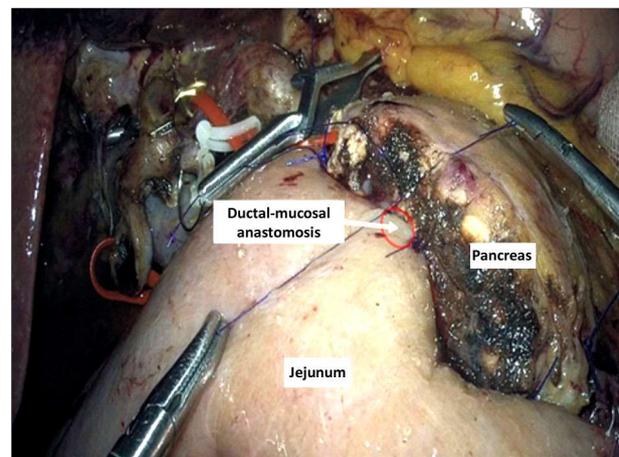


Figure 12. Duct-to-mucosal anterior layer

anterior layer of the pancreato-jejunal anastomosis is sutured similarly to the posterior one (Fig. 13).

The end-to-side hepaticojejunostomy is performed about 10 cm distant from the pancreaticojejunostomy. Usually, two 5-0 monofilament running sutures (PDS®, Ethicon Endosurgery Inc, Cincinnati, OH) with RB 1 needle are used; first, the posterior layer is sutured in a lateral-to-medial direction and then the anterior one in the opposite way (Fig. 14). The knot of each suture falls outside of the anastomosis and never inside (Fig. 15). When the bile duct has a small diameter, the anastomosis is performed using interrupted 5-0 monofilament sutures (PDS®, Ethicon Endosurgery Inc, Cincinnati, OH).

The side-to-side gastrojejunostomy is performed using a 60 mm linear stapler (Signia™, Ultra Powered stapling System, Covidien) with a purple cartridge and two 3-0 running suture (V-Loc®, Covidien, Inc, Mansfield, Massachusetts, USA) close the hole of the stapler insertion.

This anastomosis is carried out in an antecolic fashion, between the posterior wall of the stomach and the jejunal loop, along the greater curvature, following omental split.

Two closed suctioning drain (Jackson-Pratt®) are finally placed: the right drain goes behind the hepaticojejunostomy and cranially to the pancreaticojejunostomy; the left one goes behind the gastrojejunostomy and beneath the pancreaticojejunostomy. The naso-gastric tube is removed at the end of the procedure.

Discussion

Due to its technical complexity, LPD is a demanding procedure with poor standardization and a long learning curve (12). A correct indication to LPD and a careful patient selection is of paramount importance and depends on the surgical team experience: at the beginning of the learning curve, small ampullary or distal biliary tract tumors and patients with low BMI could facilitate the surgery and result in a lower conversion and injury rate (13-14).

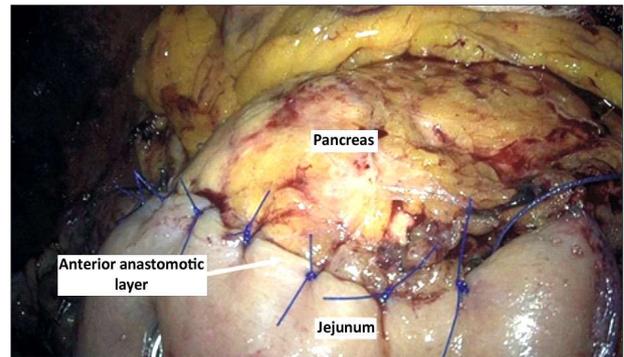


Figure 13. Anterior layer of pancreato-jejunal anastomosis

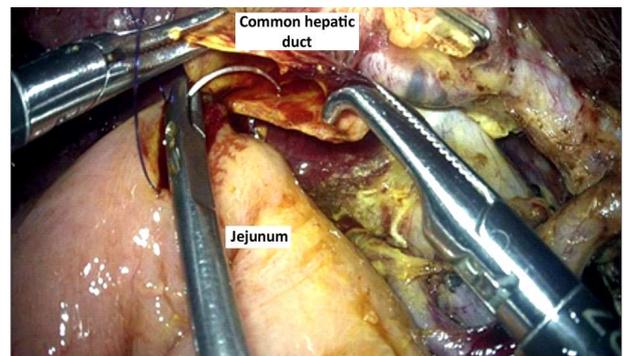


Figure 14. Biliary duct anastomosis

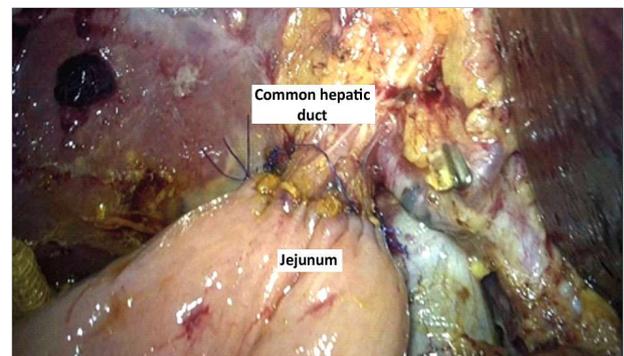


Figure 15. End of biliary duct anastomosis

Relative contraindication to LPD are related to the patients' fitness status (significant comorbidities (1,2,15,16), previous upper-mesocolic abdominal surgeries (1,16,17,18)) or to the primary disease (large tumours (1,19), previous chronic pancreatitis, neoadjuvant radiotherapy (19,20), and neoplastic vascular involvement (13,15)).

In our institution, we offer a minimally

invasive option to all patients that will receive PD, except for the cases with vascular infiltration, previous neoadjuvant therapy or anesthesiological contraindications to laparoscopy.

To perform LPD we use 5 trocars, different from other authors that described a 6 (9,21), or, more rarely, 7 (18,22) trocars technique. This setting allows to perform all the steps of the intervention without changing the position of the operators with a good visualization of all the regions; the first operator is positioned between the patient's legs; the first assistant (on the patient's left) plays a dynamic role, helping in the introduction and extraction of gauzes and surgical specimens through a 12 mm trocar; the second assistant can retract the liver or do traction according to the phase of the intervention through a 5 mm trocar.

Pancreatic neck is sectioned using cold shear, to easily identify and avoid thermal injuries of the Wirsung duct that could lead to pancreatic stump pancreatitis, as hypothesized by some authors (23).

Our technique consists of a particular dissection of retroportal lamina using a modified "artery first approach"; this is obtained firstly by approaching the lamina "downward", with a clear visualization of the resection plane along the SMA and an easier and reproducible identification of the IPDA; once the IPDA is sectioned, the lamina is approached by "upperward", with the section of pancreaticoduodenal veins and completing the total mesopancreas excision (TMpE).

We always perform TMpE, as we deem it advantageous both in case of benign disease and malignancy: in the first case, it allows easier recognition of the correct dissection plane, reducing bleeding; in the second one, it reduces the incidence of R+ resections improving the posterior margin clearance and the number of harvested lymphnodes, compared to standard pancreaticoduodenectomy (24).

The specimen is extracted by using an endobag through a suprapubic Pfannenstiel incision as it reduces the risk of incisional hernia and surgical site infection (25). This extraction site is reported in 15.7% of cases in

the literature and is the second most common one after minilaparotomy at the umbilical port (42.2%) (26-28). Other described extraction sites are subxiphoid (15%) (16,29), sub-umbilical (8.9%) (21) and right inferior quadrant (8.8%) (1, 30) mini-laparotomies.

We perform the reconstructive phase using a 3D scope, taking advantage of the enhanced depth perception. We perform a pancreaticojejunal anastomosis, as most authors do (84%); less common anastomoses are pancreaticogastrostomy (9,8% of cases) and duct occlusion (6,8%) (1,16,26,30). There is no strong evidence in favor of pancreatojejunostomy vs pancreatogastrostomy (32). At the beginning of our experience, we used to perform the anastomosis with two running sutures, but the drawback of this technique is that in case of a suture line dehiscence, it would involve half of the anastomosis. We now use a double layer of interrupted sutures, similarly to the majority of authors (respectively 90,6% for double layer and 74,6% for interrupted sutures) (14,21). We use poly-propylene and polydioxanone sutures because they have less variation after exposure to pancreatic juice, bile, and their mixture (33).

Many authors (72,8%) place a stent in the pancreatic duct, either routinely or selectively, to reduce the risk of postoperative pancreatic fistula (POPF) (33). We never place stents in the Wirsung duct because of no evidence of minor risk of POPF (35) and higher risk of early stent occlusion, with consequent pancreatitis of the stump (23).

Consistently to most reported series, we perform an antecolic gastrojejunal anastomosis in order to improve gastric emptying; other authors perform a retromesenteric or retrocolic anastomosis (1,27,28). In most reported cases, gastrojejunal (or duodenojejunal) anastomosis are hand sewn (3,10,14,31); mechanical gastrojejunal anastomoses are reported in the minority of cases (5,14,21).

LPD is a technically demanding operation with a steep learning curve; building a dedicated surgical team, the standardization of the technique and the development of advanced laparoscopic skills could be useful to

favor its adoption and improve intra- and post-operative outcomes.

Conflict of Interest

The authors declare no conflicts of interests.

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