13 Robotic Pancreaticoduodenectomy

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Historical Perspective

Pancreatic head adenocarcinoma is a common solid malignancy with aggressive course and high mortality. Despite significant progress in chemotherapeutic regimens and other adjunctive treatments, its median survival remains less than 2 years with overall 5-year survival rate less than 10% [1]. Pancreaticoduodenectomy (PD) is considered to be the only potential cure, but unfortunately, only a minority of patients are candidates for resection at the time of diagnosis. In 1935, Dr. Allen Oldfather Whipple reported the first successful PD in a two-stage procedure in three patients [2], and 6 years later, he described the first single-stage PD [3]. Since then, more than 80 years have passed, but the technique has not dramatically changed and PD is still considered one of the most complex and technically challenging abdominal operations with high perioperative morbidity and mortality.

In an effort to improve postoperative outcomes, less invasive approaches were adopted. Improvements in technology and technique over the last two decades have allowed us to perform laparoscopic and robotic pancreatic surgeries. These approaches have become popular for distal pancreatectomy, such that minimally invasive procedures are now considered to be the standard of care [4]. The first laparoscopic PD was reported by Ganger and Pomp in 1994 [5]. It was a 10 hour operation for chronic pancreatitis with prolonged postoperative hospital stay. Since then, the literature supports that laparoscopic PD is safe and feasible [6, 7]. Despite being performed in specialized centers, laparoscopic PD has not been widely adopted for numerous reasons including difficult anatomic location of the pancreas with close proximity to important vascular structures, limited working space of the retroperitoneum, complexity of the procedure requiring three anastomoses, and limitations of laparoscopy such as two-dimensional view, lack of depth perception, limited range of instrument motion, and long learning curve [8].

The introduction of the daVinci robotic system (Intuitive Surgical, CA) has helped to overcome some of these limitations. It offers improved ergonomics for the surgeon to decrease fatigue,

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offers fine motor control while eliminating tremor, provides 540° of articulating wrist movement and enhanced 3-D vision, and allows for more precise dissection and suturing on delicate tissues [9]. Using these advantages, Giulianotti in 2003 reported the first robotic-assisted PD (RAPD) [10]. Over the next 15 years, multiple pancreatic centers have incorporated the robot in their practice and have reported very promising results [4, 7–9, 11]. The paradigm has shifted from RAPD to hand-assisted robotic PD to purely robotic PD. Current literature supports when compared to open PD, the robotic approach provides comparable oncologic results in margin positivity and harvested lymph nodes, perioperative fistula rate, morbidity, and mortality and likely reduces blood loss, length of stay, pain, wound complications, and delayed gastric emptying [7–9, 11]. On the other hand, robotic PD is associated with longer operative times, especially for those at the beginning of the learning curve, and higher direct costs [8, 9, 11]. These results are better reproduced by highly trained and skilled surgeons in high-volume centers. It is our belief and experience that robotic PD is safe with equivalent technical and oncologic results in appropriately selected patients. In this chapter, we will present a reproducible step-by-step technique for robotic PD that follows the natural flow of open PD.

Indications

With experience, most patients who would qualify for open PD (OPD) would also qualify for robotic approach. It is our preference to reserve RAPD for patients that are felt to have clearly resectable tumors. Patient selection is critical, and the novice robotic surgeon should not engage in resecting a large periampullary tumor in a difficult abdomen early in the learning curve. Some groups have routinely performed robotic vein resection, but this is not our preference at this time. The robotic technique can be applied for pancreatic adenocarcinoma, neuroendocrine tumor (NET), intraductal papillary mucinous neoplasm (IPMN), common bile duct cholangiocarcinoma, duodenal lesion, pancreatitis, and others. At this time, our contraindications for this approach are patients with hostile abdomen from numerous previous operations and tumors that require vascular resection. As with OPD, patients with contraindications such as presence of metastatic disease, short life expectancy due to comorbidities, uncontrolled coagulopathy, and contraindications to general anesthesia should not be considered for robotic PD. Inability to tolerate pneumoperitoneum automatically excludes patients from this minimally invasive approach.

Preoperative Workup

For patients requiring PD, detailed history and physical exam are performed, including the onset of symptoms, presence of upper abdominal and/or back pain, jaundice, and symptoms of pancreatic insufficiency. Past medical history including onset of diabetes, cardiac disease, and respiratory comorbidities is pertinent, as well as family history, including first-degree cancer history and history of pancreatitis. Smoking and alcohol history is obtained and cessation counseling is held. Focused physical examination of the heart, lungs, and abdomen and exams for lymphadenopathy and peripheral vascular diseases are conducted.

Preoperative laboratory values including complete blood count, comprehensive metabolic panel, coagulation panel, cancer marker CA19-9, and HbA1C are obtained. Computed tomography (CT) of the chest is obtained to rule out metastatic disease to the lungs. CT of the abdomen and pelvis with triple phase contrast is also obtained to evaluate for metastatic disease and to assess for anatomic resectability. Routine endoscopic ultrasound (EUS)-guided biopsy of periampullary lesions is controversial. With the increased use of neoadjuvant chemotherapy, there has been a need to obtain tissue diagnosis prior to chemotherapy. It is imperative that the surgeon not insist on tissue diagnosis; the presence of a solid mass or distal CBD stricture in the appropriate clinical scenario should warrant PD. If there is any doubt of the diagnosis, liberal use of EUS is encouraged. If the patient has a duodenal mass requiring PD, esophagogastroduodenoscopy and colonoscopy are obtained.

Anesthesia, Patient Positioning, and Port Placement

Use of an Enhanced Recovery After Surgery (ERAS) pathway is encouraged in patients undergoing PD [12]. This will include high carbohydrate liquid intake until 2 h prior to surgery, use of aggressive pre-emptive pain regimen with acetaminophen and gabapentin, and use of alvimopan.

The patient is laid supine on a well-padded operating table. After induction of anesthesia, appropriate lines are placed. Arterial line is routinely used. For patients without many comorbidities, at least two large bore intravenous lines are sufficient for surgery. However, central lines are often placed in patients that require more invasive monitoring. After securing lines and pulse oximetry monitoring, both arms are tucked to the patient's side, using egg crate rolls to pad the elbows and hands. It is preferable to use a nonslip foam and restraint belts on the bed to prevent sliding when the patient is in reverse Trendelenburg position.

Positioning is Different for the Xi or Si Robotic Platforms

For the Si configuration, the patient is placed in split-leg position with the assistant surgeon between the legs. The patient's legs are secured well with straps and foot boards. Positioning is checked by both anesthesia and the surgeon to ensure that the patient does not move when placed into reverse Trendelenburg position.

For the Xi configuration, a foot board is secured at the bottom of the table, with the patient's feet in slight "V" configuration for ergonomic comfort, using appropriate foam rolls to pad the bottom and heel of the feet. Pillows are used to pad the legs at the knees. The assistant stands at the patient's left side. Again, positioning is checked with the patient in reverse Trendelenburg position to ensure that the patient does not move.

The patient is prepped from mid-chest to the groin. Appropriate warming devices such as the Bair hugger and blankets are placed in the head/shoulder area and on the lower extremities. After appropriate draping and an operative time-out, we place a 5-mm port using an optical trocar and a 0 degree 5-mm camera at the midline in the supraumbilical area. Pneumoperitoneum is achieved with CO_2 insufflation to 15 mm Hg. Under direct visualization, two additional trocars on the patient's left are placed: an 8-mm port in the left midclavicular line one handbreadth away from the midline port and a second 8-mm robotic port in the left, anterior to the mid-axillary line that is one handbreadth away from the first 8-mm port (Fig. 13.1). Then an additional 12-mm camera port on the patient's right midclavicular line in the subcostal region that is one handbreadth away from the midline port (Fig. 13.1) is placed. The camera is placed to the patient's right of midline because it gives

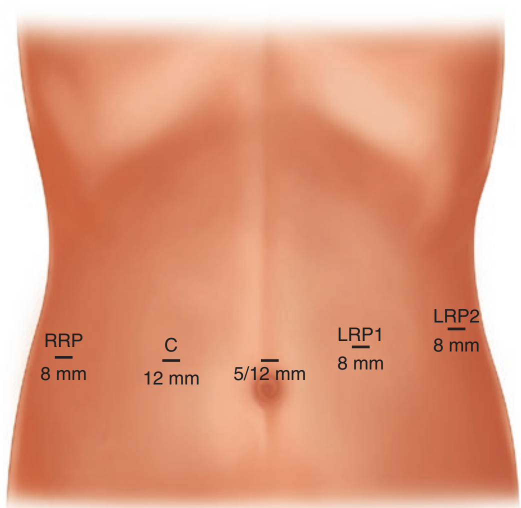

Fig. 13.1 Trocar placement for the Si system. RRP right robotic port, LRP left robotic ports 1 and 2. Arm 2 connects to RRP. Arm 1 to LRP 1, and Arm 3 to LRP 2

the best visualization of the superior mesenteric vein (SMV) and portal vein (PV) structure, which is the critical anatomic structure to identify and dissect around during PD. All ports are at least one handbreadth away from each other so that the robotic arms will not conflict with each other. Finally an 8-mm robotic port is placed on the patient's right, anterior to the mid-axillary line that is one handbreadth away from the last 12-mm midclavicular port. Subsequently, the original midline 5-mm port is upsized to a 12-mm air seal port (SurgiQuest Airseal, Medline) which can be used by the bedside assistant as an extra laparoscopic port (Fig. 13.1). Notably, the Airseal port must be placed last, because once Airseal mode is initiated, it becomes difficult to place additional trocars. Furthermore, for the Xi system, the trocars are placed in a more linear fashion, while the trocars for the Si system are placed in a more curvilinear fashion (Fig. 13.1). After an initial brief laparoscopic portion of the case, the patient is placed in slight reverse Trendelenburg position. The robot (Si system) is docked just above the patient's head. Figure 13.2 shows our typical port placements and robot docking position.

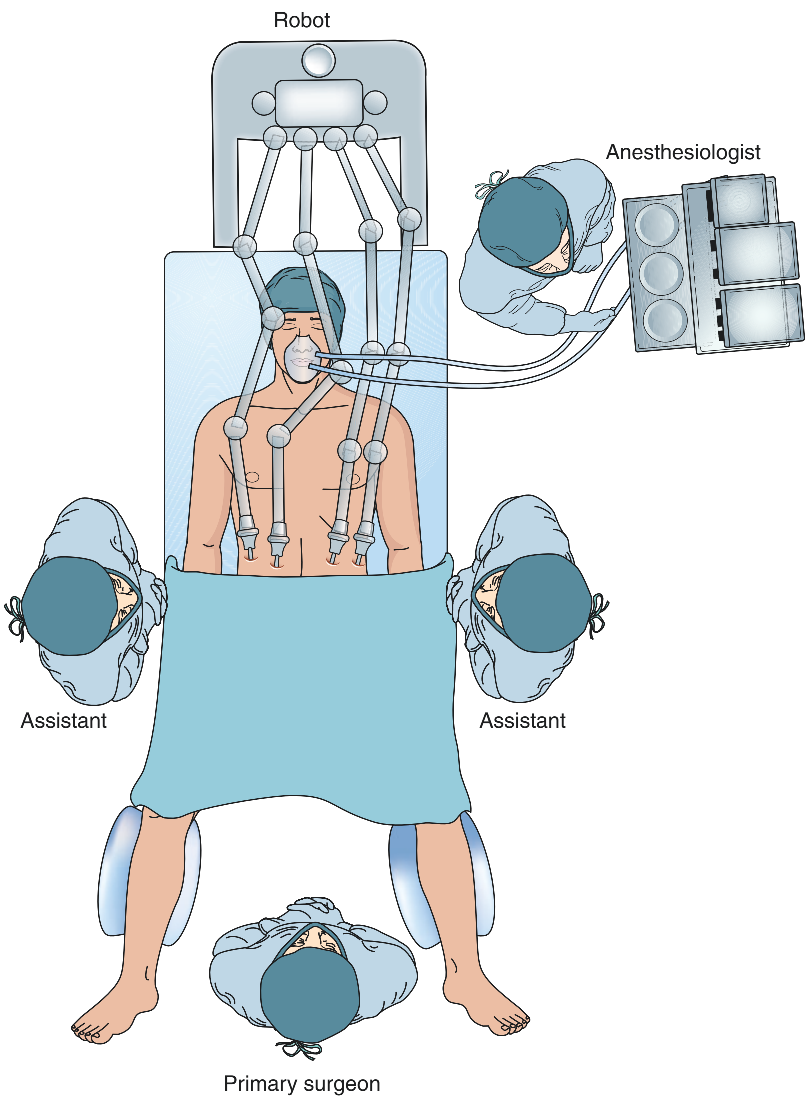

Fig. 13.2 Patient positioning for robotic pancreaticoduodenectomy with the Da Vinci Si system. The Si platform is docked from above the patient's head. The Xi platform can come from above the head or from the patient's left or right side. The authors prefer to position the Xi from the patient's left side

Operative Technique

Step 1: Laparoscopy and Robot Docking

The procedure starts laparoscopically by inspecting the abdomen for peritoneal disease. If there is no evidence of metastasis, the case continues. The greater curvature of the stomach is mobilized, entering the lesser sac through the gastrocolic ligament. The operating surgeon uses an atraumatic grasper (such as a DeBakey grasper) and a harmonic scalpel, and posterior gastric adhesions to the pancreas are taken down during this step. The transverse colon with its mesentery is retracted cephalad and the ligament of Treitz is identified. The small bowel is run distally and the anti-mesenteric side of the small bowel, approximately 40–60 cm distal to the ligament of Treitz, is sutured to the posterior wall of the stomach using 2-0 Ethibond and a Ti-KNOT device near the greater curvature, proximal to the future location of the gastrojejunostomy (Video 13.1 ref. 0:01″ to 0:30″). This step is performed before the robot is docked. Notably, the suture between the stomach and jejunum is placed toward the left of the patient with the small bowel traveling from left to right. This is important to prepare for the gastrojejunostomy at the end of the PD.

Robotic Resection

The robot is docked over the patient's head (Si) or over the patient's head or from the patient's left or right sides (Xi).

Instrument selection for initial dissection with Si system: arm 1, vessel sealer; arm 2, fenestrated bipolar; and arm 3, prograsp.

Instrument selection for initial dissection with Xi system: arm 1, fenestrated bipolar; arm 2, camera; arm 3, vessel sealer; and arm 4, prograsp.

Step 2: Identify SMV and Create the Tunnel

The next step is to identify and follow the right gastroepiploic vein to the superior mesenteric vein (SMV) at the inferior edge of the pancreas. The right gastroepiploic vein joins with the middle colic vein to form the gastrocolic trunk of Henle which leads the surgeon to the SMV and should be viewed as the key step to identifying the SMV. There is tendency to be far to the patient's right at this point of dissection.

The gastroepiploic vein may have to be sacrificed at this point with a single hemolock clip at its origin followed by ligating the vein with the vessel sealer. A tunnel is started under the neck of the pancreas using the vessel sealer, staying just anterior to the SMV (Fig. 13.3).

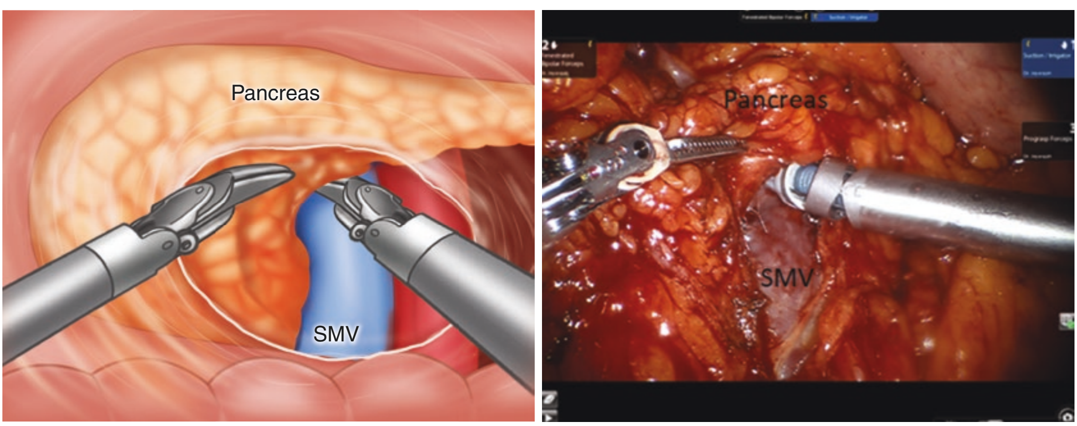

Fig. 13.3 Creation of the tunnel posterior to the neck of the pancreas

Fig. 13.4 Division of the stomach with the pancreas lying underneath

The assistant should use an atraumatic instrument to retract the transverse colon mesentery inferiorly and to provide counter-traction. The tunnel over the SMV is created for as long a distance as possible (Video 13.1 ref. 0:31″ to 0:50″). The assistant can also use the bedside suction to assist with development of this tunnel.

Step 3: Division of the Stomach

At this time, as long as the surgeon is certain that the SMV is free, it is reasonable to divide the stomach (Fig. 13.4). This is completed much earlier in RAPD than OPD, where our practice is to fully commit to PD only after all critical structures are dissected and isolated. The lesser and greater curvature vessels of the stomach are dissected and ligated using the vessel sealer device and the antrum is transected using a Flex 60-mm gold load stapler entered through the 12-mm Airseal port by the bedside assistant (Video 13.1 ref. 0:51″ to 1:10″). Care must be taken to ensure that the nasogastric tube is not included in the staple line. The proximal stomach is reflected toward the patient's left upper quadrant and the transected antrum toward the patient's right side.

Step 4: Hepatic Artery Dissection and Identification of the Gastroduodenal Artery

The lesser omentum is opened and the superior pancreatic node lying just anterior to the common hepatic artery (CHA) (station 8a) is identified. The superior pancreatic node is dissected and sent to pathology for permanent section only (Video 13.1 ref. 1:24″ to 1:57″). It is important to be aware that the CHA lies directly between this node and the superior aspect of the pancreas. If the portal vein is found directly underneath this node, this indicates replaced anatomy. The surgeon must be prepared for a replaced (and not accessory) right hepatic artery.

Then the CHA is traced to the patient's right side until the gastroduodenal artery is identified. It is important to practice good vascular technique and identify the correct "shiny white" plane of the artery to avoid bleeding. The gastroduodenal artery is carefully isolated (Fig. 13.5) and doubly clipped on the patient side and singly clipped on the specimen side with hemolock clips. The artery is transected with robotic scissors, whereas dissection of the vessels is performed using the vessel sealer. Other surgeons may find that the scissors can be useful for dissection.

Step 5: Creation of the Tunnel and Division of the Pancreas

The portal vein at the superior edge of the pancreas is identified. It is normally directly underneath the hepatic artery and to the patient's left of the gastroduodenal artery. The tunnel is completed starting inferiorly from the SMV toward the portal vein superiorly (Video 13.1 ref. 1:59″ to 2:20″) . An umbilical tape is passed through this tunnel so that the pancreas can be pulled anteriorly away from the vein. This is achieved using robotic arm 3 (Si) or robotic arm 4 (Xi) with the prograsp to hold the umbilical tape taut anteriorly. Then the pancreas is transected at the neck using the robotic scissors with electrocau-

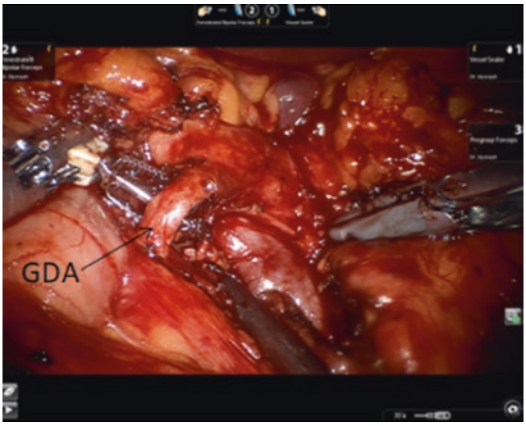

Fig. 13.5 Isolation of the gastroduodenal artery

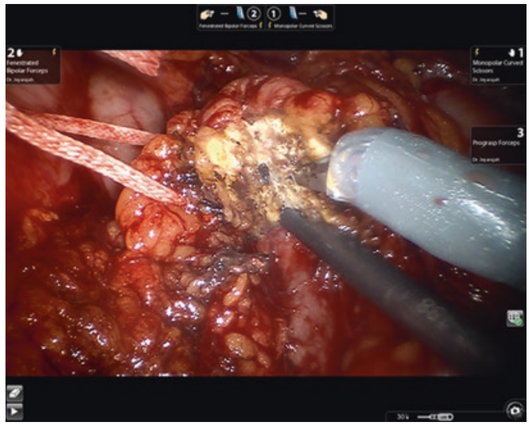

Fig. 13.6 Division of the pancreas, which is held anteriorly with an umbilical tape

tery (Fig. 13.6) (Video 13.1 ref. 2:23″ to 2:36″). The pancreatic duct is identified during the transection. Hemostasis is achieved with monopolar electrocautery attached to the scissors or bipolar energy attached to the fenestrated bipolar instrument. This technique can control bleeding effectively. Notably, some surgeons use the harmonic scalpel to transect the pancreas. While this may reduce bleeding, the pancreatic duct can be obstructed using this technique. In the instance that the pancreas is firm and the pancreatic duct is large, we may elect to use the harmonic scalpel.

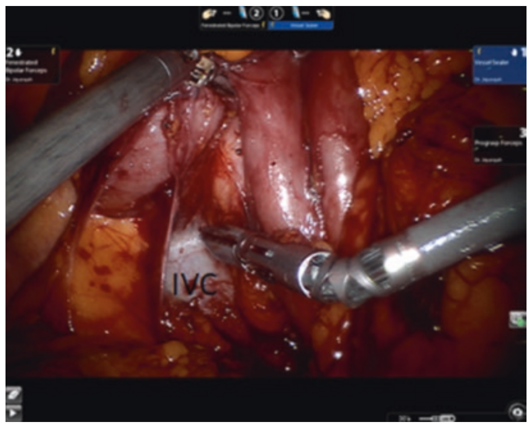

Fig. 13.7 Kocher maneuver exposing the inferior vena cava

Step 6: Kocher Maneuver and Division of the Jejunum

A wide Kocher maneuver is started in retrograde fashion on the right side of the abdomen. This can be very difficult, so it is imperative to mobilize the hepatic flexure completely. In this manner, the duodenum is exposed and can be dissected away from the vena cava (Fig. 13.7). The duodenum is passed to robotic arm 3 (Si) or robotic arm 4 (Xi) using the prograsp to retract the duodenum up and toward the patient's head. The dissection is continued until the ligament of Treitz is reached from the right side of the patient and the proximal jejunum is prolapsed toward the patient's right side. The proximal jejunum is transected using a Flex 60-mm blue load stapler (Video 13.1 ref. 2:38″ to 3:20″). The proximal jejunal mesentery is divided using the vessel sealer and the fourth part of the duodenum is "unwound" such that the duodenum is now straightened and is in the right upper quadrant.

Step 7: Uncinate Process Dissection

At this point, only the uncinate pancreatic process and bile duct are left to be dissected. The uncinate is dissected off the SMA using the

Harmonic scalpel inserted through the assistant port (Video 13.1 ref. 3:22″ to 3:51″). The authors often utilize the SMA first approach, dissecting the mesopancreas off the SMA and then teasing the uncinate process away from the SMV.

Retraction of the uncinate process toward the patient's right side is best achieved with the fenestrated bipolar in robotic arm 2 (Si) or robotic arm 1 (Xi). The robotic suction can be placed to retract the SMV toward the patient's left side. This allows an excellent angle for the bedside assistant to use the harmonic scalpel to take the uncinate process off the SMA. Care must be taken to control the most superior venous branch off the SMV that is always at the most cranial portion of the specimen. This is usually controlled with hemoclips.

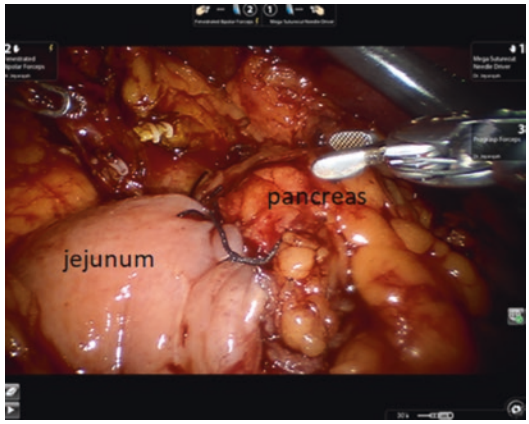

Fig. 13.8 Completed pancreaticojejunostomy with the Blumgart technique

Step 8: Bile Duct Dissection

Next the common hepatic duct is dissected. This is located at the most superior aspect of the specimen, and the lateral common bile duct node will need to be taken to the patient's right of the common hepatic duct. Then, the common hepatic duct is isolated and transected using the robotic scissors. A margin is sent to pathology for frozen section examination at the time of transection of the duct. The entire specimen is placed in a large endocatch bag and placed in the left upper quadrant for later retrieval. It is our preference to leave the specimen in the endobag for the remainder of the operation which usually lasts about 1 hour.

Step 9: Pancreaticojejunostomy

The reconstruction now begins. The transected jejunum is already in the RUQ quadrant. The jejunum is oriented appropriately in a C-loop fashion in the RUQ. An end-pancreas to side-jejunal anastomosis is performed with the Blumgart technique [13]. Three 2-0 silk sutures on MH needles are placed through the pancreas near the transected neck, then to the anti-mesenteric side of the jejunum, and back through the pancreas again in a U stitch configuration. These three silk sutures with needles are left in, and the cephalad most suture is retracted toward the patient's LUQ using the prograsp in robotic arm 3 (Si) or robotic arm 4 (Xi). The pancreatic duct-to-jejunal mucosa inner layer is completed using four 5-0 Monocryl sutures placed at the 3-, 6-, 9-, and 12-o'clock configurations (Video 13.1 ref. 3:55″ to 5:37″). It is useful to use a dyed suture in order to visualize it. We frequently insert a 5-Fr pediatric feeding tube cut at 10 cm into the pancreatic duct and passed through the enterotomy into the jejunum before the last monocryl suture is placed and tied. Then the Blumgart anastomosis is completed by using the three 2-0 silk sutures and taking a bite of the anti-mesenteric side of the jejunum again and tying the silk sutures, thus completing the outer anterior and posterior invaginating layers of jejunum over the transected pancreatic edge (Fig. 13.8).

Step 10: Hepaticojejunostomy

The hepaticojejunostomy is performed next. If the gallbladder remains in place, we use a 2-0 V-Loc suture to tie the fundus of the gallbladder to the anterior abdominal wall, using this method of liver retraction to help visualize the common hepatic duct. An enterotomy in the anti-mesenteric side of the jejunum distal to the pancreatic anastomosis is made, and an end-to-side

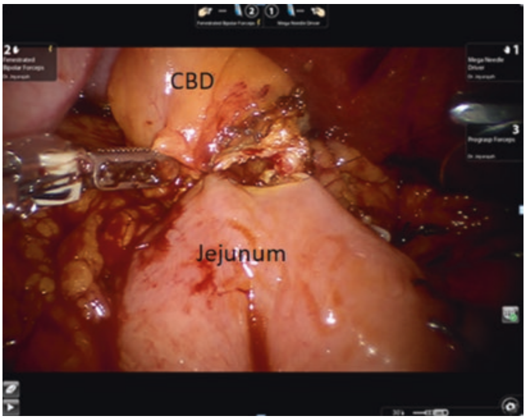

Fig. 13.9 Creation of the hepaticojejunostomy with running 4-0 monocryl suture

hepaticojejunostomy using running 4-0 monocryl suture is created (Fig. 13.9). Some surgeons will use two V-Loc 4-0 sutures for this anastomosis, but the barbs on the V-Loc can be traumatic so it has been our practice to use a 4-0 monocryl suture instead (Video 13.1 ref. 5:39″ to 6:18″) . Afterward, a cholecystectomy is performed. The gallbladder is dissected from the triangle of Calot using the robotic scissors, and the specimen is placed in another endocatch bag and placed in the patient's left upper quadrant for later retrieval.

Step 11: Gastrojejunostomy

The area where the distal jejunum was attached to the stomach is identified. A gastrotomy and enterotomy are made distally on the stomach and jejunum after the small bowel and stomach are lined up. A flex 60-mm blue load stapler is inserted by the bedside assistant, with each lip of the stapler entering into the two holes that were made, and the stapler is fired to create a gastrojejunostomy. The ensuing hole between the stomach and small bowel is closed with a running 2-0 V-Loc suture.

Step 12: Specimen Retrieval

The endocatch bags are retrieved through the 12-mm midline port and hemostasis is achieved. A drain is placed through the R1 port near the pancreaticojejunostomy and hepaticojejunostomy anastomosis. The robot is undocked and moved away. Using laparoscopic camera visualization, the 12-mm camera port is closed with 0-Vicryl suture using an endoneedle device. The abdomen is then deflated, and all ports are removed. The midline 12-mm port site is enlarged to retrieve the specimens. Often, the final incision at this site is no more than 3 cm in length. The fascia at this site is closed with 0 PDS suture and skin is closed with 4-0 monocryl sutures and Dermabond is placed on the skin.

Postoperative Care Algorithm

The majority of the postoperative course after robotic PD is routine and consistent with the ERAS pathway; and most patients are admitted directly to the surgical ward. Patients with perioperative arrhythmia, hypotension, and increased blood loss requiring intraoperative transfusion or patients with significant comorbidities requiring close monitoring may warrant ICU admission. In our practice, patients do well when admitted directly to the floor. Patients are admitted from the OR with an abdominal drain, a nasogastric (NG) tube on low intermittent wall suction, and Foley catheter. Immediate postoperative blood work is obtained. Fluids at slightly higher than maintenance rate are given, and the urine output is trended along with vital signs to evaluate for resuscitation. Pain is controlled in multimodality fashion, with intravenous acetaminophen given for 24 h (Ofirmev, Mallinckrodt Pharmaceuticals), intravenous nonsteroidal anti-inflammatory agents given for 48 h (Caldolor, Cumberland Pharmaceuticals) and patient-controlled analgesia with a narcotic agent such as hydromorphone. Transverse abdominis plane (TAP) block is also administered by anesthesia during the preoperative period using a mix of Exparel (Pacira Pharmaceuticals), 0.25% marcaine, and saline in a 1:1:1 ratio. The patient is maintained nothing per os with limited oral intake, although alvimopan is given postoperatively and continued for 12 days. Pneumatic compression devices are used for deep vein thrombosis (DVT) prophylaxis, but chemical prophylaxis is held in the immediate postoperative period. Per ERAS pathway, patients are encouraged to walk with assistance 4–6 h postoperatively.

On postoperative day (POD) 1, the NGT is discontinued and the patient is placed on sips of liquids, gum, and hard candy. Unless contraindicated, the Foley catheter is removed and intravenous fluids are lowered. Chemical DVT prophylaxis, usually lovenox, is started. Activity is increased, often with help from physical and/or occupational therapy. Drain fluid is sent amylase analysis, and levels three times above normal or greater are considered positive for pancreatic leak [14].

On POD3, diet is slowly advanced to clears and full liquid diet. The patient is weaned from the PCA and started on oral pain medications. If the patient has symptoms of delayed gastric emptying, metoclopramide is given. A second drain fluid is sent for amylase analysis. If the amylase is lower than three times above normal levels, we often remove the drain at this time.

On POD5, the patient is tolerating regular diet. Postoperative pain should be controlled with oral pain medication. If the drain has not been removed, a third fluid sample is sent for amylase check. If the amylase level is lower than three times above normal values, the drain is removed. The patient will be normally discharged between POD4-6 unless complications arise. If drain amylase levels remain high, the patient will be discharged with the drain.

Conclusions

It is well documented that robotic PD is a safe technique in appropriately selected patients with good oncologic and perioperative results. Despite the fact that the daVinci surgical platform offers significant advantages compared to traditional laparoscopy, robotic PD still remains a very complex and challenging procedure with a long learning curve. This is the main reason that robotic PD has not been universally adopted. It is expected that with improved robotic technology, increased competition, and decreasing cost, the utilization of robotic techniques in pancreatic surgery will increase and surgeons will become more proficient and skilled [9]. Following the example of urology and gynecology, many general surgery residency programs provide robotic exposure and have adopted specialized training programs to teach their residents this new technology [9]. On the other hand, the benefit of this rapid adoption of robotic technology must be examined against the backdrop of an expensive health care system.

References

1. Jemal A, et al. Cancer statistics, 2006. CA Cancer J Clin. 2006;56(2):106–30.
2. Whipple AO, Parsons WB, Mullins CR. Treatment of carcinoma of the ampulla of Vater. Ann Surg. 1935;102(4):763–79.
3. Whipple AO. Observations on radical surgery for lesions of the pancreas. Surg Gynecol Obstet. 1946;82:623–31.
4. Mesleh MG, Stauffer JA, Asbun HJ. Minimally invasive surgical techniques for pancreatic cancer: ready for prime time? J Hepatobiliary Pancreat Sci. 2013;20(6):578–82.
5. Gagner M, Pomp A. Laparoscopic pylorus-preserving pancreatoduodenectomy. Surg Endosc. 1994;8(5):408–10.
6. Wang M, et al. Minimally invasive pancreatico-duodenectomy: a comprehensive review. Int J Surg. 2016;35:139–46.
7. Dai R, Turley RS, Blazer DG. Contemporary review of minimally invasive pancreaticoduodenectomy. World J Gastrointes Surg. 2016;8(12):784–91.
8. Peng, L et al. Systematic review and meta-analysis of robotic versus open pancreaticoduodenectomy. Surg Endosc. 2017;31(8):3085–97.
9. Baker EH, et al. Robotic pancreaticoduodenectomy for pancreatic adenocarcinoma: role in 2014 and beyond. J Gastrointes Oncol. 2015;6(4):396–405.
10. Giulianotti PC, et al. Robotics in general surgery: personal experience in a large community hospital. Arch Surg. 2003;138(7):777–84.
11. Kornaropoulos M, et al. Total robotic pancreaticoduodenectomy: a systematic review of the literature. Surg Endosc. 2017;31:4382.
12. Lassen K, et al. Guidelines for perioperative care for pancreaticoduodenectomy: enhanced recovery after surgery (ERAS(R)) society recommendations. Clin Nutr. 2012;31(6):817–30.
13. Blumgart LH. A new technique for pancreatojejunostomy. J Am Coll Surg. 1996;182(6):557.
14. Bassi C, et al. Postoperative pancreatic fistula: an international study group (ISGPF) definition. Surgery. 2005;138(1):8–13.