Surgical Technique

The British technique of purely robotic Whipple's pancreatoduodenectomy a systematic and stepwise ('clockwise') approach

Hassaan Bari[1#^], Adithya Malolan Pathanki[1#^], Zaed Hamady[2], Ali Arshad[2], Declan Dunne[3], Ryan Baron[3], Timothy Pencavel[4], Rajiv Lahiri[4], Tim Worthington[4], Ricky Bhogal[5], Michael Silva[6], Zahir Soonawalla[6], Siong-Seng Liau[7], Jawad Ahmad[1]

[1]Department of HPB Surgery, University Hospitals of Coventry and Warwickshire, Coventry, UK; [2]Department of HPB Surgery, University Hospital Southampton, Southampton, UK; [3]Department of Pancreato-biliary Surgery, Liverpool University Hospitals NHS Foundation Trust, Liverpool, UK; [4]Department of HPB Surgery, Royal Surrey NHS Foundation Trust, Surrey, UK; [5]Department of HPB Surgery, The Royal Marsden NHS Foundation Trust, London, UK; [6]Department of HPB Surgery, Oxford University Hospitals NHS Foundation Trust, Oxford, UK; [7]Department of HPB Surgery, Cambridge University Hospitals NHS Foundation Trust, Cambridge, UK

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[#]These authors contributed equally to this work as co-first authors.

Correspondence to: Mr. Jawad Ahmad, FRCS, Consultant HPB surgeon. Department of HPB Surgery, University Hospitals of Coventry and Warwickshire, Clifford Bridge Road, Coventry, CV2 2DX, UK. Email: jawad.ahmad@uhcw.nhs.uk.

Abstract: The growing trend towards minimally invasive hepato-biliary and pancreatic (HPB) surgery has led to the evolution of multiple techniques in the performance of the pancreaticoduodenectomy (PD), either Whipple's procedure or pylorus-preserving pancreaticoduodenectomy (PPPD), for lesions in the head of the pancreas and other indications. Recent trials have highlighted the limitations of the laparoscopic technique when it comes to PD. The use of robotic assistance allows surgeons to circumvent these limitations and carry out robotic pancreaticoduodenectomy (RPD) with good outcomes. The technique described has been adopted and practiced in multiple UK HPB centres and is based on a collective experience of performing over 200 purely robotic PDs. The technique has been implemented in over 20 robotic HPB centers across the UK and Europe and has been widely adopted as the go-to technique in the implementation of RPD. The method is described as distinct steps to allow for a systematic stepwise approach to the procedure. This technique is particularly suitable for all cases where there is no risk of vascular involvement, as confirmed by a preoperative scan conducted two weeks prior to surgery, especially in malignant conditions. A video description of all the steps is included with the publication. The method described has been adopted successfully in HPB programs across the UK and some European centers, with some variations according to local preferences. A separate article is being constructed with the data on short and long-term outcomes being collated across the UK centers in a prospective manner. This paper is to share the British technique of purely robotic PD.

Keywords: Robotic pancreaticoduodenectomy (RPD); minimally invasive pancreatic surgery; robotic technique; Whipple procedure

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^ ORCID: Hassaan Bari, 0000-0001-7098-6942; Adithya Malolan Pathanki, 0000-0002-9796-1689.

Introduction

Background

Pancreaticoduodenectomy (PD), eponymously known as the Whipple's procedure, is one of the most complex operations in abdominal surgery. It is primarily performed for malignancies of the pancreatic head and periampullary region, and other indications include pre-malignant lesions of the duodenum, pancreatic head and distal bile duct. Despite its potential for curative outcomes, the procedure presents significant challenges due to the intricate dissection required around major vascular structures and the demanding reconstruction involving the gastrointestinal, biliary, and pancreatic tracts. Traditionally, PD has been performed using an open approach [open pancreaticoduodenectomy (OPD)], which allows direct access to these critical structures.

The growing trend towards minimally invasive surgery (MIS) led to the development of laparoscopic PD (LPD), albeit with limited success. The limitations of the laparoscopic approach are especially evident in PD, where the long and complex nature of the operation is limited by the capabilities of laparoscopy. The lack of depth perception and restricted instrument mobility in traditional laparoscopy heighten the technical difficulty of performing precise dissections near major blood vessels. Furthermore, laparoscopic suturing of the gastrointestinal, biliary, and pancreatic anastomoses, required to restore digestive continuity, demands exceptional expertise and can be a source of frustration even for experienced surgeons (1). As a result, LPD has not gained widespread adoption, and concerns about its safety have been raised. Recent trials, such as the LEOPARD-2 trial, highlighted these issues by demonstrating a higher rate of complication-related deaths in LPD compared to open surgery, further limiting its application (2).

Highlight box

Surgical highlights

- The robotic approach to the Whipple procedure allows for greater precision in delicate tissue dissection and reconstruction.

What is conventional and what is novel/modified?

- Open surgical techniques are often employed in these complex procedures, offering the surgeon direct visualization and enhanced tactile feedback. Increasing shift towards minimally invasive surgery has led to the development of laparoscopic pancreaticoduodenectomy (PD). However, the limitations of the laparoscopic approach are particularly evident in PD, a complex and lengthy procedure that can be frustrating even for experienced surgeons.
- Robotic pancreaticoduodenectomy (RPD) provides several technological advantages, particularly with magnified, three-dimensional vision and EndoWrist instruments, which offer more than 360 degrees of movement. These features help to address the limitations of laparoscopy, allowing surgeons to perform more precise dissection and reconstruction.

What is the implication, and what should change now?

- There is no unified approach to RPD, variations in how the dissection, resection, and reconstruction are carried out create further variability in the published data. Despite these complexities, RPD continues to gain traction over both laparoscopic and open techniques.
- A standardized technique for a fully robotic pancreaticoduodenectomy, can help improve the surgical quality and lead to better operative outcomes.

Rationale

In contrast, the advent of robotic systems has opened new possibilities for minimally invasive pancreatic surgery, including PD. Robotic pancreaticoduodenectomy (RPD) offers several technological advantages over laparoscopy, primarily due to the stable and magnified three-dimensional visualization it provides, as well as the EndoWrist instrumentation with its more than 360-degree range of motion. These features help address the limitations of traditional laparoscopy, offering surgeons greater precision during the delicate dissection and reconstruction phases of the operation. The enhanced ergonomics and improved dexterity afforded by the robotic platform may also shorten the learning curve and broaden the adoption of minimally invasive PD (3-7).

Several small series have reported on the efficacy of RPD in well-selected patient populations, suggesting advantages such as reduced estimated blood loss (EBL), shorter hospital stays, and faster recovery times compared to OPD, without compromising oncologic outcomes. However, these studies are often subject to patient selection bias, as well as performance bias related to the surgeons' experience and learning curve. Furthermore, there is no standardized technique for RPD, with variations in both the type of Whipple's procedure performed—pylorus-preserving versus classic—the method of digestive tract reconstructions, which may involve either pancreatogastrostomy or pancreatojejunostomy and the order in which the dissection proceeds (8,9).

Additionally, differences in how the dissection, resection, and reconstructions are carried out (entirely robotic, partly laparoscopic, or partly open) add further heterogeneity to the published data. Despite these challenges, RPD continues to gain ground on both laparoscopic and open techniques for select patients.

Objective

The aim of this paper is to describe a standard technique for a fully RPD, as performed by the lead author, the main UK-based proctor for hepato-biliary and pancreatic (HPB) surgery. All contributing surgeons have significant experience in establishing and leading robotic pancreatic surgery programs at their respective centers in UK. We present this article in accordance with the SUPER reporting checklist (available at https://hbsn.amegroups.com/article/view/10.21037/hbsn-2025-137/rc).

Preoperative preparations and requirements

Patient selection

At the author's centre, all patients are discussed in HPB multidisciplinary team (MDT) discussion. High-quality, up-to-date imaging [triple phase computed tomography (CT)] prior to the operation is obtained to allow for planning and to ascertain and confirm resectability. magnetic resonance cholangiopancreatography (MRCP) was used selectively based on MDT discussion, clinical judgement and imaging needs. Current practice is to proceed with resectable [National Comprehensive Cancer Network (NCCN)] cases as robotic procedures in the setting of pancreatic malignancy (10). Borderline resectable/locally advanced cases usually undergo a course of neo-adjuvant chemotherapy/chemoradiotherapy as directed by the regional multidisciplinary team, followed by open exploration with a view to performing a Whipple's procedure. The patients are often assessed for fitness objectively using CPEX and those with borderline outcome metric are taken through a process of prehabilitation with the physiotherapy team with a view to improving fitness prior to the procedure. Closer to the time of the operation, patients are reassessed and are often admitted to the ward early on the morning of the procedure. All procedures performed in this article were in accordance with the ethical standards of the institutional and/or national research committee(s), and with the Helsinki Declaration and its subsequent amendments. Written informed consent was obtained from the patients for the publication of this article, accompanying images and video. A copy of the written consent is available for review by the editorial office of this journal.

Preoperative imaging

A pancreatic protocol CT scan is obtained and discussed in regional MDT and with a dedicated HPB radiologist with regard to:

- ❖ Tumor location, size and surrounding venous and arterial vessel involvement;
- ❖ Recognizing any arterial anomaly, origin of gastro-duodenal artery (GDA), inferior pancreaticoduodenal artery (IPDA) and pancreatic duct location and size.

Pre-operative preparation in theatre

Pre-operative carbohydrate loading drinks are given to the patient in keeping with the local enhanced recovery after surgery (ERAS) protocol. From the anesthetic perspective, induction is carried out on the operating table, which is appropriate for the "French" position that the patient would be in for the duration of the procedure. The standard technique includes intra-thecal morphine, arterial line, central line, Foley's catheter, pneumatic compression devices and nasogastric tube insertion. An epidural is avoided at the start as intrathecal morphine is felt to be the appropriate modality of neuraxial analgesia to cover all bases. The patient's arms are wrapped, and appropriate warming measures are placed.

Robotic system

This protocol is specifically applicable to the Intuitive (Sunnyvale, CA, USA) da Vinci surgical system (Si, X, Xi). As of the time of writing, robotic surgical systems from other manufacturers had not yet been approved for use in major hepato-biliary procedures in UK and Europe.

Surgical team

A surgical team typically comprises an operating surgeon and two bedside assistants, one of whom is a trainee doctor and the other is a surgical care practitioner nurse. The bedside assistant works between the patients' legs

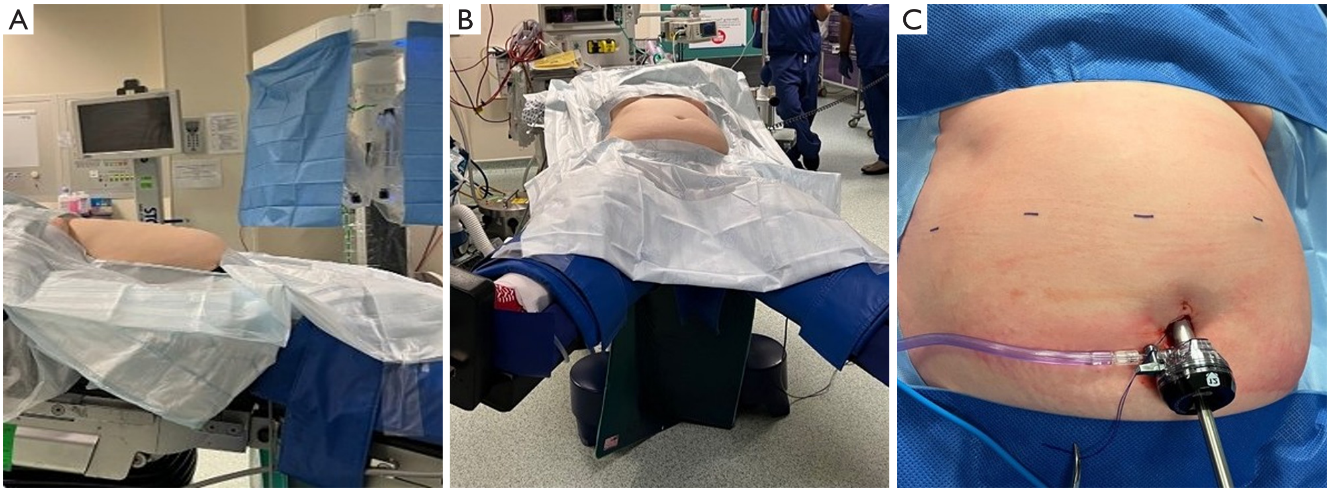


Figure 1 Positioning and ports placement. (A) 15° head up; (B) 'French position', placing the patient supine with their legs spread apart, allowing the assistant to stand between the patient's legs; (C) standard ports placement for robotic pancreaticoduodenectomy. Four ports, 8 mm each are placed in a straight line across the upper abdomen, roughly 8 cm apart. The 12 mm assistant port is placed below the umbilicus.

and is expected to have the necessary basic and advanced laparoscopic skills to assist the console surgeon safely. He/she is also expected to play a role in the situation where conversion from a robotic to an open procedure is required and assist the console surgeon. The surgical care practitioner nurse helps in carrying out the smooth exchange of instruments and maintains the correct positioning of the robotic arms throughout the procedure.

Ports placement and patient positioning

The patient's habitus is considered during port placement. Open sub-umbilical peritoneal entry is the authors' preferred method of pneumoperitoneum creation. The insufflation is optimized with the AirSeal™ or standard insufflation systems, and 8 mm robotic ports are used as standard (*Figure 1*). The ports across the upper abdomen are placed in a straight line as recommended for the DV Xi system. The standard ports are in the right anterior axillary line, right mid-clavicular line, paramedian/midline and left mid-clavicular line. The patient is placed in a 15–20° reverse Trendelenburg position and with a mild 5° left side tilt. In low body mass index (BMI) patients, the 1st open 12 mm assistant port is placed halfway between the umbilicus and the pubic symphysis, and the robotic ports are placed at the level of the umbilicus in a straight line. In high BMI patients, the 1st open 12 mm assistant port is placed supraumbilical and the robotic ports are placed halfway between the xiphisternum and the umbilicus. The instruments utilized by robotic arms at various stages of the procedure, as well as those employed by the bedside assistant, are detailed in *Table 1*.

Robot docking and falciform stitch

For the purposes of this description, the DaVinci Xi platform is used. A diagnostic laparoscopy is carried out prior to docking the DaVinci Xi. Adhesionolysis, if needed, is carried out to allow for all ports to be placed safely. The authors' preferred initial step after assessment is to secure a transabdominal stitch to hold the falciform ligament up to the abdominal wall. The authors' preference is to use a 2/0 Prolene stitch on a straight needle to place the trans-abdominal suture. In addition to keeping the falciform out and hitched up to the abdominal wall, the stitch reduces the amount of retraction needed on the liver (*Figure 2*).

Tips

- ❖ At the start of surgery, the lower drape on patient, when fashioned into a "pouch" by being folded over itself, is a useful measure to store robotic instruments

Table 1 Instrumentation per operative step including resection and reconstruction phase

Operation steps	Robotic arm 1	Robotic arm 2	Robotic arm 3	Robotic arm 4	Bedside surgeon
Resection phase					
Duodenum	Fenestrated bipolar	Camera	Cautery hook; vessel sealer	Cadiere forceps	Lap grasper; lap fan retractor
Hilum	Fenestrated bipolar	Camera	Cautery hook; maryland bipolar; 8 mm SureForm 30; large clip applier; monopolar scissors	Cadiere forceps	Lap grasper; Hem-o-lock; applicator; bulldog grasper; suction
Stomach	Fenestrated bipolar	Camera	Cautery hook; vessel sealer; 8 mm SureForm 30	Cadiere forceps	Lap grasper; suction
Port hopping					
SMV	Cadiere forceps	Fenestrated bipolar	Camera	Cautery hook; vessel sealer; large clip applier; maryland bipolar; monopolar scissors	Lap grasper; suction
Pancreatic neck	Cadiere forceps	Fenestrated bipolar	Camera	Cautery hook; vessel sealer; large clip applier; maryland bipolar; monopolar scissors	Lap grasper; suction; lap ultrasound probe
Jejunum	Cadiere forceps; vessel sealer	Fenestrated bipolar	Camera	Cautery hook; vessel sealer; 8 mm SureForm 30	Lap grasper; suction
Uncinate	Cadiere forceps	Fenestrated bipolar	Camera	Vessel sealer	Lap grasper; suction
Reconstruction phase					
Pancreatic anastomosis	Large needle driver	Fenestrated bipolar	Camera	Large suture cut; needle driver; monopolar scissors	Lap grasper; suction; needle holder; bulldog grasper
Biliary anastomosis	Large needle driver	Fenestrated bipolar	Camera	Large suture cut needle driver; monopolar scissors	Lap grasper; suction; needle holder; bulldog grasper
Gastric/duodenal anastomosis	Large needle driver	Fenestrated bipolar	Camera	Large suture cut needle driver; monopolar scissors	Lap grasper; suction; needle holder

Lap, laparoscopic; SMV, superior mesenteric vein.

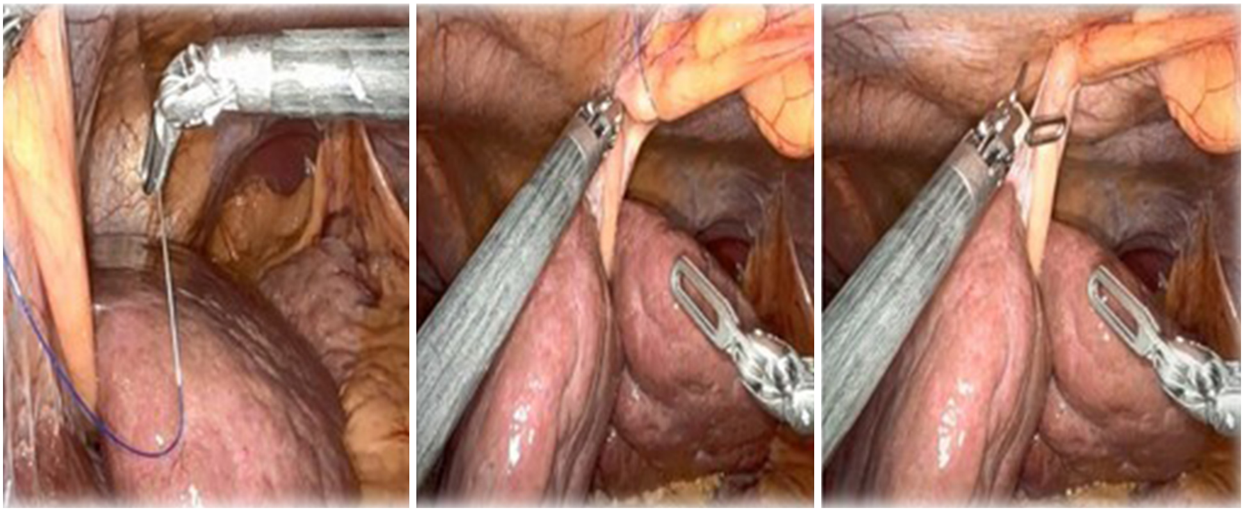


Figure 2 Falciform is stitched to the abdominal wall with prolene 2/0 on a straight needle.

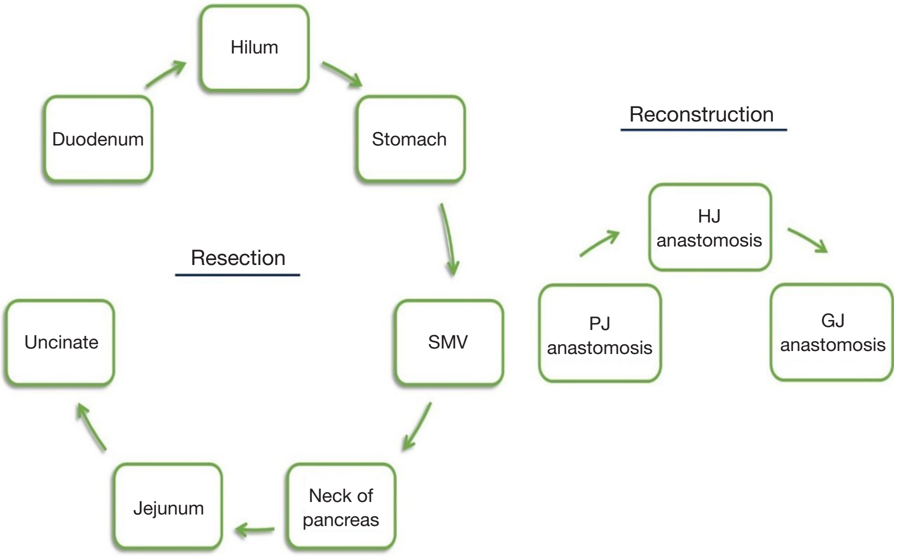


Figure 3 Scheme and steps of robotic pancreaticoduodenectomy, including resection and reconstruction phases. GJ, gastro-jejunostomy; HJ, hepatico-jejunostomy; PJ, pancreatico-jejunostomy; SMV, superior mesenteric vein.

and allow the bedside assistant to change instruments quickly.

- ❖ The falciform stitch allows for smoother and uninterrupted instrument exchanges on the left-sided ports (*Figure 2*).

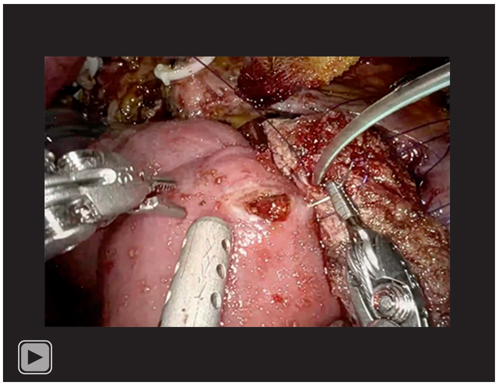
Step-by-step description

Similar to the open approach, the robotic Whipple's operation is performed in two phases, resection followed by reconstruction (*Figure 3*). All steps of the resection and reconstruction are depicted in *Video 1*.

Step 1—duodenum: hepatic flexure mobilisation, duodenal kocherisation, division of ligament of Treitz

Once the falciform stitch is in place, it is the authors' routine practice to mobilise the hepatic flexure of the colon to provide for better space during the further steps of the operation. The aim of dissection is to adequately mobilise the hepatic flexure from cecum to the middle of transverse colon, as it then stays out of the way for rest of the operation and provides generous space for uncinate dissection later.

Duodenal mobilisation then begins. In the earlier stages of the dissection, the Cadiere in arm 4 is used to retract the liver upwards, and as the dissection proceeds down further along the duodenum, this retraction changes to lifting the duodenum off the retroperitoneum to provide visualisation of the retroperitoneal structures (*Figure 4*), allowing complete mobilisation to the duodeno-jejunal (DJ) flexure by providing incremental retraction up towards the abdominal wall and towards the left shoulder. This also ensures good capture of the lymph nodal tissue behind the pancreas. If dissection and lymphadenectomy of the inter-aortocaval groove is needed, it can be carried out at this time point.



Video 1 Purely robotic Whipple's procedure.

Care is taken to completely release the ligament of Treitz from the right-sided view. From this perspective, it can be noted that the ligament attaches to the DJ flexure across 270° with the mesentery proving to be the mobile area. It is important to walk down D3 and D4 with Cadiere (R4) and roll it out like a cogwheel to completely release the ligament on all sides (which is holding DJ flexure in a U-shaped manner). Once all three sides are released, it allows the jejunum to slide up easily to the right side via the natural DJ passage.

Tips

- In cases with biliary obstruction and/or a large gall bladder, performing the cholecystectomy at the start will prevent the gall bladder from dropping into the dissection field.

Step 2—hilum: cholecystectomy, hepatic hilar dissection, division of GDA

This step usually begins with the cholecystectomy in a standard manner, with the gallbladder left attached to the bile duct. The dissection is then carried across the porta hepatis to define the bile duct, and subsequently the arteries. The peri-choledochal and porta hepatis nodes are dissected off at this time and harvested as specimen. Similar dissection is carried out over the hepatic artery as well to

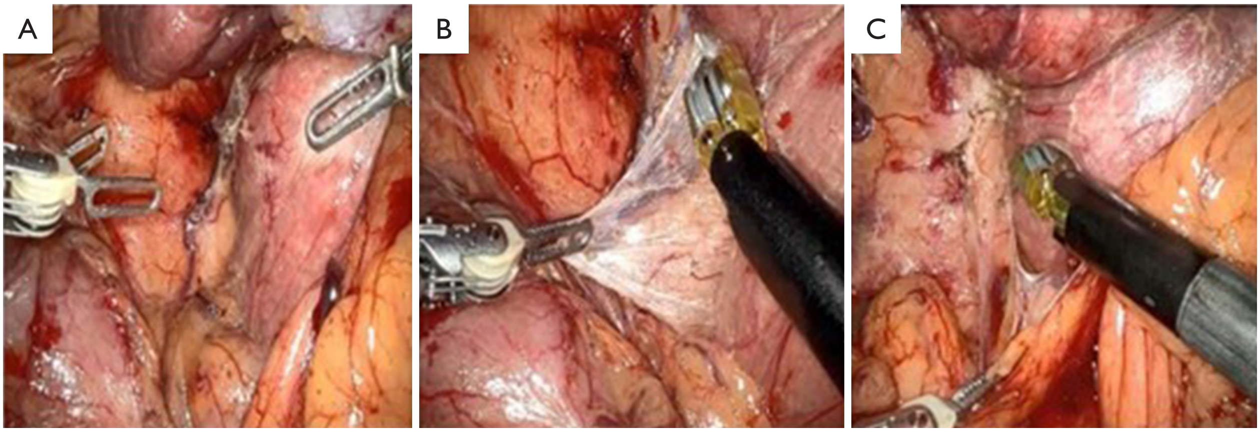


Figure 4 Duodenum. Kocherisation involves (A) retraction of the duodenum by lifting with Cadiere; (B) the hook diathermy is used to enter the correct plane and separate the duodenum from retroperitoneal structures; (C) the ligament of Treitz is opened from the right side and mobilised completely.

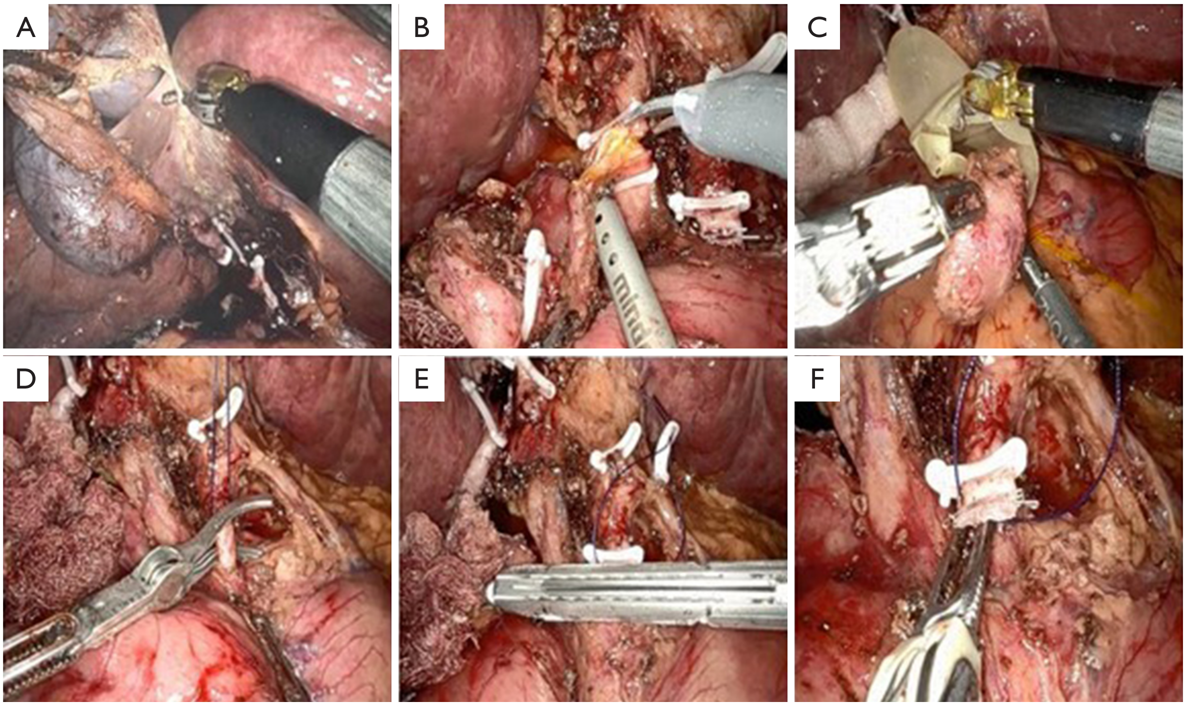


Figure 5 Hilum dissection starts with (A) standard cholecystectomy and gall bladder is left attached to bile duct; (B) proximal and distal bile duct control is achieved, secured with hem-o-locks and divided above cystic duct junction with scissors; (C) station 8 lymph node is retrieved separately; (D) GDA control is achieved, test-clamped by placing a bulldog; and (E) divided with SureForm; (F) GDA stump after stapler. GDA, gastroduodenal artery.

define and retrieve the station 8 node. The bile duct is defined, encircled and can be controlled proximally with a laparoscopic bull-dog clamp or a Hem-o-lok® to avoid bile spillage (which is then excised with a cuff of bile duct before the anastomosis). The lower end is often controlled with a Hem-o-lok® clip or tie and the bile duct is transected.

The dissection is then carried downwards with the division of the relevant lympho-neural tissues of the porta to define the proper hepatic artery and the right gastric artery (RGA) and GDA. The RGA and vein are transected between double placed hem-o-lok® clips; attempts are made to preserve RGA in cases where pylorus-preserving pancreaticoduodenectomy (PPPD) is performed. The GDA is then encircled and controlled with a short 10 cm 2/0 Vicryl tie. The vessel is test clamped by placing a soft DeBakey bulldog clamp and after confirmation of good hepatic arterial inflow, the GDA is divided with da Vinci 8 mm SureForm 30 Curved-Tip stapler (white cartridge) (*Figure 5*) or with double clipped (with two Hem-o-lok® clips). The proximal stump can be oversewn with 4/0 Prolene. The division of the GDA opens access to the portal vein superior to the neck of the pancreas. The soft tissue covering the portal vein is cleared and the cranial end of the superior mesenteric vein (SMV)/portal vein (PV) tunnel is exposed and defined. There are some variations with regard to control of GDA control and resection techniques, according to local preferences.

Tips

- ❖ The laparoscopic bulldog clamp or Hem-o-lock on the proximal end of the transected bile duct should be placed a few millimetres distal to the planned level of anastomosis [hepatico-jejunostomy (HJ)]. This will allow for a further resection of the bile duct margin at the time of the anastomosis and the possibility to revise the bile duct further in case of a positive frozen section (*Figure 5B*).

Step 3—stomach: opening the lesser sac, division of gastroepiploic vessels, transection of the stomach/duodenum

This step begins with the entry into the lesser sac. The

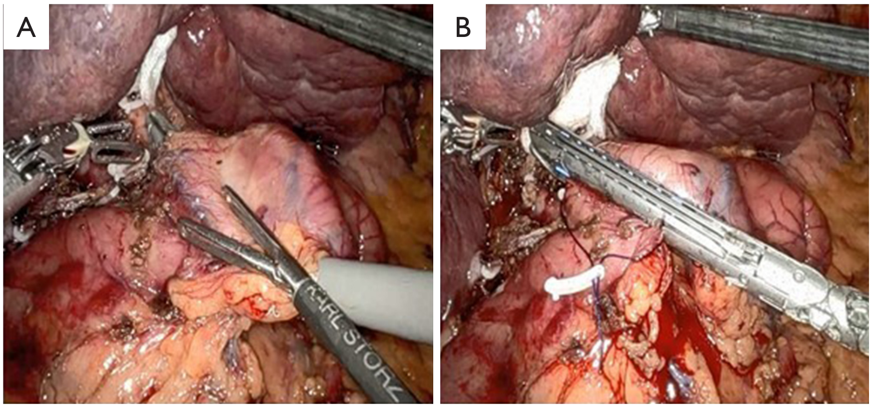


Figure 6 Stomach. (A) First part of duodenum is lifted off and a window is created in lesser sac; (B) SureForm is used to transect the first part of duodenum.

authors' preference is to use a vessel sealer for this step and to stay inferior to the gastric arcade along the greater curvature. A wide area of the lesser sac is opened and the distal stomach or first part of duodenum in the situation of a pylorus preserving operation (PPPD) is mobilised off the pancreas. The pars flaccida is also opened and a wide window is created for the transection.

The area of transection of the stomach is defined after controlling the right gastro-epiploic vessels with Hem-o-lok® clips. Similar definition is carried out for the first part of the duodenum in the case of a pylorus-preserving PD. The stomach/D1 is then stapled across with a da Vinci 8 mm SureForm 30 Curved-Tip stapler (blue cartridge) or with a laparoscopic stapler from the midline assistant port (two fires of a blue cartridge on a 60 mm laparoscopic stapler) (*Figure 6*).

Tips

- ❖ Transection of the stomach before defining inferior border of pancreas allows greater access to the neck of the pancreas for the forthcoming steps. The anaesthetist should be reminded to withdraw the Ryle's tube into the proximal stomach prior to the stapler being engaged to avoid inadvertent stapling of NG tube while gastric transection.

Step 4—SMV: ***pancreatic dissection*, *Tunnel*, *Henles trunk***

The inferior border of the pancreas is identified at the neck of the pancreas. The aim is to define the SMV in this area. Well-mobilised hepatic flexure and duodenum play a key role in this step. Port hopping at this stage allows for two working ports on the right side of the abdomen for better traction and control of the pancreaticoduodenal complex on the right side of the abdomen and with the camera in the median/paramedian position (R3), allows better visualisation of the SMV tunnel.

The gastrocolic arterial trunk and venous trunk of Henle is controlled with a Vicryl tie and is ligated and divided. The division of the gastrocolic trunk is often key to gain wide exposure to the SMV as it approaches its confluence with the splenic vein (SV) behind the neck of the pancreas (*Figure 7*). The authors find greater advantage in mobilising the pancreas off the SMV and SV just to the left of the confluence, allowing for greater access to the vein at the neck and a safer approach for the SMV tunnel. The neck of the pancreas is not routinely slooped before division, as it offers no added advantage as such, and care is taken to preserve any jejunal branches draining into the SMV in this area.

Tips

- ❖ A controlled retraction of mesentery during dissection of SMV and developing tunnel at the neck of pancreas is extremely important. Care should be taken to avoid traction injuries to the venous tributaries to the SMV/PV complex, especially the transected Henle's trunk. It is worthwhile at the start of this step to remind the theatre team and bedside assistant about the risk of bleeding due to excessive traction or avulsion of mesenteric veins, which may need an emergency conversion and to ensure good preparedness.

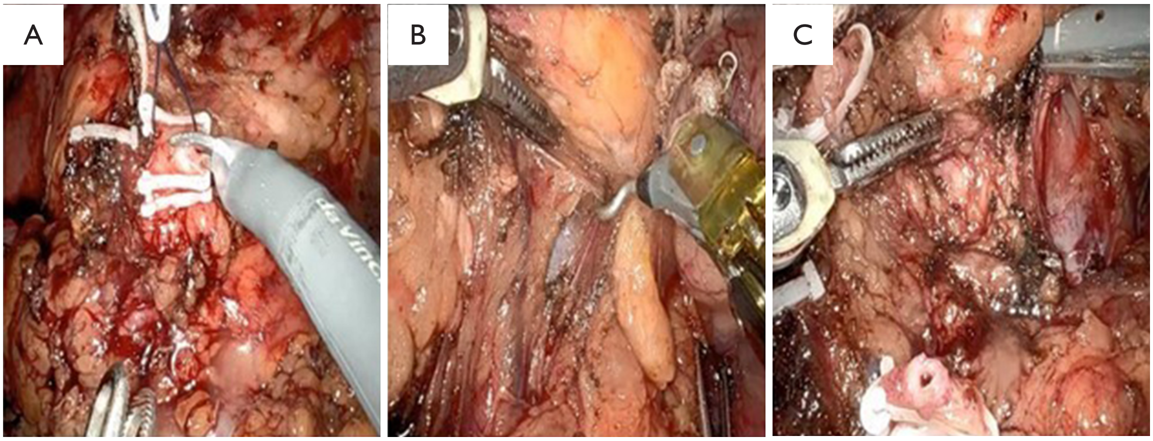


Figure 7 SMV. (A) Early control and division of gastrocolic trunk helps in reaching; (B) the SMV at inferior border of pancreas; (C) pancreas is mobilised off SMV at neck. SMV, superior mesenteric vein.

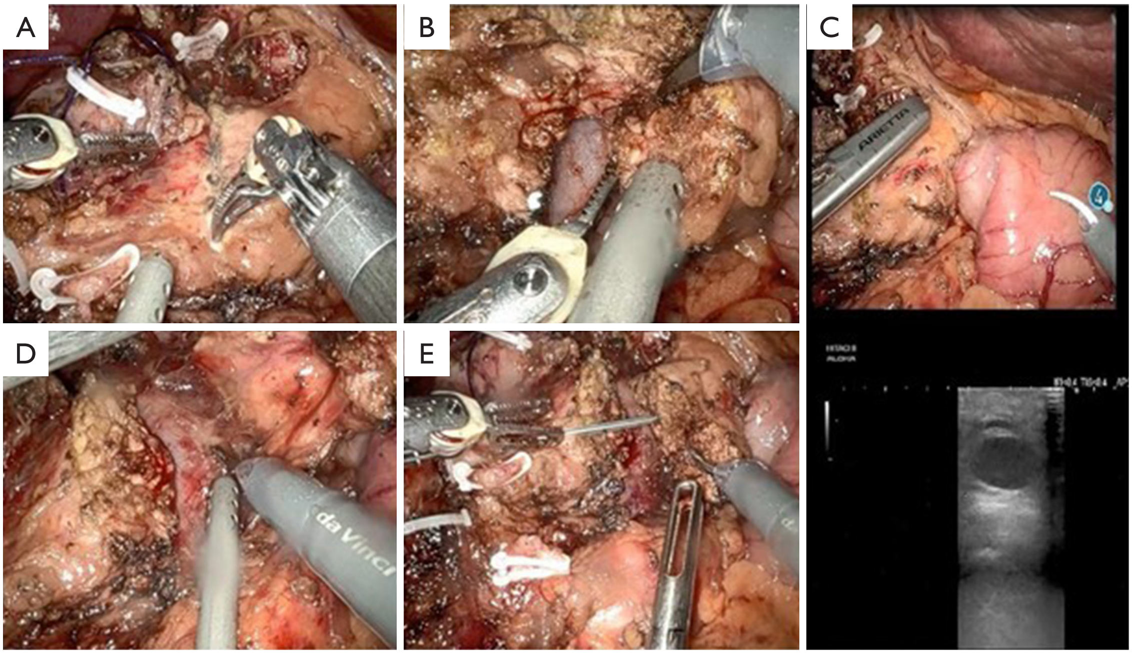


Figure 8 Neck of pancreas. (A) Demarcation of pancreatic neck; (B) division of pancreas with monopolar-scissor and bipolar; (C) IOUS is done to identify the expected location of pancreatic duct and avoid use of energy in that area; (D) distal pancreas is mobilised off SMV/SV junction in preparation of PJ anastomosis; (E) appropriate size feeding tube is placed in pancreatic duct in distal stump. IOUS, intraoperative ultrasound; PJ, pancreatico-jejunostomy; SMV, superior mesenteric vein; SV, splenic vein.

Step 5—neck of pancreas: *transection*

With adequate exposure and access to the neck of pancreas, the transection is commenced. This is carried out primarily in a caudo-cranial direction with robotic scissors and monopolar diathermy until the duct is transected. The duct is identified and transected cold. Further transection after the duct is completed with the vessel sealer and bipolar diathermy for haemostasis. The authors do not routinely use stay sutures or trans pancreatic sutures (*Figure 8*).

In cases where the pancreatic duct is very small, it is

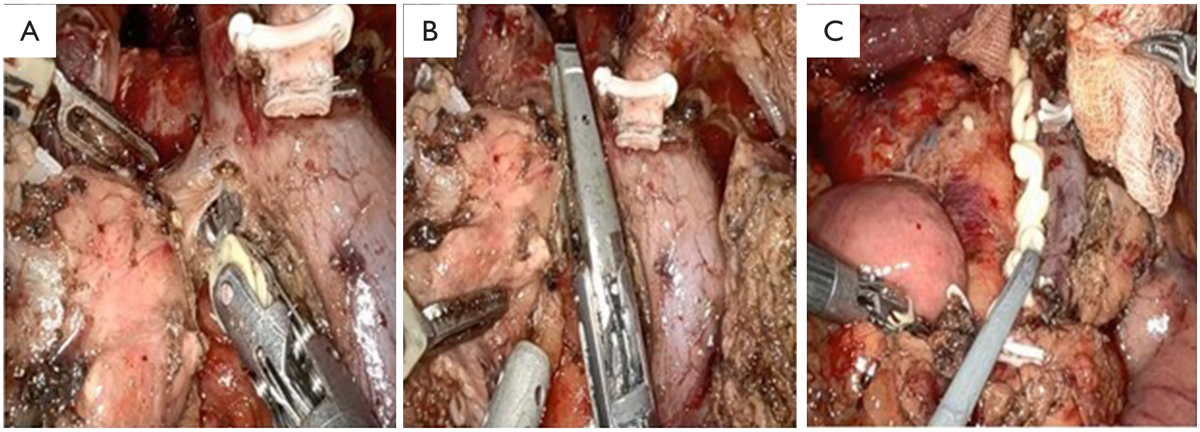


Figure 9 Uncinate. (A) Careful dissection and control of venous branches along right lateral border of SMV is take; (B) division of veins with vessel sealer; (C) specimen is completely removed from SMV and the remaining distal stump is covered with a haemostatic agent (floseal was used in this case). SMV, superior mesenteric vein.

important to localise the duct on the preoperative CT scan and use perioperative ultrasound scan to localise the duct. Once the specimen is dissected and if the duct is still not visible, carefully inspect the head of the pancreas which can give a useful indicator of the position of the duct in the neck of pancreas.

The tunnel is completed as the transection progresses and the pancreas is lifted off the SMV/PV complex to complete the transection. Complete hemostasis is ensured on both the specimen and pancreatic remnant sides prior to proceeding. An appropriately sized feeding tube/stent is placed in the pancreatic duct to allow for easy localisation afterward and to allow for it to dilate prior to the anastomosis. The neck of the pancreas and remnant is mobilised off the SMV/PV complex to allow for better retraction and greater manoeuvrability at the time of the pancreatic anastomosis.

Tips

❖ Intraoperative laparoscopic ultrasound probe can be used to locate the pancreatic duct before pancreatic transection, especially in cases where duct is nondilated on preoperative scans (*Figure 8C*).

Step 6—jejunum: *deliver and divide*

Once the SMV/PV complex is exposed and the pancreas is split, the dissection proceeds back to the right side. After the complete division of the ligament of Treitz, the jejunum is mobilised and brought to the right side of the abdomen by rotating it in a clockwise manner. Enough jejunum is delivered across the natural DJ passage to allow it to rest in the right side of the abdomen and not allow it to slip back down to the left side. The mesenteric window of the jejunum is opened, close to the bowel, taking care to create a wide enough band of sealed mesenteric tissue for hemostasis. The jejunum is divided with da Vinci 8 mm SureForm 30 Curved-Tip stapler or stapled with a blue cartridge reload on a laparoscopic stapler from the assistant port. The mesentery from the jejunum on the specimen side is then released from the bowel using the Vessel Sealer or bipolar until the uncinate process and retroperitoneal tissue behind the pancreas is revealed, and the uncinate dissection can commence.

Step 7—uncinate: *dissection and resection of specimen*

The final part of the resection is to release the uncinate process off the SMV, SMA and retroperitoneal lympho-neural connections. This naturally continues from the release of the jejunum and division of the jejunal mesentery of the specimen. The uncinate is dissected off in three layers with alternate use of diathermy and the vessel sealer (*Figure 9*). The three layers encountered are the venous layer adjacent to the SMV/PV complex; the arterial layer, adjacent to the SMA, and the posterior-most-adventitial layer to remove the specimen off the retroperitoneum.

During the dissection of the venous layers, care is taken to release the SMV and PV to at least two-thirds of their circumference so that it can be rolled over to the left side and expose the SMA well. The jejunal veins are safeguarded initially and small pancreatic branches draining into the jejunal branches can often be controlled well with the vessel sealer. The dissection proceeds in a cranial direction and the most cranial structure encountered in this plane is the superior pancreaticoduodenal vein. This is left attached for as long as feasible to prevent the specimen from becoming congested.

The arterial layer proceeds similarly adjacent to the SMA. The IPDA is identified, isolated and secured with either da Vinci 8 mm SureForm 30 Curved-Tip stapler or Hem-o-lok® clips or with a vascular stapler (white cartridge), depending on the size and peri-vascular tissue thickness. Once released, dissection can be taken along with judicious use of the vessel sealer in thin layers.

The third adventitial layer is amenable to resection with the vessel sealer, and any large chylous branches are secured with a clip. The last structure to be divided is the superior pancreaticoduodenal vein (Belcher's vein) and this is often large enough to need a da Vinci 8 mm SureForm 30 Curved-Tip stapler or stapler transection with a 35 mm white cartridge. This releases the specimen, which is bagged and placed in the right iliac fossa, out of the way of reconstruction.

Steps of reconstruction

The authors' preference is a single loop pancreatico-jejunostomy (PJ), HJ and gastro-jejunostomy (GJ). There are some variations with regard to reconstruction techniques, according to local preferences.

Step 8—pancreatic anastomosis

The authors prefer a modified Blumgart style, end-to-side pancreatic anastomosis technique. The staple line of the jejunal transection may be reinforced with a 3/0 polydioxanone suture (PDS) or V-loc® suture prior to commencement of the anastomosis. The outer pancreatic parenchymal sutures are placed in a cranio-caudal direction and allow for approximation of the bowel and the cut surface of the pancreatic stump. This is placed as a mattress suture with 3/0 Prolene, on a straightened 23 mm needle on 22 cm length. The needle is left on the suture, and this is used for the anterior layer to complete the invagination. The duct-to-mucosa component of the anastomosis is carried out with a 5/0 PDS suture on 8–10 cm length (needle 18 mm) over a stent (either biodegradable or an appropriately sized feeding tube. These sutures are placed in a deep-to-superficial sequence to allow for all sutures to be taken under direct vision without compromising on the access, in a circumferential fashion and tied sequentially (*Figure 10*). The Toronto video atlas has produced a useful animation which is similar to our technique (11).

Step 9—biliary anastomosis

End-to-side hepaticojejunostomy is then performed with a 4/0 or 5/0 PDS. Two stay sutures are placed at 3 and 9 o'clock positions using PDS suture on 22 cm length. The stay suture at 9 o'clock is held in a bulldog and flipped over the liver retracting instrument to offer steady traction and prevent rotation of the bile duct onto the bowel (*Figure 11*). Depending on the size of the duct, for larger sized ducts, the posterior wall is continuous with interrupted sutures placed anteriorly. In smaller ducts, both the anterior and posterior wall are carried out in an interrupted fashion.

Step 10—gastric or duodenal anastomosis

A 50–70 cm loop of small bowel is measured to prevent afferent loop reflux and the small bowel is brought up in an antecolic fashion to lie adjacent to the stomach. The standard anastomosis is an end-to-side gastro-jejunal anastomosis. This is carried out with an anchoring sero-submucosal layer posteriorly and a single continuous full thickness layer all around using 3/0 stratafix or v-lock on a 23 cm suture. Alternatively, a side-to-side gastrojejunostomy is fashioned if feasible by firing da Vinci 8 mm SureForm 30 Curved-Tip stapler, twice or a laparoscopic stapler via the assistant port. The enterostomy site is closed in single layer with 3/0 PDS barbed sutures. In cases where the pylorus is preserved, an end-to-side duodeno-jejunal anastomosis is fashioned with 3/0 anchoring sero-submucosal layer posteriorly and a single continuous full-thickness layer all around.

Tips

- ❖ The use of barbed sutures (e.g., V-loc® or Stratafix®) should be avoided on the biliary anastomosis due to the risk of a bile leak, especially, in cases where the bile duct is not dilated or thickened due to previous treatment (ERCP stent insertion).
- ❖ The use of a laparoscopic bull-dog clamp during pancreatic and biliary anastomosis as a stay allows the sutures to stay lined and taut and prevents them from

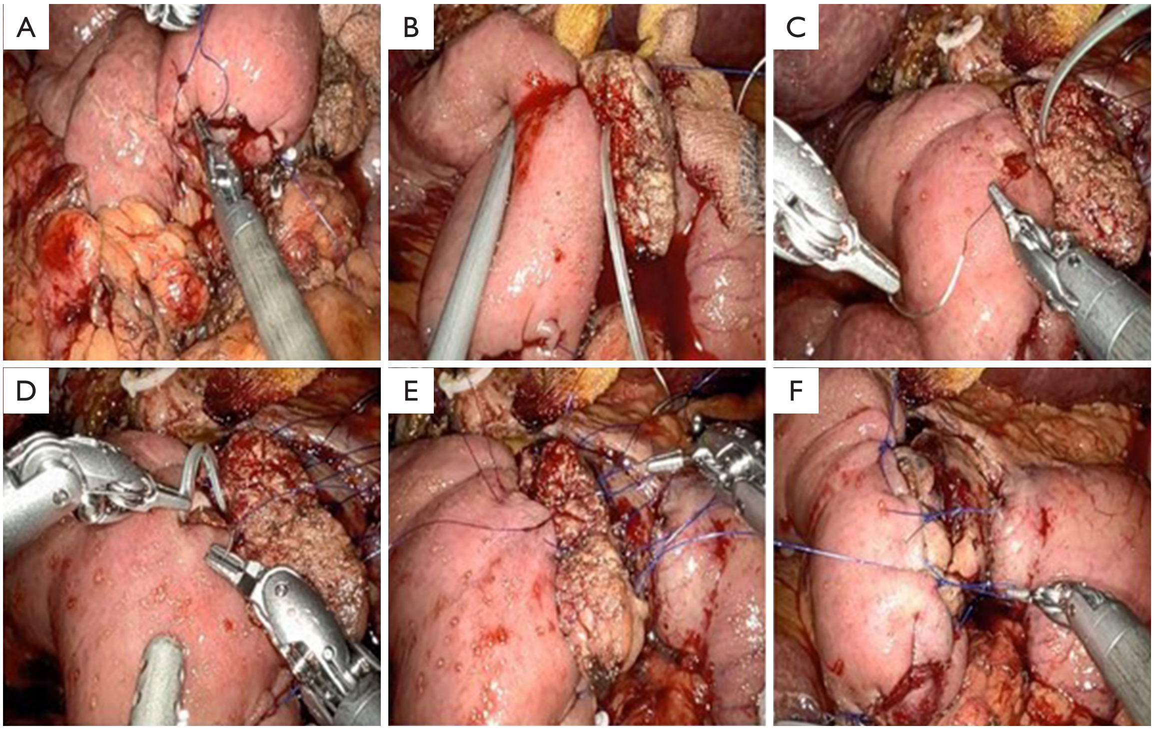


Figure 10 Pancreatic anastomosis. (A) Oversewing of jejunal stapled end; (B) outer layer first stitch, starting from the cranial end; (C) inner layer (duct to mucosa) 6 o'clock stitch; (D) pancreatic duct stent is used for gentle retraction and exposing the mucosa for last few stitches of inner layer; (E) suturing of anterior layer; and (F) sequential closure to achieve invagination of pancreatic stump.

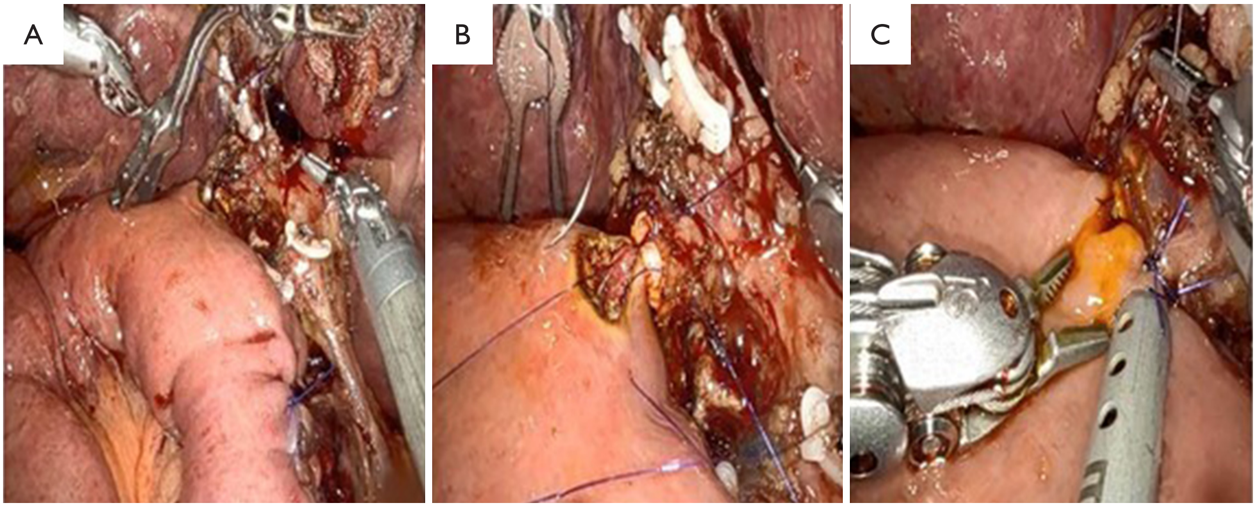


Figure 11 Biliary anastomosis. (A) Stay suture at 9 o'clock is held with bulldog and flipped over the instrument retracting liver; (B) anterior and (C) posterior layer of hepaticojejunostomy.

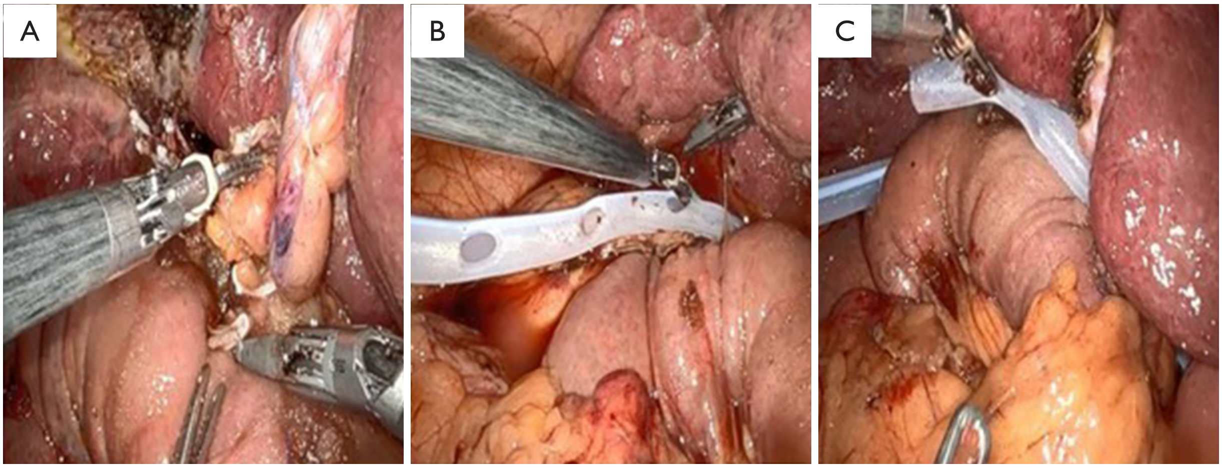


Figure 12 Final steps of robotic Whipple. (A) Falciform ligament is mobilised and used to cover the GDA sump; (B) a right sided 27 Fr Robinson drain is placed from R1 (right anterior axillary port) and placed posterior to hepaticojejunostomy; (C) another 27 Fr Robinson drain is placed from R4 (left lateral most port) and the tip is placed posterior to pancreatojejunostomy.

being entangled (*Figure 11*).

- The authors' preference is to make the gastrojejunostomy at least 6 cm wide and measure it with a sterile ruler tape. This allows for adequate opening even in the setting of early post-operative oedema at the site of the anastomosis.

Final details

- Falciform wrap. The free edge of falciform ligament (round ligament) is dissected off from the anterior abdominal wall with the help of the vessel sealer up to its attachment to the liver. The distal cut end of the falciform ligament is secured with either a hem-o-lock or endo loop. This pedicled flap of ligament is placed over the GDA stump and tucked behind pancreaticojejunostomy anastomosis, to separate the PJ anastomosis completely from GDA and limit the risk of pseudo-aneurysm in case of pancreatic fistula (12).
- Drain placement. Drains are placed and secured while the robot is still docked. The authors' practice is to use two drains—the left sided drain is placed posterior to the GJ and anterior to the pancreatic and biliary anastomoses, while the right sided drain is placed behind the biliary anastomosis in the Morrison's pouch and postero-superior to the pancreatic anastomosis. These are then confirmed to be in position laparoscopically after undocking the robot and during the exsufflation and specimen extraction (*Figure 12*).
- Specimen extraction. The midline assistant port is enlarged to allow for specimen extraction, which is carried out carefully to avoid injuries.
- Completion and closure. The extraction site is closed with loop PDS. The authors' practice is to close the fascia of any abdominal ports that are 10 mm or more. The 8 mm robotic ports are not closed at the fascial layer routinely.

Postoperative considerations and tasks

Post-operatively, these patients are managed according to the institutional ERAS protocol, with some variations according to local preferences. The nasogastric tube, arterial and central venous lines are removed on the first post-operative day, drain amylase levels are checked on morning of third and fifth post-operative days and removed if normal or showing downward trend and in the absence of complications, patients are discharged on post-operative day 5. All patients undergo CT scans to rule out collections, pseudoaneurysm or any other complications prior to discharge.

Discussion

Surgical highlights

The technique described in this paper represents the culmination of years of refinement and evolution in RPD. The lead author's extensive experience, not only as a primary surgeon but also as a proctor to over 21 units across different stages of robotic HPB program development, has been instrumental in shaping this approach. This method has undergone continuous improvements aimed at reducing reliance on the bedside surgeon, thereby allowing the procedure to be led primarily by the console surgeon. This shift not only enhances efficiency but also offers the potential for greater standardization across different settings and surgical environments.

Strengths and limitations

One of the key advantages of this technique is the reduction of active bedside surgeon involvement in tissue dissection. In previously described techniques, portions of the dissection were carried out through the midline or left-sided port by the bedside surgeon, laparoscopically, but this has now largely been eliminated in the current technique (4,5,7). This enables the console surgeon to independently carry out the majority of both the resection and reconstruction, facilitating a fully RPD and ensuring consistent standards can be maintained across different settings. The author's belief is that this development has paved the way for a more streamlined and reproducible procedure. The one notable exception to this facet is the continued use of laparoscopic staplers by the bedside surgeon, particularly for transecting the jejunum, stomach, and other vascular structures as described (e.g., Henle's trunk, IPDA, Belcher's vein, etc.). The authors find that the angles achievable with laparoscopic staplers (via the assistant port) are particularly suited to these tasks, making them a valuable tool in the procedure.

The evolution of the dissection scheme is another key refinement. Early iterations of the technique involved identifying the SMV and the inferior border of the pancreas early in the operation, after opening the lesser sac. While this approach was effective, it proved cumbersome and added to the overall length of the surgery. In contrast, the current technique prioritizes the transaction of the stomach, which significantly improves exposure to the neck of the pancreas. This modification has improved efficiency but requires careful preoperative planning, particularly in borderline resectable cases where SMV impingement from the uncinate process is a concern. In such cases, the authors advocate for proceeding with the resection while keeping the option of a type 1 or 2 (PV) resection and reconstruction on the table. This approach, when handled by experienced surgeons, can also be performed robotically. Over the course of multiple cases, the lead author has yet to encounter a scenario where the resectability of the tumour changed at a point after committing to transection of the stomach or duodenum. This success also underscores the importance of thorough preoperative assessments, including high-quality pancreatic protocol CT, which is arranged within 2 weeks, particularly for PDACS in determining the resectability.

Comparison with other surgical techniques and research

A noteworthy feature of the refined technique is the clockwise direction of dissection (*Figure 3*). This structured approach allows for a smooth, sequential flow throughout the operation, which the authors believe contributes to fewer instrument exchanges and a reduction in overall procedure time. This flow also enhances the surgeon's ability to maintain focus and precision during the complex dissection in the resection phase. The benefit of this refined technique is not just in efficiency but also in potentially improved outcomes due to a more systematic and controlled dissection.

Reconstruction is another area where this technique has shown improvements. The robotic approach to pancreatic anastomosis has shown promise in reducing leak rates, particularly in patients with high-risk pancreatic glands (13). The ability to replicate well-established techniques, such as the modified Blumgart pancreatic anastomosis, within the robotic setting offers a significant advantage (7,14,15). This not only helps ensure consistency in surgical outcomes but also shortens the learning curve for surgeons transitioning to robotic pancreatic surgery. Rather than having to learn an entirely new method of anastomosis, surgeons can directly translate their open surgery skills into the robotic platform, facilitating smoother adoption of the technology.

Using this technique, preliminary results from the senior author's database showed a mean operative time of 466 minutes and an average EBL of 204 mL. The incidence of grade B pancreatic fistula was 2.6%, grade A was 40%, and the biliary leak rate was also 2.6%. Conversion to open surgery occurred in 3% of cases, and the 90-day mortality rate was 2.6%. A prospective data collection on the Whipple procedure is currently ongoing at our center, with the intention of publishing the results in due course.

Despite the many advances, there remains room for improvement. One area that could benefit from further refinement is the incision technique. Currently, the procedure uses a midline scar, which carries a higher risk of incisional hernias compared to the Pfannenstiel incision (16).

A shift toward using the Pfannenstiel incision could reduce this risk and improve patient outcomes. Additionally, the technique does not employ a fixed liver retractor, which might otherwise free up the third robotic arm for greater assistance during certain parts of the procedure.

Implications and actions recommended

Moving forward, the authors believe that standardizing this technique will lead to greater efficiency and better patient outcomes in RPD. By reducing the variability inherent in such a complex procedure, the method has the potential to improve the speed of the operation, economy of movement, thereby influencing postoperative recovery and potentially long-term patient outcomes. Furthermore, as robotic systems become more widely adopted in the surgical community, the availability of a standardized and reproducible technique will be crucial in promoting their broader use. The teaching of a standardized approach across the whole of the UK will also mean that training of future senior surgeons will be standardized and lead to an organic growth of robotic surgery similar to that seen in the early days of laparoscopy.

Conclusions

The technique continues to undergo evaluation, with ongoing data collection on safety, efficacy, and patient outcomes. This data is being maintained prospectively, with plans for future publication. As robotic surgery continues to evolve, this standardized approach to RPD will contribute to further advancements in the field and help establish it as a viable and potentially superior alternative to traditional open surgery in select patients.

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Footnote

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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. All procedures performed in this article were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration and its subsequent amendments. Written informed consent was obtained from the patient for publication of this article and accompanying video and images. A copy of the written consent is available for review by the editorial office of this journal.

References

1. Corcione F, Pirozzi F, Cuccurullo D, et al. Laparoscopic pancreaticoduodenectomy: experience of 22 cases. Surg Endosc 2013;27:2131-6.
2. van Hilst J, de Rooij T, Bosscha K, et al. Laparoscopic versus open pancreatoduodenectomy for pancreatic or periampullary tumours (LEOPARD-2): a multicentre, patient-blinded, randomised controlled phase 2/3 trial. Lancet Gastroenterol Hepatol 2019;4:199-207.
3. Marino MV, Podda M, Pisanu A, et al. Robotic-assisted Pancreaticoduodenectomy: Technique Description and

Performance Evaluation After 60 Cases. Surg Laparosc Endosc Percutan Tech 2020;30:156-63.
4. Galvez D, Sorber R, Javed AA, et al. Technical considerations for the fully robotic pancreaticoduodenectomy. J Vis Surg 2017;3:81.
5. Wilson GC, Zeh HJ 3rd, Zureikat AH. How I Do It: Robotic Pancreaticoduodenectomy. J Gastrointest Surg 2019;23:1661-71.
6. Napoli N, Kauffmann EF, Menonna F, et al. Indications, technique, and results of robotic pancreatoduodenectomy. Updates Surg 2016;68:295-305.
7. Boggi U, Signori S, De Lio N, et al. Feasibility of robotic pancreaticoduodenectomy. Br J Surg 2013;100:917-25.
8. Chen S, Chen JZ, Zhan Q, et al. Robot-assisted laparoscopic versus open pancreaticoduodenectomy: a prospective, matched, mid-term follow-up study. Surg Endosc 2015;29:3698-711.
9. Lai EC, Yang GP, Tang CN. Robot-assisted laparoscopic pancreaticoduodenectomy versus open pancreaticoduodenectomy--a comparative study. Int J Surg 2012;10:475-9.
10. Giannone F, Capretti G, Abu Hilal M, et al. Resectability of Pancreatic Cancer Is in the Eye of the Observer: A Multicenter, Blinded, Prospective Assessment of Interobserver Agreement on NCCN Resectability Status Criteria. Ann Surg Open 2021;2:e087.
11. Blumgart-style Pancreaticojejunostomy. Available online: https://pie.med.utoronto.ca/TVASurg/project/blumgartpj/
12. Welsch T, Müssle B, Korn S, et al. Pancreatoduodenectomy with or without prophylactic falciform ligament wrap around the hepatic artery for prevention of postpancreatectomy haemorrhage: randomized clinical trial (PANDA trial). Br J Surg 2021;109:37-45.
13. Park SE, Choi HJ, You YK, et al. Effectiveness and stability of robot-assisted anastomosis in minimally invasive pancreaticoduodenectomy. Ann Surg Treat Res 2021;100:329-37.
14. Kamarajah SK, Bundred JR, Marc OS, et al. A systematic review and network meta-analysis of different surgical approaches for pancreaticoduodenectomy. HPB (Oxford) 2020;22:329-39.
15. Boone BA, Zenati M, Hogg ME, et al. Assessment of quality outcomes for robotic pancreaticoduodenectomy: identification of the learning curve. JAMA Surg 2015;150:416-22.
16. den Hartog FPJ, van Egmond S, Poelman MM, et al. The incidence of extraction site incisional hernia after minimally invasive colorectal surgery: a systematic review and meta-analysis. Colorectal Dis 2023;25:586-99.

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