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Robotic-assisted Lateral Pancreaticojejunostomy for Chronic Pancreatitis

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Abstract

Chronic pancreatitis is a debilitating, benign inflammatory disorder that significantly alters a patient's quality of life. Pancreatic drainage procedures have long been demonstrated to be safe and feasible using laparoscopic and open surgical approaches but have largely been replaced by pancreaticoduodenectomy. Over the past several decades, perioperative outcomes using the robotic platform in hepatobiliary surgery have been rapidly improving and, in many cases, surpassing outcomes in open and laparoscopic approaches. In appropriately selected patients with pancreatic duct obstruction and without an inflammatory mass at the head of the pancreas, there remains a role for parenchymal-sparing operations that relieve recurrent pancreatitis but also limit endocrine and exocrine insufficiency. We present a robotic-assisted lateral pancreaticojejunostomy for a patient with recurrent pancreatitis in the setting of a pancreatic duct stricture. The intention of this manuscript is to provide fellowship-trained hepatobiliary surgeons with a concise and adoptable method for performing robotic-assisted lateral pancreatojejunostomy. This article demonstrates critical aspects of the operation performed in a minimally invasive, robotic fashion to treat recurrent acute/chronic pancreatitis.

Introduction

Lateral pancreaticoduodenectomy, more often referred to as a modified Puestow procedure, is a pillar of open pancreatic surgery. First performed in 1958, this procedure addresses complex chronic pancreatitis with a dilated pancreatic duct and normal pancreatic head while preserving much of the pancreatic parenchyma[1]. Primary indications for this operation include chronic pancreatitis with chronic pain, narcotic dependency, and poor quality of life. Drainage procedures typically involve relief of obstruction in the pancreatic duct while preserving the pancreatic head parenchyma. The Puestow procedure falls into the category of drainage procedures for chronic pancreatitis, a group that also includes the Partington and Rochelle modification and the Izbicki procedure[2]. The vast majority of patients with chronic pancreatitis present with the involvement of the pancreatic head and are thus not eligible for

drainage procedures and instead undergo resection. The pancreaticoduodenectomy is an extensive procedure with resection of the pancreatic head, duodenum, and a portion of the stomach. The Beger and Frey procedures are also parenchymal resection procedures that involve the removal of the lesion from the pancreatic head while sparing the duodenum and more of the pancreatic parenchyma[3].

For much of the history of treatment for chronic pancreatitis, drainage procedures and pancreaticoduodenectomy were the mainstay of treatment. The optimal surgical approach for chronic pancreatitis remains unanswered and should be individualized based on clinical, imaging, and endoscopic assessment. As detailed in the discussion, surgical drainage procedures have recently been shown to have significantly lower 90-day readmission rates and need for reintervention, with no differences in pain scores compared to resective procedures[4]. However, in the era of minimally invasive surgery, drainage procedures have fallen out of favor as compared with other current options: laparoscopic or robotic pancreaticoduodenectomy and duodenal-preserving pancreatic head resections[5,6]. While these procedures provide a safe and attainable treatment for the majority of chronic pancreatitis patients, they are highly morbid operations that resect already diseased parenchyma, further increasing the risk of endocrine and exocrine dysfunction. Pancreaticoduodenectomy is most often linked to delayed gastric emptying, bleeding, pancreatic insufficiency, and infection[7]. Distal pancreatectomy is most often complicated by pancreatic fistula and abscess formation/infection[3,8,9]. In the interest of preserving pancreatic parenchyma in the surgical treatment of chronic pancreatitis, robotic lateral pancreaticojejunostomy may have an underestimated utility.

Use of robotic surgery in the management of pancreatic disease has advanced rapidly in the past decade, similar to the implementation of laparoscopic surgery decades prior. Both robotic and laparoscopic approaches are associated with decreased recovery times and lower levels of post-operative pain, allowing patients to return to their day-to-day lives sooner[10,11,12]. The robotic platform has the additional benefits of 3-dimensional visualization with high magnification and articulating instruments, which is particularly advantageous with the manipulation of delicate pancreatic tissue and suturing complex anastomoses. The extent of a learning curve for robotic pancreatic surgery is controversial; however, it is generally agreed that mastery of port placement and coordination with laparoscopic assistance is critical[13]. As more surgeons graduate from training programs with this skill set, utilizing the versatility of the robotic platform to leverage a minimally invasive approach to all pancreatic procedures that are possible with open surgery is feasible and may improve outcomes associated with surgery for pancreatitis[14].

This paper provides a clear and easily adaptable method for robotic-assisted lateral pancreatojejunostomy. As more surgical techniques are adapted to robotic surgery, we include the largely historical drainage approach in this growing list and ensure the technique is accessible to fellowship-trained hepatobiliary surgeons.

CASE PRESENTATION:

We report a 39-year-old male with no significant past medical history and no history of alcohol or tobacco use. He presents with recurrent episodes of pancreatitis for 5 years in the setting of gallstone pancreatitis, for which a laparoscopic cholecystectomy was performed at the time of his initial presentation. Unfortunately, the episodes recurred

and worsened over time. After presentation to our facility, he underwent endoscopic retrograde cholangiopancreatography (ERCP), which revealed pancreatic divisum and pancreatic duct stricture at the neck, which could not be traversed for duct stent placement.

Diagnosis, Assessment, and Plan:

As previously stated, the patient had a significant pancreatic duct stricture in the neck of the pancreas, evidenced by the pancreatogram (**Figure 1**). Magnetic resonance cholangiopancreatography (MRCP) further elucidated irregular upstream dilation of the pancreatic duct in the body and tail of the pancreas (**Figure 2**). Importantly, these studies revealed no significant disease of the pancreatic head or major biliary involvement, indicating that this patient was a candidate for a robotic pancreatic drainage procedure to decompress the distal pancreatic duct, thereby limiting further episodes of pancreatitis.

Protocol

Per West Virginia University Office of Human Research Protections protocols and consistent with federal policy, this protocol is classified as non-human subjects research and does not require Institutional Review Board approval. As part of our standard surgical consent process, patients provided informed consent for intraoperative video recording.

1. Patient positioning and port placement

1. The patient was placed supine on a split-leg table with their arms out. Sterile preparation was applied using a chlorhexidine applicator, and the patient was draped in a standard fashion. An incision was made in the upper left quadrant to allow for abdominal entry with the optical separator device. The peritoneal cavity was insufflated with CO_2 and explored with the laparoscope.
2. Four robotic ports were inserted in the upper abdomen, and two assistant ports were inserted in the lower abdomen (**Figure 3**). The camera was placed in the midline supraumbilical robotic port. In the left lower quadrant, a 12 mm port served as the site for stapler insertion.
3. After ports were inserted, the patient was placed in reverse Trendelenburg with their left side up.

2. Entry into the lesser sac and docking the robot

1. A flexible triangle liver retractor was introduced in the right upper quadrant just caudal to the ribs to retract the liver cranially. The lesser sac was entered using bipolar electrocautery along the greater curvature of the stomach, taking care not to cauterize the gastroepiploic vessels. Following mobilization of the stomach, it was retracted anteriorly along with the liver.
2. The robot was docked, ensuring that the surgeon controlled the robot sitting at the console and a bedside laparoscopic assistant standing between the patient's legs.

3. Identifying the pancreatic duct and longitudinal incision along the body of the pancreas

1. Intraoperative ultrasound was used to identify the dilated pancreatic duct, locate strictures, and track the course of the duct along the body of the pancreas.
2. The body of the pancreas was incised using cauterized scissors primarily along the anterior surface of the duct to the tail. A 4-French Hobbs stent can be used to track the pancreatic duct as it is opened (**Figure 4**).

4. Dividing loop of jejunum and passage through the retrocolic tunnel

1. Once the pancreatic duct was opened, the ligaments of Treitz and the proximal jejunum were identified. 20 cm distal to this, a loop of jejunum was identified as the site for future anastomosis with the pancreatic duct.
2. Using a bipolar electrocautery device, a mesenteric window was created, and the bowel was divided with a 60 mm purple load of an Endo GIA stapler. The bipolar electrocautery device was again used to divide the mesentery with care to avoid mesenteric vasculature.
3. A retrocolic tunnel was created in the mesentery of the transverse colon using blunt dissection. The Roux limb was then subsequently passed through this space into the lesser sac. It was ensured that the jejunum reached the pancreas without tension.

5. Longitudinal enterotomy and running anastomosis

1. A longitudinal enterotomy on the anti-mesenteric aspect of the jejunum was created using a combination of electrocautery and sharp dissection to match the length of the incision along the pancreas.
2. The anastomosis began at the tail of the pancreas, where two 3-0 barbed sutures were anchored to the distal end of the ductotomy and enterotomy. One barbed suture was run along the inferior aspect of the anastomosis, while the other was run along the superior aspect of the anastomosis. Again, a 4-French Hobbs stent was used to ensure the duct remains patent, particularly at the beginning and end of anastomosis creation (**Figure 4**).
3. The anastomosis was completed when the barbed sutures met at the neck of the pancreas, where they were tied together.

6. Re-establishing GI continuity with jejunojejunostomy

1. Neo-gastrointestinal anatomy was confirmed by identification of the Roux and Biliopancreatic limbs. Small enterotomies were created near the previously stapled edge of the jejunum and a segment of jejunum more distal at the Roux limb, approximately 50 cm. A 60 mm purple load endo GIA staple fire was used to create a side-to-side jejunojejunostomy.
2. The common enterotomy was closed with 3-0 barbed sutures followed by interrupted 3-0 silk Lembert sutures. 3-0 silk sutures were again used to close the colon mesenteric defect created around the Roux limb.

7. Placing drains and abdominal closure

1. Two drains were placed using previously placed robotic port-sites. One drain passed posterior to the pancreaticojejunal anastomosis, and the other anterior to the anastomosis. The liver retractor was removed, and the stomach was returned to anatomical position.
2. The abdomen was extensively irrigated. A laparoscopic port-site closure device was used to close a 12 mm assistant port with #1 absorbable sutures. The skin and subcutaneous tissue were irrigated and closed with 4-0 monofilament absorbable suture.

Representative Results

This patient had an unremarkable postoperative course with drain amylases decreasing from 139 U/L to 15 U/L anteriorly, and 48 U/L to 13 U/L posteriorly on postoperative

days one and three, respectively, indicating no pancreatic leak. His drains were removed at the time of discharge on post-operative Day 4, and he experienced a significant improvement in quality of life with mild intermittent and infrequent pain episodes at two years following surgery. He is not narcotic dependent. The patient's blood glucose remained well controlled at two years with a hemoglobin A1c of <3.4% (**Table 1**). Success in this procedure is defined by pain relief without the need for narcotic medication and the patient's return to normal activities[15].

Figure 1: Pancreatic duct stricture (pancreatogram): Pancreatogram obtained during ERCP for patient work-up of recurrent pancreatitis showing a stricture seen as narrowed contrast opacification (red arrow) with distal ductal dilation. Please click here to view a larger version of this figure.

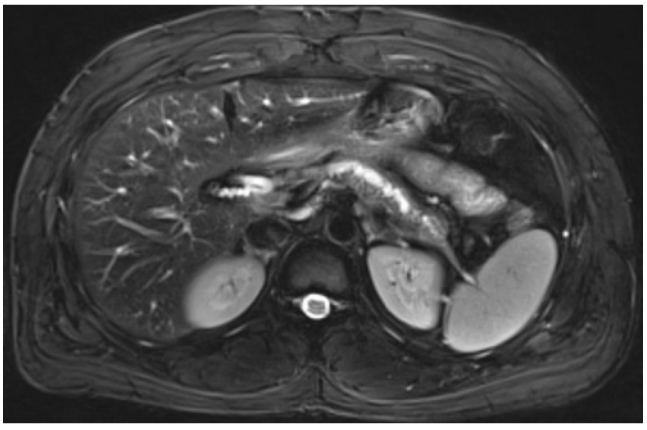

Figure 2: Pancreatic duct structure (MRCP): Axial view of MRCP obtained during work-up showing irregular dilation of the pancreatic duct within the body and tail of the pancreas. Please click here to view a larger version of this figure.

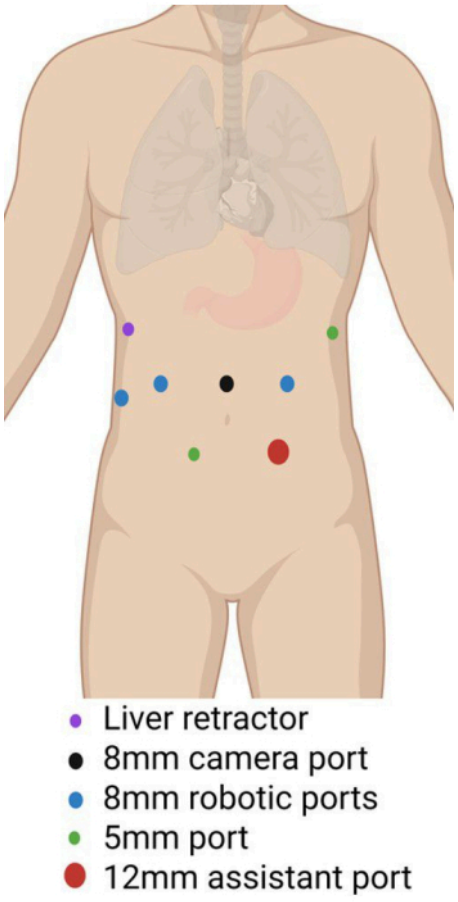

Figure 3: Suggested port placement for robotic-assisted lateral pancreaticojejunostomy. Four supra-umbilical robotic ports were placed (blue and black dots), with a camera placed at the midline port site. Two infraumbilical assistant points were placed, with a larger 12 mm site in the left lower quadrant (red dot) used for insertion of the endoscopic stapler. Created in BioRender. Sestito, M (2025) http://BioRender.com/w75x011. Please click here to view a larger version of this figure.

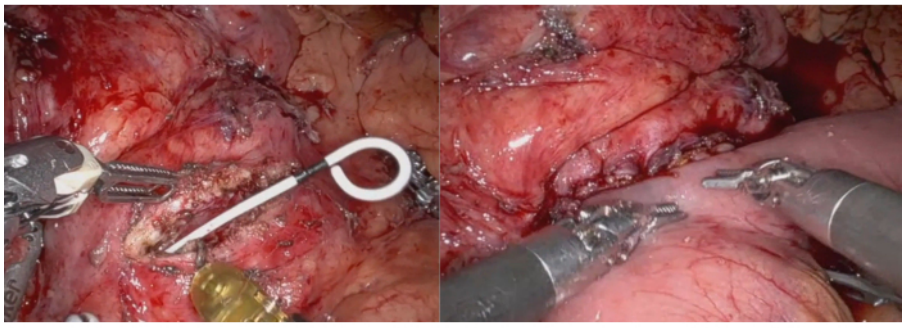

Figure 4: Critical portions of robotic-assisted lateral pancreaticojejunostomy. Left: Anterior surface of the pancreas gradually opened with hook electrocautery. The 4-French Hobbs stent is used to assist in tracking the pancreatic duct. **Right:** Completed pancreaticojejunostomy with duct-to-mucosa anastomosis using 3-0 barbed sutures. Please click here to view a larger version of this figure.

Postoperative outcomes	Outcome
Drain Amylase, 3 days	15 U/L & 13 U/L
Length of stay, days	4
Discharge destination	Home
Reoperation, 24 months	None
Reinterventions, 24 months	None
Pain, 24 months	Mild, Intermittent
Narcotic dependency	No
Readmissions within 6 months	1
Readmissions within 24 months	1
Hemoglobin A1c, 24 months	<3.4%

Table 1: Perioperative and postoperative outcomes. Pertinent inpatient and postoperative outcomes are included for reference.

Discussion

Here we present a robotic approach to lateral pancreaticojejunostomy for the management of chronic pancreatitis with pancreatic duct stricture. Critical steps demonstrated for a successful operation include our precise robotic port placement, the use of intra-operative ultrasound to track the pancreatic duct along the pancreatic body, and performing a longitudinal pancreatic ductotomy with the use of a 4-French Hobbs stent. Additionally, our technique for the pancreaticojejunostomy anastomosis is highlighted using two running 3-0 barbed sutures along the inferior and superior aspects of the anastomosis. At the start and finish of the anastomosis, a 4-French Hobbs stent is also used to ensure patency of the duct for optimal drainage. Lastly, our approach to standard gastrointestinal reconstruction is seen during this operation.

Chronic Pancreatitis is a debilitating and severe inflammatory condition that can present in patients with a range of family and social histories. The chronic subtype is typically accompanied by depressed pancreatic digestive function and an abnormal pancreatic lesion or pancreatic duct stricturing visible during endoscopic evaluation. These patients typically struggle with debilitating epigastric abdominal pain and steatorrhea, accompanied by nausea, vomiting, anorexia, and weight loss. Over time, cases get complicated by both exocrine and endocrine deficiency, the former resulting in chronic diarrhea and osteoporosis, and the latter resulting in pancreatogenic diabetes[16]. The natural history of chronic pancreatitis often leads to a significant reduction in patient quality of life.

The approach to management of chronic pancreatitis is multifaceted, including endoscopic therapy, lifestyle changes, pharmacological treatment, and pain management[17]. In patients who do not respond to these measures, surgical management is indicated. As previously discussed, pancreaticoduodenectomy or duodenum-preserving pancreatic head resections are the most common surgical choice, particularly in patients with an inflammatory pancreatic head mass[5,18]. However, for patients who do not have such lesions and have sufficient pancreatic duct dilation to perform an anastomosis with adequate drainage (approximately 10 mm in our institution), robotic-assisted lateral pancreaticojejunostomy is an effective option that does not involve pancreatic resection and limits the development of exocrine and endocrine sequela[19]. One recent major multicenter prospective study in Europe (ESCOPA) found that surgical drainage procedures had significantly lower rates of surgical reintervention when compared to duodenal-preserving pancreatic head resections and formal pancreatic resections (4% vs 16% vs 6%; p=0.05). Similarly, they reported a lower 90-day readmission rate (8% vs 25% vs 12%; p=0.033)[4]. While all three surgical groups experienced significant improvement in Izbicki pain scores after 6 months (median 61.3 to 19.0), there was no difference in pain outcomes between the three surgical groups (p=0.428).

As the availability of robotic procedures increases, so do questions regarding the increased cost of the robotic platform. While upfront costs of the robotic approach have previously been shown to be unequivocally more expensive than the other modes of surgery, the cost is dramatically improving and is not isolated to the surgery itself. Retrospective analysis from one specialized center demonstrated that patients undergoing open distal pancreatectomy had significantly higher length of stay and higher overall costs compared to laparoscopic and robotic modalities (p=0.0001 & p=0.002). On Multivariate analysis, robotic surgery had independently reduced LOS and total

cost compared to an open approach (odds =6.5[p=0.0001] and odds=5.7[p=0.002][20]. Post-hoc cost analysis of 588 consecutive patients undergoing pancreaticoduodenectomy either with robotic or open approach found that total hospital costs were €4,804 higher for the robotic group (p=0.010)[21]. However, as experience with this modality increased over the second half of the decade studied, costs of robotic surgery decreased from €32,836 to €21,778 (p=0.001), which were comparable to those seen in the open approach, which showed no change over time (€24,025 to €21,013, p=0.210). Further, key operative outcomes improved with the robotic approach: hospital stay (12 to 9 days, p<0.001), pancreatic fistula (48.6% to 31.8%, p=0.012), delayed gastric emptying (33.6% to 15.0%, p=0.001), and operative time (373 to 310 min, p<0.001). This study highlights important trends witnessed in the implementation of laparoscopic surgery decades earlier. Costs of robotic surgery are improving, and so too are outcomes of relatively morbid surgery.

Despite the historical use of the Puestow procedure, its application is not confined to open surgical and laparoscopic approaches exclusively. This patient's case exhibited a classic recurrent pancreatitis that could not be resolved medically and eventually required surgical intervention. Without pancreatic head involvement, he was a candidate for a drainage procedure and was successfully treated with a lateral pancreaticojejunostomy. This article demonstrates that the modified-Puestow procedure done *via* a robotic approach is a safe and feasible option for the management of chronic pancreatitis in appropriately selected patients.

Disclosures

The authors have nothing to disclose.

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