Robotic pancreaticoduodenectomy for pancreatic cancer: a narrative review

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Background and Objective: The indications and evidence base for robotic-assisted pancreaticoduodenectomy have grown exponentially over the last two decades and robotic-assisted resection is now considered a safe and oncologically-equivalent surgical option for patients with pancreaticobiliary cancers. In this narrative review, we outline the published literature regarding technical considerations and operative steps for robotic pancreaticoduodenectomy including techniques for safe vascular resection and reconstruction.

Methods: A PubMed search was performed to identify all articles, in English, published between January 1st, 1996 to July 18th, 2022 which were related to robotic-assisted pancreaticoduodenectomy for patients with pancreatic cancer.

Key Content and Findings: Significant advances in have been made in robotic-assisted techniques and approaches for patients requiring pancreaticoduodenectomy and these are described in detail. Advances have additionally been made regarding intraoperative visualization and identification of vascular and biliary structures. More research is needed to characterize oncologic outcomes for patients undergoing open versus robotic pancreaticoduodenectomy, including the frequency of adjuvant chemotherapy completion as well as differences in progression-free and overall survival.

Conclusions: The surgical technique of robotic-assisted pancreaticoduodenectomy has evolved and improved as greater number of surgeons gain experience with this technique. Advanced procedures such as vascular resection and reconstruction and the TRIANGLE resection are possible for surgeons with previous experience in robotic-assisted pancreatic surgery. The results of a recently completed randomized clinical trial for patients with pancreatic cancer undergoing robotic-assisted versus open pancreaticoduodenectomy are awaited.

Keywords: Robotic; pancreaticoduodenectomy; Whipple; minimally invasive

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Introduction

As recently as two decades ago, robotic-assisted pancreaticoduodenectomy was only on the horizon. The first known robotic-assisted pancreatic resection (distal pancreatectomy) was reported by Melvin *et al.* in 2003 (1) and the technique was improved over the subsequent seven years, with the first single-institution series being published in 2010 (2). Early reports published between 2010 to 2013 established the safety and feasibility of the robotic-assisted approach for pancreatic resection (2-18). By 2014, the robotic-assisted pancreaticoduodenectomy was accepted to be safe and associated with decreased intraoperative blood loss, a lower rate of conversion to open compared to laparoscopic pancreaticoduodenectomy, and overall shorter length of stay (19-23). In the following years, the procedure was demonstrated to be safe and feasible in patients with hepatic arterial anomalies and those requiring resection and reconstruction of the superior mesenteric/portal vein and celiac axis (24-37) with equal oncologic outcomes compared with laparoscopic and open procedures (38-56). To date, a comprehensive review regarding the published techniques for robotic-assisted pancreaticoduodenectomy has not yet been published. This review was therefore written with the hope that it might be a resource for early and mid-career pancreatic surgeons interested in perfecting the art of robotic pancreaticoduodenectomy. In this review, we highlight the advances in oncologic assessment of robotic versus open pancreaticoduodenectomy, technical details and standardization of the robotic pancreaticoduodenectomy procedure (4,37,57-70), as well as advances in enhanced intraoperative imaging and tumor identification. We present the following article in accordance with the Narrative Review reporting checklist (available at https://ls.amegroups.com/article/view/10.21037/ls-22-52/rc).

Methods

A PubMed search was performed for articles published between January 1st, 1996 to July 18th, 2022 related to robotic-assisted pancreaticoduodenectomy for patients with pancreatic cancer. Six-hundred and twenty-six unique articles were identified using the search terms ‘robotic pancreatic resection’ and ‘similar articles for PMID: 29078644 [Technical considerations for the fully robotic pancreaticoduodenectomy]’. Only articles published in English were included (see *Table 1*). All articles were screened by the first author. Publications were excluded if they focused primarily on open, laparoscopic, or distal pancreatic surgery, gastric surgery, liver, colorectal surgery, or were otherwise unrelated to the robotic-assisted pancreaticoduodenectomy procedure.

Results

Advances in oncologic outcomes for pancreatic cancer, moving beyond equivalency

Two publications report oncologic benefit with improved progression-free survival and a trend towards improved median overall survival between patients undergoing open and minimally invasive pancreaticoduodenectomy (39,51). Croome *et al.* showed laparoscopic pancreaticoduodenectomy offers shorter hospital stay, fewer complications and reduced delay in initiating adjuvant treatments ultimately impacting progression-free survival (39). Baimas-George *et al.* supported these findings by performing a retrospective review of robotic-assisted pancreaticoduodenectomy for pancreatic adenocarcinoma. The authors found an equivalent R0 resection rate and lymph node positivity ratio with a trend towards improved median overall survival (P=0.11) (51). The authors hypothesized that the decreased inflammatory response associated with robotic surgery, in addition to decreased rates of delayed gastric emptying (and earlier return to baseline functional status), might improve overall survival when studied in future prospective series.

The learning curve for robotic pancreaticoduodenectomy

Much has been written about surgical learning curves specific to the adoption of robotic pancreatic surgery (23,71-74). The international consensus statement on robotic pancreatic surgery states that for surgeons with extensive experience in laparoscopic pancreatectomy, the operative time required to complete a robotic pancreaticoduodenectomy significantly decreases following the completion of 40 cases. There is an additional recommendation that robotic pancreaticoduodenectomy requiring vascular resection/reconstruction not be performed in the preliminary stages of training (74). In the most comprehensive institutional review published on this topic to date, Zuriekat *et al.* (75) retrospectively demonstrated that operating times fell after 40 cases and plateaued after 240 cases, the majority of which were performed by three expert surgeons. Data presented by Shyr *et al.* all seem to suggest that the learning curve for

Table 1 Search strategy summary

Items	Specification
Date of search (specified to date, month and year)	19/07/2022
Databases and other sources searched	PubMed
Search terms used	'Robotic pancreatic resection' and 'similar articles for PMID: 29078644 [Technical considerations for the fully robotic pancreaticoduodenectomy]'
Timeframe	January 1st, 1996 to July 18th, 2022
Inclusion and exclusion criteria	Published in English, no specific study type
Selection process	Articles were screened for inclusion by the first author and confirmed for inclusion by the senior author

robotic pancreaticoduodenectomy might be as low as 20 cases if the surgeon is already familiar with use of the robotic platform and has extensive experience in robotic distal pancreatectomy (76). After reviewing institutional experience, Beane *et al.* further found the learning curve for robotic pancreaticoduodenectomy with vascular resection to be approximately 35 cases for surgeons who were already experienced with robotic pancreatic surgery (27). As alluded to in the international consensus statement, the benefit to use of the robotic platform is case selection—whereby a surgeon has the ability to choose which method of surgical resection best fits the patient's needs and surgeon's comfort level with the robotic platform. This creates the opportunity to generate an ever-changing case complexity/learning curve as skill and experience is acquired as a result of using the robotic platform itself.

Advances in robotic-assisted techniques and approaches

Fourteen publications outlined the step-by-step technical approach to performing a robotic-assisted pancreaticoduodenectomy (see *Table 2*). These publications are instructional in nature and offer detailed guidance on how to set up and execute a robotic-assisted pancreaticoduodenectomy. MacKenzie *et al.* were the first to outline a step-by-step approach to the robotic Whipple procedure (4). Their publication delineated the technical aspects of port placement, robotic docking, kocherization, superior mesenteric vein (SMV) identification, portal dissection, releasing the ligament of Treitz, uncinate dissection, and reconstruction. Port placement in this publication is described using the Da Vinci S Surgical System (Intuitive Surgical, Sunnyvale, CA, USA), which has been largely replaced by the most recent *Xi* model. In the same year, Zeh *et al.* highlighted the advantages of robotic-assisted surgery and offered a detailed outline of the steps to the procedure with illustrative graphic renderings (10). Parisi *et al.* presented technical considerations for the robotic pylorus-preserving pancreaticoduodenectomy using the Da Vinci Si Surgical System (70). The authors reviewed positioning, trocar placement, docking, entry into the lesser sac, kocherization, creating the retropancreatic tunnel, cholecystectomy, gastro-duodenal artery identification and division, duodenal division and reconstruction. In 2017, Galvez *et al.* outlined the robotic surgical approach using the Da Vinci Xi Surgical System for a single patient with a mass in the pancreatic head abutting the portal vein (77). This patient had aberrant arterial anatomy necessitating meticulous dissection of the superior mesenteric artery (SMA), performed in a caudal to cephalad direction.

By 2018, Giulianotti *et al.* identified 17 key surgical steps outlining a standardized technique for robot-assisted pancreaticoduodenectomy (69). Per the authors, the primary purpose of describing these steps was to ease the learning curve of surgeons wishing to pursue technical competency in robotic-assisted pancreaticoduodenectomy. They made specific note that extended kocherization, dissection of the uncinate process, and creation of the pancreatico-enteric anastomosis requires extended time and expertise to master. Kim *et al.* outlined the above standard steps in list rather than narrative format and provided guidance on which of the robotic arms and instruments is most useful during each step of the procedure (60). Müller-Debus *et al.* shared their experience with robot-assisted pancreaticoduodenectomy in 11 separate steps (57). The authors noted that a structured and dedicated training program is essential to acquiring efficiency and mastery of the robotic-assisted pancreaticoduodenectomy procedure. In

Table 2 Summary of the literature regarding technical considerations/operative steps for robotic pancreaticoduodenectomy

Title	Authors	Year	Journal
The robotic Whipple: operative strategy and technical considerations	MacKenzie *et al.*	2011	*J Robot Surg*
Robotic-assisted major pancreatic resection	Zeh *et al.*	2011	*Adv Surg*
Robotic pylorus-preserving pancreaticoduodenectomy: Technical considerations	Parisi *et al.*	2015	*Int J Surg*
Technical considerations for the fully robotic pancreaticoduodenectomy	Galvez *et al.*	2017	*J Vis Surg*
Operative technique in robotic pancreaticoduodenectomy (RPD) at University of Illinois at Chicago (UIC): 17 steps standardized technique	Giulianotti *et al.*	2018	*Surg Endosc*
Technical Detail for Robot Assisted Pancreaticoduodenectomy	Kim *et al.*	2019	*J Vis Exp*
Robot-Assisted Pancreatic Surgery: A Structured Approach to Standardization of a Program and of the Operation	Müller-Debus *et al.*	2020	*Visc Med*
The technique of precise and systematic vascular control during robotic pancreaticoduodenectomy for periampullary and pancreatic tumours	Kalayarasan *et al.*	2021	*J Minim Access Surg*
Technical progress in robotic pancreatoduodenectomy: TRIANGLE and periadventitial dissection for retropancreatic nerve plexus resection	Kinny-Köster *et al.*	2021	*Langenbecks Arch Surg*
Minimally Invasive Techniques for Pancreatic Resection	Nassour *et al.*	2021	*Surg Oncol Clin N Am*
Mesopancreas Excision and Triangle Operation During Robotic Pancreatoduodenectomy	Machado *et al.*	2021	*Ann Surg Oncol*
Robotic Artery-First Approach During Pancreatoduodenectomy	Machado *et al.*	2021	*Ann Surg Oncol*
The standardized technique and surgical video of robotic pancreaticoduodenectomy at the Chinese PLA General Hospital	Zhao *et al.*	2022	*Updates Surg*
International expert consensus on precision anatomy for minimally invasive pancreatoduodenectomy: PAM-HBP surgery project	Nagakawa *et al.*	2022	*J Hepatobiliary Pancreat Sci*

2021, Kalayarasan *et al.* described the precise identification and systematic control of the vessels supplying the head and the uncinate process of the pancreas during robotic-assisted pancreaticoduodenectomy (68). This step-by-step guide reviewed the standard vascular anatomy and illustrated how to identify and control the anterosuperior pancreaticoduodenal artery, anteroinferior pancreaticoduodenal artery, posterosuperior pancreaticoduodenal artery, posteroinferior pancreaticoduodenal artery, anteroinferior pancreaticoduodenal vein, posteroinferior pancreaticoduodenal vein, and posterosuperior pancreaticoduodenal vein when dissecting the uncinate process of the pancreas.

Kinny-Köster *et al.* delineated the technical aspect of performing a robotic-assisted TRIANGLE resection to include the periadventitial and retropancreatic nerve plexi of the dorsal and medial pancreatic margins in patients with resectable or borderline resectable disease (37). Description of this dissection advanced the scope of radical oncological resections using the robotic platform and highlighted the optical and mechanical advantages of the robotic platform. Nassour *et al.* reviewed the technical aspects of the robotic-assisted pancreaticoduodenectomy breaking it down into seven steps and also emphasized a dedicated curriculum to decrease the learning curve (62). Machado *et al.* outlined the anterior approach for mesopancreas excision and Triangle tissue excision as well as an artery-first approach but did not discuss arterial divestment in detail (as compared to the Kinny-Köster manuscript) (78). Zhao *et al.* characterized their institutional experience with robotic-assisted pancreaticoduodenectomy in 18 standardized steps, including using an uncinate-first dissection and creation of a retrocolic gastrojejunostomy (67).

In 2022, The Expert Consensus Meeting: Precision Anatomy for Minimally Invasive HBP Surgery (PAM-HBP Surgery Project) convened and released an international consensus statement aimed at developing recommendations for a precision anatomy approach to robotic and minimally invasive pancreaticoduodenectomy (59).

This Delphi consensus panel reviewed three clinical questions regarding the technical aspects of minimally invasive pancreaticoduodenectomy and a majority of surgeons agreed that preoperative identification of SMA and SMV branch patterns, hepatic arterial anatomy, the presence or absence of celiac artery stenosis and knowledge of a circumportal pancreas were all recommended to safely perform minimally invasive pancreatoduodenectomy. They additionally agreed that all surgeons should be aware of each approach to SMA dissection and should confirm of the course of the SMA, inferior pancreaticoduodenal arteries (IPDAs), first jejunal vein, and inferior pancreaticoduodenal veins before starting the dissection. The panelists agreed that surgical trainees be familiar with and comfortable performing anterior, posterior, right and left approaches to the SMA depending on the individual patient anatomy and tumor location.

Advances in robotic-assisted vascular resection and reconstruction

Ten publications focused on vascular resection and reconstruction during robotic-assisted pancreaticoduodenectomy (see *Table 3*). Giulianotti *et al.* reviewed five cases of left-sided splenopancreatectomy with celiac axis resection, left-sided splenopancreatectomy with portal vein resection, and pancreaticoduodenectomy with portal vein resection (8). As the first publication reporting safety and feasibility of robotic-assisted vascular reconstruction during pancreaticoduodenectomy, the authors highlighted the modified Appleby operation and use of a polytetrafluoroethylene (PTFE) patch for portal venous reconstruction with portal vein clamping time of 20–24 minutes. Kauffmann *et al.* discussed type 2, 3, and 4 venous resections as classified by the International Study Group of Pancreatic Surgery (ISGPS) classification (24,79). This publication additionally outlined the technical steps of both the anterior, posterior, and left-sided approaches to the SMA. No conversions were required due to inability to proceed with planned resection and reconstruction of the SMV/portal vein. Allan *et al.* detailed seventy robotic Whipple procedures with concomitant vascular resections (26). The authors describe tangential resection and partial venectomy according to the extent of involvement as described with use of a 5-0 prolene suture for primary repair or diamond-shaped pericardial bovine patches infused with heparinized saline. In the largest series to date, Beane *et al.* reported fifty patients who underwent robotic pancreatoduodenectomy with vascular resections and reported equivalent post-operative outcomes including post-operative pancreatic fistula (POPF), length of stay, major morbidity, and 30- and 90-day mortality when compared to patients not requiring vascular resection (27). In 2020, Kauffmann *et al.* reported on arterial resection and repair of the celiac trunk, hepatic artery, splenic artery, and SMA for both anticipated arterial involvement and unanticipated injury (29). The authors outlined SMA reimplantation to the stump of the gastroduodenal artery with an interposition jump graft as well as resection and reconstruction of a replaced right hepatic artery, originating from the SMA. Marino *et al.* outlined a series of eight patients undergoing tangential portal vein/superior mesenteric venous resection/reconstruction with tangential occlusion for cases with less than 25% circumferential involvement and proximal and distal complete occlusion in case of higher circumferential venous involvement (>25%) (34). This group documented higher rates of blood loss and longer operating time associated with venous reconstruction compared to cases not requiring such vascular techniques. Shyr *et al.* reviewed eleven cases of robotic-assisted pancreaticoduodenectomy with vein reconstruction with equivalent rates of post-operative complications and length of stay though an average of an additional hour of operative time (28). The authors conclude that portal vein/SMV resection and reconstruction can be safely performed with minimal risks by surgeons trained in robotic-assisted pancreaticoduodenectomy. Machado *et al.* presented a single case of tangential venous resection and reconstruction (32). Similar to other reports, the SMV was clamped for 30 minutes and the transverse repair lasted 23 minutes with minimal blood loss and no need for blood transfusion. This publication offered clear and helpful intraoperative pictures to guide the discussion of robotic reconstruction. Jin *et al.* offered a retrospective review including fourteen patients requiring venous resection and reconstruction (35). The authors outlined two vascular reconstruction techniques—Type 1 and Type 3—which were utilized for the majority of patients as per the ISGPS classification with similar post-operative outcomes and equivalent oncologic outcomes within the limited follow-up period studied. In 2022, Yang *et al.* characterized a 1:1 propensity-score matched comparison between robotic-assisted and open pancreatoduodenectomy with vascular resection (36). The technique of vascular reconstruction was not described, but similar to several of the papers mentioned above, the authors found longer operative times

Table 3 Summary of the literature regarding robotic-assisted vascular resection and reconstruction required during pancreaticoduodenectomy

Title	Authors	Year	Journal	No. of patients	Type of vein resection	Surgical procedure(s) performed
Robotic extended pancreatectomy with vascular resection for locally advanced pancreatic tumors	Giulianotti *et al.*	2011	*Pancreas*	5	Celiac trunk and portal vein	Robotic-assisted: 2 modified Appleby operations (extended left pancreatectomy with resection of the celiac axis), 1 DP with portal vein resection, and 2 PDs with portal vein resection.
Robotic pancreatoduodenectomy with vascular resection	Kauffmann *et al.*	2016	*Langenbecks Arch Surg*	14	Superior mesenteric/portal vein	Robotic-assisted pancreatoduodenectomy with resection and reconstruction of the superior mesenteric/portal vein
Robotic vascular resections during Whipple procedure	Allan *et al.*	2018	*J Vis Surg*	N/A	N/A	N/A; technical review article
Robotic pancreatoduodenectomy with vascular resection: Outcomes and learning curve	Beane *et al.*	2019	*Surgery*	50	(I) Side-bite or tangential resection using a linear stapler. (II) Venorrhaphy using 5-0 polypropylene suture or placement of a bovine pericardial patch. (III) Segmental resection and primary veno-venous anastomosis	Robotic pancreatoduodenectomy
Resection or repair of large peripancreatic arteries during robotic pancreatectomy	Kauffmann *et al.*	2020	*Updates Surg*	31	Resection or repair of arterial segments in five cases (1.3%): celiac trunk (n=1), hepatic artery (n=2), splenic artery (n=1), and superior mesenteric artery (n=1)	Robotic-assisted pancreatic resection
Tangential Venous Resections during Robotic-Assisted Pancreaticoduodenectomy: the Results of a Case Series (with Video)	Marino *et al.*	2020	*J Gastrointest Surg*	8	Superior mesenteric/portal vein	Robotic-assisted pancreaticoduodenectomy with tangential portal/superior mesenteric vein resection/reconstruction
Surgical, survival, and oncological outcomes after vascular resection in robotic and open pancreaticoduodenectomy	Shyr *et al.*	2020	*Surgical Endoscopy*	11	Superior mesenteric/portal vein	Robotic-assisted pancreaticoduodenectomy
Robotic Resection and Reconstruction of the Superior Mesenteric Vein Without Graft During Pancreatoduodenectomy (with Video)	Machado *et al.*	2021	*J Gastrointest Surg*	1	SMV resection and primary anastomosis	Robotic-assisted pancreaticoduodenectomy with superior mesenteric artery-first approach
Robotic versus open pancreaticoduodenectomy with vascular resection for pancreatic ductal adenocarcinoma: surgical and oncological outcomes from pilot experience	Jin *et al.*	2022	*Langenbecks Arch Surg*	14	Partial venous resection and venorrhaphy or segmental resection with primary veno-venous anastomosis	Robotic-assisted pancreaticoduodenectomy with superior mesenteric artery-first approach
Minimally-invasive versus open pancreatoduodenectomies with vascular resection: A 1:1 propensity-matched comparison study	Yang *et al.*	2022	*J Minim Access Surg*	6	Venous reconstruction and/or arterial reconstruction	Robotic-assisted pancreatoduodenectomy

N/A, not available; SMV, superior mesenteric vein; DP, distal pancreatectomy; PDs, pancreaticoduodenectomies.

Table 4 Advantages of robotic-assisted pancreatic resection

3D magnification 10–30×
Image resolution of surgeon console is 1,280×1,024 pixels*
Stereotactic binocular vision
Range of motion of instruments
Improved dexterity
Elimination of tremor
Improved surgeon comfort

*, for the DaVinci Xi system.

with equivalent blood loss and need for transfusion.

Advances in intraoperative visualization and landmark identification

Rompianesi *et al.* offered a systematic review, meta-analysis and report of a single-center experience in the use of intraoperative near-infrared indocyanine green (ICG)-fluorescence in detecting pancreatic tumors (65). In addition to using ICG to assess vascular and biliary structures intraoperatively, the meta-analysis demonstrated that intraoperative ICG fluorescence is able to identify pancreatic lesions with an accuracy of 81.3% and can predict margin status with 83.3% positive predictive value and 100% negative predictive value. Juhl *et al.* used a novel optical urokinase plasminogen activator receptor (uPAR) targeted probe ICG-Glu-Glu-AE105 and were also able to demonstrate clear localization of tumor deposits in an orthotopic human xenograft pancreas tumor model with increased identification of intraperitoneal metastases (61). In contrast to regular ICG, the uPAR targeted probe is specifically designed to target neoplastic pancreatic adenocarcinoma cells (of which 82% in the test sample had elevated uPAR expression). In the *in-vivo* model, the authors identified additional metastases in 50% of the mice using fluorescence guided surgery and an additional 14% using the uPAR optical guidance.

Discussion

Surgical approaches to the robotic pancreaticoduodenectomy

Herein we present the most up-to-date review of the literature regarding the technical aspects to the approach of performing the robotic-assisted pancreaticoduodenectomy. More work is required to individualize the surgical approach depending on specific anatomic factors particular to each patient. It is imperative that all robotic pancreas surgeons and trainees feel comfortable with multiple approaches to the dissection depending on the patient's anatomy and possible anomalous vascular patterns. Pre-operative radiologic assessment remains crucial to planning safe surgery using the robotic approach. Vascular resection and reconstruction has been proven safe and possible for patients undergoing robotic-assisted pancreaticoduodenectomy with similar outcomes among measured variables. The comfort of the operating surgeon remains important, especially with these advanced techniques, and we advise surgeons that are early in their learning curve to select straightforward cases until they become complete comfortable using the platform and all of the robotic instruments available. We hope that this review can be used as a resource by those interested in perfecting the robotic-assisted pancreaticoduodenectomy procedure.

What are the benefits of the robotic approach for patients with pancreatic cancer?

As discussed in several of the above-mentioned manuscripts, the robotic approach to pancreaticoduodenectomy allows 10–30× magnification, high-resolution images, improved rotational dexterity and stereotactic binocular vision (see *Table 4*). The intricate anatomy of the pancreatic head and its feeding and draining vasculature require precise technique for safe operating procedures which are enabled and enhanced with use of the robotic platform. Currently, ICG enhances intraoperative identification of vascular and hepatic anatomy and work is being done to create cancer-specific ICG tags to increase the intraoperative visualization of neoplastic tumors and possible metastatic deposits. As presented, the oncologic equivalency of robotic versus open procedures has been well established. Select data assess the impact of robotic versus open surgical intervention on the receipt of adjuvant chemotherapy and additional multidisciplinary treatment and recent work has confirmed the safety of advanced robotic-assisted oncologic dissection such as the TRIANGLE procedure.

Limitations

Like all reviews of the literature, this narrative review has limitations including that only one citation library (PubMed) was searched, that included publications were limited to only those in the English language, and that unpublished conference presentations and/or abstracts were not included despite potentially offering additional advancements in the field of robotic-assisted pancreaticoduodenectomy. Most of the included studies outline institutional and expert experiences and are therefore may not be generalizable. A quality analysis was not performed given that this was not a systematic review. Several publications included in this review offered supplemental videographic material that was not reviewed primarily but is likely to be of help for surgeons interested in learning more about the above-mentioned techniques (67,80-82).

Conclusions

In conclusion, several advances have been made in the last decade to establish robotic-assisted pancreaticoduodenectomy as a safe and oncologically equivalent surgical option for patients with pancreatic cancer. We eagerly await the results of a completed but not yet reported randomized clinical trial from the University of Heidelberg reporting on the surgical and oncologic outcomes of patients with pancreatic cancer (83). Additionally, now that several surgeons in multiple high volume centers have surpassed the learning curve, oncologic superiority should be revisited as expert robotic surgeons continue to advance the technique of robotic-assisted pancreatic surgery for patients with pancreatic cancer.

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