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Robotic-Assisted Pancreatoduodenectomy

Mohammad Khreiss · Herbert J. Zeh · Brian A. Boone · Amer H. Zureikat

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Abstract Pancreatoduodenectomy remains one of the most complex and technically challenging procedures of the upper gastrointestinal tract with a mortality rate of 5 % and morbidity of 40 %. In an attempt to refine the Whipple procedure and taking into consideration the success of minimally invasive surgery in other organ systems, some have popularized the laparoscopic pancreatoduodenectomy (LPD). However, laparoscopic surgery carries several limitations that can make the LPD difficult to implement. Use of the robotic platform offers multiple advantages that may allow robotic assisted pancreatoduodenctomy to be readily adopted. As the robotic platform becomes increasingly popular, this report will provide an up to date review on the robotic pancreatoduodenectomy.

Keywords Robotic-assisted pancreatoduodenectomy · Pancreatoduodenectomy · Whipple · Pancreatic cancer · Laparoscopic pancreatoduodenectomy · Pancreatic resection

Introduction

First performed by Allen O. Whipple in 1935 [1], pancreatoduodenectomy for periampullary lesions remains one of the most complex and technically challenging procedures of the upper gastrointestinal tract, with a mortality of 5 % and a morbidity of 40 % [2–5]. Short of the pylorus-preserving modification by Traverso and Longmire [6], the procedure has withstood the test of time since its advent. In an attempt to refine the Whipple procedure and taking into consideration the success of minimally invasive surgery in other organ systems with equal or superior outcomes [7–9], the first minimally invasive pancreatoduodenectomy (LPD) was described by Gagner and Pomp in 1994 [10]. Several series have been published since then that reported outcomes comparable to the open approach, but fell short of realizing any advantages. As a result, and due to potential benefits of the robotic platform, robotic-assisted pancreatoduodenectomy (RAPD) has been reported with increasing frequency. Here, we review the current outcomes of RAPD and LPD.

M. Khreiss · B. A. Boone
University of Pittsburgh Medical Center, Pittsburgh, PA, USA

H. J. Zeh · A. H. Zureikat (✉)
Division of GI Surgical Oncology, University of Pittsburgh Medical Center, 5150 Centre Ave, Suite 421, UPMC Cancer Pavilion, Pittsburgh, PA 15232, USA
e-mail: zureikatah@upmc.edu

Robotic-Assisted Pancreatodoudenectomy (RAPD)

Background

Despite early reports of safety, laparoscopic surgery has not been widely adopted for complex pancreatic resection and reconstruction. Today, LPD is only being performed in highly specialized centers and by highly skilled laparoscopic surgeons. We believe this is because the laparoscopic platform may not be adequate for complex uncinate dissections nor allow the fine motor skills required for safe complex reconstruction. The technology itself with two-dimensional imaging, limited range of instrument motion and poor surgeon ergonomics limits rather than augments the surgeons ability to perform these procedures through a minimally invasive approach [9, 11–13]. In an attempt to overcome these shortcomings and to maintain maximal adherence to the traditional open surgical technique, several surgeons have adopted a combined laparoscopic/robotic approach for the surgical management of peri-ampullary lesions. The use of robotics offers multiple advantages to the operating surgeon such as improved three-dimensional imaging, near 360 degree movement of surgical instruments, along with improved surgeon comfort and precision [9, 11–13]. Robotics offers elimination of tremor and improved dexterity allowing near perfect replication of the open procedure. The platform, however, is not without its limitations. From a technical point of view, one of the disadvantages of robotic surgery is its lack of haptic feedback which makes dependence on visual cues essential [11]. Another disadvantage is the inability to maneuver the patient on the table after the robot is docked. This prevents the surgeon from using gravity for exposure and makes it difficult to operate in multiple quadrants of the abdomen at the same time [11, 12]. In addition, early data suggest prolonged operative times and higher costs as expected with any new surgical technology [2, 14].

Patient Selection

At the University of Pittsburgh, we have attempted to standardize patient selection criteria and technique in order to achieve strict adherence to the principles of open PD. Surgeons performing the RAPD should be facile with the open approach and have extensive laparoscopic pancreas surgery experience. Our early experience mandated that two experienced surgeons work in unison from the bedside and consol. Our later experience has allowed for the incorporation of fellows at both the bedside and robotic console. The surgeons are supported by a dedicated robotic nursing staff in the operating room. Although initially limited by body habitus, previous abdominal surgery, and administration of neoadjuvant therapy, at the present time, the only absolute contraindication to an attempted RAPD is vascular involvement on preoperative imaging.

Technique of RAPD

The patient is positioned in the supine position on a split leg table. The right upper extremity is tucked. The distance between the head of the table and the umbilicus is always measured to maintain the robotic camera within its “sweet spot”. We use seven ports. A 5 mm optical separator is inserted to the left of the umbilicus in the left mid clavicular line (MCL) to ensure access to the abdomen—this port site will be eventually be upsized to 8 mm and serve as Robotic arm 1 (R1). A 10 mm camera port is inserted 2–3 cm above and to the right of the umbilicus. The two right sided robotic ports R2 and R3 are placed to the right of the camera in the mid clavicular and anterior axillary lines (AAL). A 5 mm liver retractor port is place in the right upper quadrant anterior axillary line. An assistant 5 mm port is inserted 4–5 cm inferior to the camera port in the right MCL, and a 4 cm utility/specimen extraction incision is placed 4–5 cm inferior to the camera in the left MCL respectively. We have found this port placement allows maximal distance between the robotic arms and prevents contact during surgery. It also allows for the assistant to have access with two surgical instruments during the procedure, which increases the collaboration between the operating surgeon and the assisting surgeon.

The first step is achieved laparoscopically with use of a LigaSure device (Covidien AG, Switzerland) and includes mobilization of the right colon and kocherization of the duodenum along with mobilization of its third and fourth portions. We usually perform a near total Cattell-Brasch maneuver to expose the SMV at the root of the small bowel mesentery. This is followed by an extended Kocher maneuver in an attempt to pull the jejunum into the right upper quadrant. The ligament of treitz is lysed. The jejunum is transected around 10 cm distal to the ligament of treitz using a linear stapler then marked with a suture around 50 cm distally and tacked to the stomach. We have learned with experience that this allows for easier reconstruction of the gastrojejunostomy, as it eliminates the need to look for the small bowel in the infracolic compartment once the robot is docked. The second step includes division of the gastrocolic omentum and entrance into the lesser sac. The posterior stomach is dissected from the anterior surface of the pancreas. The right gastric artery is ligated close to the stomach (if the pylorus is sacrificed) with Ligasure and clips. The right gastroepiploic is ligated with ligasure and clips at the corresponding greater curvature side. The stomach is divided with a linear stapler at this time and an automated liver retractor is inserted to facilitate with the exposure once the robot is docked. This laparoscopic portion of the procedure generally requires between 30 and 40 min to accomplish.

The robot is docked after the patient is positioned in reverse Trendelenburg position. The operating surgeon assumes the position at the console and the assisting surgeon stands between the legs to handle instruments and assist with suction and stapling. Dissection is carried out at the level of the superior border of the pancreas using the robotic hook to identify the common hepatic artery. The right gastric artery is doubly clipped or tied and divided at it s origin, and the GDA transected with a vascular load stapler and secured with a metal clip for future radiographic identification of needed. Care is made to check for flow in the CHA before dividing the GDA. Cholecystectomy is performed and the lymph nodes are dissected along the lateral border of the CBD taking care to identify any aberrant right hepatic artery. The CBD is identified and divided between 10 mm clips or a linear stapler to limit bile contamination to the peritoneal cavity. The portal dissection can be accomplished between 20 and 30 min.

The right gastroepiploic vein is identified and followed to its origin to locate the SMV and middle colic vein. The gastroepiploic vein is doubly clipped or tied and divided. The SMV is dissected off the inferior border of the pancreas and a tunnel is created over the portal vein. The angle afforded by the robotic camera insures safe visualization of the tunnel. After completion of the tunnel, the neck of the pancreas is divided with electrocautery, reserving sharp robotic scissor transection for the PD. The pancreas is then mobilized from the lateral border of the SMV-PV working caudad to cephalad. This dissection utilizes a hook or Maryland in R1, a Bipolar in R2, and a Pro-grasp in R3. The first jejunal branch is divided with a vascular stapler. The SMV-PV is reflected medially and the SMA is identified. Dissection proceeds along the SMA by clearing all the tissue around the anterior, right side, and posterior surface of the SMA. The superior and inferior PDA are individually identified, and divided with a vascular stapler. The superior pancreaticoduodenal vein is transected with a stapler or controlled with ties or clips. The specimen is removed and sent for pathology. This last two steps generally require between 60 and 90 min. Total time from incision to removal of the specimen including time to dock, insert ports and close incision will vary between 180 and 240 min.

Reconstruction is started with a two layered end-to-side duct to mucosa pancreaticojejunostomy using 5.0 vicryl interrupted sutures and 2.0 silk mattress sutures in a modified Blumgart fashion [15]. A 5 Fr 7 cm Hobbs (Hobbs Medical, Connecticut) pancreatic stent is placed to assure duct patency. The choledochojejunostomy is performed next. This is achieved using two 4–0 running V-loc suture for the posterior and anterior borders. An anticolic hoffmeister end to side gastrojejunostomy is hand sewn in two layers using 2–0 silk for the outer layer, and 3–0 V loc for the inner running Connell layer. We place two round JP drains at the conclusion of the procedure. One drain is placed posterior to the pancreaticobiliary limb and one anterior to it. As our experience has grown we have found that reconstruction is highly consistent case to case and rarely takes more than 120–150 min to accomplish. Total mean time for our last 50 RAPD was 444 ± 76 min.

Outcomes of RAPD

The first large series of robotic pancreatic resection was described by Giulianotti et al. [16•] in 2010 where 134 patients underwent various pancreatic procedures for disparate pathologies (See Table 1). The cohort contained 60 patients who underwent RAPD; 26 patients had adenocarcinoma of the head of the pancreas and 15 had adenocarcinoma of the ampulla of Vater. The mean operative time was 421 min (240–660 min), mean estimated blood loss was 394 ml (80–1,500 ml), and mean hospital stay was 22 days (5–85 days). Only four patients were re-operated on. Their fistula rate was 21 % in the patients who received a pancreaticojejunostomy and 36.5 % in patients who received sclerosis of the PD. When reviewing their oncologic outcomes, only five of the 60 patients had a positive margin and average lymph node harvested was 14 LNs in the series from the USA and 21 LNs from the series in Italy. The mortality rate was 1.5 %. The author concluded that RAPD is a safe and feasible procedure with mortality and morbidity profiles similar to open surgery [16]. In another report by the same author, outcomes of RAPD in patients older than 70 years of age were compared to those of patients that were younger than 70 years [17]. The authors reported no significant statistical difference in terms of operative time, blood loss, conversion rate, mortality or morbidity [17] between the two age cohorts.

At the University of Pittsburgh we published our initial experience with the first 30 patients who underwent robotic-assisted major pancreatic resection and reconstruction between 2008 and 2010 [13]. Twenty-four patients in our series underwent RAPD. The fistula rate was 21 % (5/24) as defined by the ISGPF criteria [18]. Of those, two were Grade B/C fistulas (8 %). There was one 90 day mortality whilst, Clavien Grade III/IV complications occurred in six patients (25 %) and grade I/II complications occurred in eight (33 %) [19, 20].

We recently updated this series to 50 patients who underwent RAPD for periampullary lesions [21•]. Selection criteria included patients with tumors in the head of the pancreas who did not have comorbidities that would prevent prolonged operative time in the reverse Trendelenburg position and who also had periampullary cancers defined as low risk for a non-R0 outcome based on a validated prediction rule [22]. Mean age and BMI were 68 years and 27, respectively; ASA III and II scores were 56 and 42 %, respectively. Seventy-four percent had a malignant process on final histology with adenocarcinoma of the head of the pancreas constituting 28 % of the whole cohort. Premalignant lesions represented 23 % with IPMN being the most common pathology in this group. Mean operative time was 568 min and mean estimated blood loss was 350 cc. Length of stay was an average of 10 days. Our pancreatic fistula rate was 22 % of which 12 % were ISGPF grade B and C. This was in the setting of soft glands (36 patients, 72 %) and small ducts (<3 mm in 60 % of patients). Major complications (Clavien III/IV) were seen in 30 % whereas Clavien I/II complications developed in 26 % of our patients. Ninety day readmission and mortality was 15 and 2 %, respectively. In evaluation of oncologic outcomes, the overall margin negative (R0) resection rate was 89 % and the average number of lymph node

Table 1 Selected large series of RAPD

Series	Patients (*n*)	Time (min)	Conversions (*n*)	EBL (ml)	Hospital stay (days)	Pancreatic fistulas (*n*, %)	Mortality (*n*)	Lymph nodes	RO resection (%)
Zhou [26]	8	718	0	153	16	2 (25)	0	NR	100
Buchs et al. [17]	15[a]	420[a]	0[a]	388[a]	14.3[a]	3 (20)[a]	1[a]	NR[a]	NR[a]
	26[b]	438[b]	2[b]	390[b]	11.2[b]	5 (19.2)[b]	0[b]	NR[b]	NR[b]
Giulianotti et al. [16]	50	421	11	394	22	19 (38)	2	18	90
Zeh et al. [21]	50	568	8	350	10	11 (22)	1	18	89
Chalikonda et al. [2][c]	30	476	3	485	10	2 (7)	1	13	100
Lai et al. [27]	20	492	1	247	14	7 (35)	0	10	73

NR not recorded

[a] Time for patients ages ≥70 years

[b] Time for patients ≤70 years

[c] *LR* hybrid, laparoscopic resection, robotic-assisted reconstruction

harvested was 18 [20]. More importantly, 73 % of the cohort needing adjuvant chemotherapy were fit to receive it in a timely fashion (median of 11.5 weeks from surgery). Our current experience now approaches 150 RAPDs. Our unpublished observations suggest significant improvement in OR times, EBL and fistula rate after 60–70 cases. This is consistent with previously published learning curves of open pancreatoducoentctomy [23–25]. It also suggest that any meaningful comparison of this platform to open or laparoscopic approaches must account for this significant improvement experience. Now that we have defined the plateau phase of many important operative metrics, a more comprehensive comparison is forthcoming.

To the best of our knowledge direct comparison in outcomes between RAPD and open PD has been reported in four series to date [2, 26, 27, 28•] (See Table 2). In a small series, Zhou et al. [26] reported the robotic group ($n = 8$) to have a significantly longer operating time (718 vs. 420 min), reduced blood loss (153 vs. 210 ml), and a shorter hospital stay (16.4 vs. 24.3 days) compared to the open group ($n = 8$). The robotic group had a significantly lower complication rate (25 vs. 75 %). There was no significant difference in mortality rate (0 vs. 12.5 %) and R0 resection rate (100 vs. 83.3 %) [26]. Buchs compared 44 patients who received RAPD to 39 patients who received open PD [28]. Indications for surgery were similar in both groups. The operative time was significantly shorter in the robotic group 444 vs 559 min. This might be because most patients in the robotic group did not receive a pancreaticojejunostomy. Although the estimated blood loss was significantly lower in the RAPD group, this did not translate into a significant decrease in blood transfusion. Length of stay was similar between the two groups (13 vs 14.6 days) despite the fact that patients in the robotic group suffered less complication (36.4 vs 48.7 %). Mortality rates were similar (4.5 vs 2.6 %). From an oncologic stand point, more LNs were harvested in the robotic group (16.8 vs 11) and more R0 resections were achieved (100 vs 83.3 %). The authors concluded that RAPD is at least similar if not better to open PD with regard to outcomes [28]. Chalikonda et al. [2] compared their initial 30 patients who received a hybrid laparoscopic/robotic approach to 30 patients who underwent an open PD at the Cleveland Clinic during the period between 2009 and 2010. The authors concluded that there was no significant difference in morbidity (30 vs 44 %) or mortality in both groups. The operative time was longer in the LRPD (476 vs 366 min) however the length of stay was less (9.8 vs 13.3 days). In the most recent report comparing RAPD to open PD, Lai et al. [27] reported their experience with 87 patients who received PD at their institution; 20 of those underwent RAPD. The RAPD group had significantly longer operative time (491.5 vs 264.9 min) but reduced blood loss (247 vs 774 ml) and a shorter hospital stay (13.7 vs 25.8 days). Overall complication and mortality rates were not different between the two groups. R0 resection rates and number of LNs harvested were also comparable [27].

Each of the above reports comparing RAPD to OPD must be interpreted with caution. Comparing a new surgical technology to an established procedure that has been continuously refined since 1935 is subject to number of obvious biases. For example, there is no doubt that selection bias exists in favor of straight forward cases in early RAPD reports; in fact, we purposely biased our early experience with this technology to favor patient safety. Second, each of these institutions' early robotic experience is considered to be within the "learning curve" for this approach; thus the true improvement for this new technology may be underestimated.

Table 2 Selected series comparing RAPD and OPD

	Chalikonda et al. [2]		Zhou et al. [26]		Lai et al. [27]		Buchs et al. [28]	
	RAPD	*OPD*	*RAPD*	*OPD*	*RAPD*	*OPD*	*RAPD*	*OPD*
Patients (*n*)	30	30	8	8	20	67	44	39
Time (min)	476	366	718	420	492	265	444	559
EBL (ml)	485	775	153	210	247	775	387	827
Hospital stay (days)	10	13	16	24	14	26	13	15
Pancreatic fistulas (*n*, %)	2 (6)[a]	5[b](17)	2 (25)	3 (38)	7 (35)	12 (18)	8 (18)	8 (21)
Lymph nodes	13	12	NR	NR	10	10	17	11
R0 resection (%)	100	87	100	83	73	64	91	82

NR not recorded

[a] 1 Grade B and 1 Grade C

[b] 2 Grade B and 3 Grade C

Table 3 Selected large series of LPD

Series	Patients (*n*)	Time (min)	Conversions (*n*)	EBL (ml)	Hospital stay (days)	Pancreatic fistulas (*n*, %)	Mortality (*n*)	Lymph nodes	RO resection (%)
Dulucq et al. [30]	25	287	3	107	16.2	1 (4)	1	18	100
Pugliese et al. [31]	19	461	6	180	18	3 (16)	0	12	100
Cho et al. [32]	15	338	0	445	16.4	2 (13)	0	19	100
Palanivelu et al. [33]	75	357	0	74	8.2	5 (7)	1	14	97
Kendrick & Cusati [34]	65	368	3	240	7	11 (18)	1	15	89
Zureikat et al.[36]	14	456	2	300	8	5 (36)	1	19	100
Kim et al. [35][b]	100	487	0	NR	15	6 (6)	1	13	100
Asbun & Stauffer [37]	53	541	9	195	8	7 (16.7)	3	23	95

NR not recorded

[a] *LRPD* laparoscopic robotic pancreaticoduodenectomy, which refers to laparoscopic resection, robotic-assisted reconstruction

[b] *LPPD* laparoscopic pylorus-preserving pancreaticoduodenectomy

Outcomes of Laparoscopic Pancreatoduodenectomy (LPD)

The first report of 10 cases of LPD by Gagner and Pomp in 1997 did not favor use of the laparoscopic over the open approach due to the high conversion rate (40 %) and lack of any perceived benefits [29]. Several studies (see Table 3) have reported their experience with LPD [30–33, 34•, 35] whilst others have directly compared outcomes to open procedures [36, 37•]. The first substantial report was published in 2007—a decade after Gagner and Pomp—by Palanivelu and colleagues [33]. In their series of 75 patients, they demonstrate the advantages and feasibility of LPD when performed by highly skilled surgeons. They reported an impressive operating time of 357 min (range 270–650) with a mean blood loss of 74 ml (range 35–410). Average hospital stay was 8.2 days (range 6–42) and mean time to bowel function was 3 days. They had no conversion to open technique with an overall postoperative morbidity of 26.7 % and a mortality rate of 1.3 %. Impressively, pancreatic fistula (which was not reported in ISGPF format) occurred in five patients (6.7 %); four were managed conservatively and one needed reoperation [33]. These impressive results have not been replicated.

Kendrick and Cusati also reported their experience in a series of 62 who underwent totally LPD [34]. Their median operative time was 368 min (258–608 min) and median blood loss was 240 ml (30 1200 ml). The mean length of hospital stay was 7 days (4–69 days). The morbidity rate was 42 % with leak from the pancreatic anastomosis occurring in 18 % of the patients and delayed gastric emptying in 15 %. Again, since pancreatic leaks were not

Table 4 Selected series comparing LPD and OPD

	Cho et al. [32]		Zureikat et al. [36]		Asbun et al. [37]	
	LPD	*OPD*	*LPD*	*LPD*	*OPD*	*OPD*
Patients (*n*)	15	15	14	14	14	215
Time (min)	338	287	456	456	372	401
EBL (ml)	445	552	300	300	400	1032
Hospital stay (days)	16.4	15.6	8	8	9	12
Pancreatic fistulas (*n*, %)	2 (13)	2 (13)	5[a] (36)	5[a] (36)	6[b] (43)	29[d] (17.3)
Lymph nodes	19	20	19	19	19	17
R0 resection (%)	100	100	100	100	92	83

NR not recorded

[a] Grade A 5, Grade B/C 0

[b] Grade A 5, Grade B/C 1

[c] Grade A 3, Grade B/C 4

[d] Grade A 14, Grade B/C 15

reported using the ISGPF guidelines, the authors report using drains in patients that were felt to have an increased risk of pancreatic leak (patients with soft glands and/or pancreatic duct less than 3 mm in diameter). Their 30 day operative mortality was 1.6 %. It can be concluded from the above two series from India and the Mayo Clinic that LPD is not only safe and feasible with results comparable to historic open series [4], but that typical benefits of laparoscopic approaches may be realized if performed by highly skilled experienced minimally invasive surgeons. Neither of these reports takes into account the learning curve for the procedure. It is highly likely that more recent experience by both of these groups would demonstrate continued refinement and improvement in outcomes.

Kim et al. [35] described the largest series of laparoscopic pylorus preserving PD. They reported their experience of 100 cases done between 2007 and 2011 for patients with periampullary benign and malignant pathology; 37 = IPMN, 17 = solid pseudopapillary tumors, 15 = neuroendocrine tumors, 7 = serous cystic neoplasms, 7 = pancreatic ductal adenocarcinoma, 5 = tumors of the ampulla of Vater/GIST of duodenum with the remaining being for chronic pancreatitis, metastatic renal cell carcinoma and adenocarcinoma of the CBD. They reported a median operative time of 7.9 h, with a mean hospital stay of 14 days. Their overall complication rate was 25 and 6 % of their patients developed significant ISGPF pancreatic fistulae grade B or C). Closed suction drains were left near the pancreaticojejunostomy and choledochojejunostomy sites. The authors also assessed their performance as their experience with the procedure matured. Improvement was evident with decreased operative time, length of hospital stay, and complication rate in the last 35 cases of their cohort [35].

Total LPD has been compared to OPD in a number of unmatched retrospective series [31, 32, 36, 40] (see Table 4). The largest report by Asbun and Stauffer included all patients that underwent a PD between 2005 and 2011 [37]. This included 53 LPDs and 215 OPDs. The Accordion Severity Grading System [40] was used to grade morbidity. There was a statistically significant difference in intra-operative blood loss (195 vs 1032 ml), blood transfusions (0.64 vs 4.7 units), hospital stay (8 vs 12 days) as well as length of ICU stay (1.1 vs 3 days), favoring laparoscopic over open PD. On the other hand, there were no differences in overall complications, pancreas fistula, or delayed gastric emptying. There was also no significant difference with respect to the 100 day mortality rate. Again, similar to robotic series, this direct comparison of LPD to open approach utilized the "learning curve" portion of LPD. No attempt was made to establish a comparison between peak performance with the new technology versus the well-established open approach.

From an oncological perspective, data suggests that the LPD yields comparable short term oncological outcomes of R0 margins and lymph node harvest. Most series report an average of 15 lymph nodes resected and an R0 resection margin close to 100 % [30–36, 38•]. This impressive data however reflects the selection bias of operating on smaller tumors not in proximity to major vasculature. Only Palanivelu et al. [39] stratified survival according to pathologic diagnosis and stage of disease and showed favorable results in LPD. Because of absence of long term follow-up, heterogeneity of pathology, small sample size, and lack of direct matched comparison to open PD, long term oncologic outcomes of LPD remain unknown.

Conclusions

Data on RAPD is still accumulating. Short term safety and oncologic outcomes in highly selected early series suggest that is comparable to open PD. No direct comparison of the laparoscopic and robotic approaches has been undertaken; however, it is interesting to note that since its inception nearly two decades ago, only 366 TLPDs have been reported in series of 10 patients or greater. RAPD is being increasingly reported with nearly 200 cases in the last 5 years. This may represent HPB surgeons "voting with their feet" for this technology platform. Neither of the two minimally invasive procedures has yet to prove advantageous over open PD. However, as previously stressed, no meaningful direct comparison of minimally invasive PD (RAPD or LPD) to open has accounted for the learning curve. It is likely that some of these early reports may be underestimating the advantages and over estimating the complications associated with the minimally invasive approach. It is also interesting to note that where it has been examined, the learning curve for each approach appears to be very similar (around 60–70 cases). This may represent some intrinsic number of hours necessary to understand the nuances of this complex anatomical area. The next challenge for minimally invasive pancreas surgery will be to develop adequate measures of comparative effectiveness that will allow meaningful comparison of the application of these three platforms (open, laparoscopic and robotic).

Disclosure Mohammad Khreiss, Herbert J. Zeh III, Brian A. Boone and Amer H. Zureikat declare that the authors have no conflict of interest.

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