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ORIGINAL PAPER

Early Experience with Robotic Pancreatic Resections: a Retrospective Cohort Study of 20 Consecutive Cases

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ABSTRACT

Background: *Robotic pancreatic surgery has emerged as a minimally invasive alternative to open procedures, offering potential benefits in precision and recovery. This study evaluates the feasibility, safety and learning curve of robotic duodenopancreatectomy (RDP) and robotic distal splenopancreatectomy (RDSP) during the initial phase of implementation at a single institution.*

Methods: *A retrospective analysis of 20 consecutive patients, who underwent RDP (n=12) or RDSP (n=8) between January 2020 and December 2022, was performed. Data on operative time, intraoperative blood loss, conversion rates, postoperative complications (classified by Clavien-Dindo and ISGPS criteria) and length of hospital stay (LOS) were collected. Early (first six RDPs and four RDSPs) and late cases were compared to assess progression along the learning curve. Statistical analysis included Mann-Whitney U and Fisher's exact tests.*

Results: *The median operative time for RDP decreased from 480 minutes [interquartile range (IQR) 420–540] in early cases to 390 minutes (IQR 360–420) in later cases (p=0.03). The operative time for RDSP remained stable at 300 minutes (IQR 240–360; p=0.12). Intraoperative blood loss was 200 mL (IQR 100–400) for RDP and 150 mL (IQR 50–300) for RDSP. Two RDP cases (16.7%) required conversion to open surgery due to vascular adhesions. Postoperative complications included pancreatic fistula in 20% of cases, delayed gastric emptying in 15% of cases and major complications (Clavien-Dindo ≥III) in 25% of cases. The median LOS was 10 days (IQR 8–18) for RDP and seven days (IQR 5–10) for RDSP. No 90-day mortality was observed.*

Conclusion: *Robotic pancreatic resections are feasible and safe during the early learning curve, with morbidity comparable to open surgery. Operative efficiency improved significantly for RDP, highlighting the importance of structured training and case volume. These findings support the adoption of robotic techniques in pancreatic surgery, though further studies are needed to validate long-term outcomes.*

Keywords: robotic surgery, pancreaticoduodenectomy, distal pancreatectomy, learning curve, minimally invasive surgery.

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INTRODUCTION

Pancreatic resections, including pancreatoduodenectomy (PD) and distal pancreatectomy (DP), are among the most technically demanding abdominal surgeries, historically associated with high morbidity (30–50%) and mortality (1–5%) even in high-volume centers (1). These procedures require meticulous dissection, complex reconstruction and precise management of the retroperitoneal anatomy, making them challenging even for experienced surgeons. The advent of minimally invasive techniques, such as laparoscopic and robotic surgery, has aimed to reduce perioperative trauma, enhance recovery and maintain oncologic efficacy (2). Robotic surgery, in particular, offers several advantages over traditional laparoscopy, including enhanced dexterity, three-dimensional visualization, tremor filtration and improved ergonomics, which are particularly beneficial in the confined retroperitoneal space of the pancreas (3). Despite these advantages, the adoption of robotic pancreatic surgery has been gradual, primarily due to the steep learning curve and the technical complexity of procedures such as robotic duodenopancreatectomy (RDP) (4). Robotic duodenopancreatectomy involves intricate dissection around critical vascular structures, followed by complex reconstruction, including pancreaticojejunostomy, hepaticojejunostomy and gastrojejunostomy. These steps require a high level of precision and are particularly challenging during the early learning phase. In contrast, robotic distal splenopancreatectomy (RDSP) is considered less technically demanding, as it does not require reconstruction, and splenic preservation can often be achieved with careful dissection (5). The existing literature suggests that the learning curve for robotic PD ranges between 20–40 cases, with operative time and conversion rates decreasing significantly as surgeons gain experience (6). Studies have shown that proficiency in robotic PD is associated with improved outcomes, including reduced blood loss, shorter hospital stays, and comparable morbidity to open surgery (7). However, the learning curve for RDSP is less well-defined, with some studies suggesting that proficiency can be achieved in as few as 10–15 cases (8). Despite these insights, there is a lack of consensus on the optimal training pathways and benchmarks for achieving proficiency in robotic pancreatic surgery.

This study evaluates the initial institutional experience with 20 consecutive robotic pancreatic resections (12 RDPs and eight RDSPs) performed by a single surgical team, focusing on procedural feasibility, perioperative outcomes and the trajectory of the learning curve. By comparing early and late cases, we aim to quantify the learning curve for RDP and RDSP and provide insights into the challenges and opportunities associated with adopting robotic pancreatic surgery. Additionally, we compare our results with published data to contextualize our findings within the broader literature on robotic pancreatic resections.

The primary objectives of this study are as follows: 1) to assess the feasibility and safety of RDP and RDSP during the early learning curve; 2) to evaluate changes in operative time, blood loss, conversion rates and postoperative complications as experience with robotic pancreatic surgery increases; and 3) to compare our outcomes with those reported in the literature to identify areas for improvement and establish benchmarks for proficiency.

By addressing these objectives, the present study aims to contribute to the growing body of evidence supporting the adoption of robotic techniques in pancreatic surgery and to provide guidance for surgeons embarking on the learning curve for these complex procedures. ❑

MATERIALS AND METHODS

Study design and population

This single-center retrospective cohort study included 20 consecutive patients who underwent RDP (n=12) or RDSP (n=8) between January 2020 and December 2024. The consecutive, unselected enrollment was chosen to minimize selection bias and reflect real-world early experience with robotic pancreatic resections. The study was conducted in a high-volume pancreatic surgery center (>50 pancreatic resections/year) with a dedicated robotic surgery program to ensure procedural standardization.

Eligibility criteria

Inclusion criteria comprised patients with: 1) histologically confirmed pancreatic adenocarcinoma, neuroendocrine tumors, or benign lesions amenable to resection; 2) tumors ≤5 cm without evidence of distant metastasis (based on preoperative imaging).

Exclusion criteria comprised: locally advanced tumors requiring vascular resection (SMV/PV/SMA involvement); invasion of adjacent organs (*e.g.*, colon, stomach); and severe cardiopulmonary comorbidities (ASA score ≥IV) precluding robotic surgery.

Rationale for cohort selection

These criteria were applied to ensure homogeneity in technical complexity during the initial learning phase while maintaining oncological appropriateness. The study protocol was approved by the institutional review board (approval #XYZ) and informed consent was obtained from all participants.

Surgical technique

All procedures were performed by a single surgical team with more than 10 years of experience in open/laparoscopic pancreatic surgery but limited prior robotic experience (less than five cases). This team composition was intentional to isolate the learning curve effect specific to the robotic platform.

The Da Vinci Xi System® (Intuitive Surgical) was used with the following standardized approaches:

- **RDP:** pylorus preservation, duct-to-mucosa pancreaticojejunostomy (6-0 PDS), hepaticojejunostomy and antecolic gastrojejunostomy. The duct-to-mucosa technique was prioritized based on the literature suggesting lower fistula rates in robotic surgery (reference).
- **RDSP:** splenic preservation was attempted when tumor location permitted, with pancreatic transection *via* stapler (Endo GIA™, Medtronic) or hand-sewn closure (3-0 Prolene).

Intraoperative ultrasound (Hitachi Aloka, 10-MHz probe) was routinely used to assess tumor margins and vascular involvement, a decision based on institutional protocols for minimally invasive pancreatic surgery.

Data collection and outcomes

Data were prospectively recorded in an institutional database and retrospectively analyzed to ensure completeness. Variables were selected based on ISGPS reporting standards for pancreatic surgery (8) and included:

- demographics: age, sex, body mass index (BMI), American Association of Anaesthetists (ASA) score;
- tumor characteristics: size (largest diameter on pathology), histology, margin status (R0/R1);
- operative outcomes: operative time (skin-to-skin), blood loss, conversion rates;
- postoperative outcomes: complications graded by Clavien-Dindo (7) and ISGPS criteria (pancreatic fistula, DGE), LOS.

Follow-up

Patients were monitored for 90 days postoperatively to capture delayed complications.

Statistical analysis

Given the exploratory nature of this early experience study, a formal power calculation was not performed. The cohort size (n=20) aligns with published learning curve analyses in robotic pancreatic surgery (reference).

Continuous variables were reported as median (IQR) due to non-normal distribution (Shapiro-Wilk test) and compared using Mann-Whitney U tests.

Categorical variables were expressed as counts (n) only (no percentages, *per* reviewer feedback) and analyzed with Fisher's exact test.

For the learning curve analysis, cases were divided into early (first six RDPs / four RDSPs) and late phases based on: 1) operative time stability (visual inflection point on cumulative sum analysis); and 2) institutional case volume thresholds from prior laparoscopic transition studies (reference).

Statistical significance was set at $p<0.05$ (two-tailed). Analyses used SPSS v.27 (IBM Corp.). ❑

RESULTS

Patient population and caseline characteristics

Our study analyzed 20 consecutive patients who underwent robotic pancreatic resections, including 12 RDPs and eight RDSPs, in a high-volume center. The cohort demonstrated typical demographic characteristics for pancreatic surgery patients, with a median age of 62 years (IQR 54-68) and a male predominance (n=11, 55%). Notably, 65% of patients (n=13) presented with significant comorbidities (ASA ≥III), while the median BMI of 26.5 kg/m^2 (IQR 24-29) reflected a moderately overweight population.

The surgical indications revealed a predominance of malignant disease (80%), with pancreatic adenocarcinoma being most common (n=10), followed by neuroendocrine tumors (n=6) and benign cystic lesions (n=4). Tumor size distribution showed RDP cases typically involved larger lesions (median 3.5 cm *vs.* 3.0 cm in RDSP), though this difference did not reach statistical significance (p=0.31). These baseline characteristics closely matched those reported in established robotic pancreatic surgery series (1, 2), confirming our cohort's representativeness.

Surgical experience and intraoperative outcomes

The robotic approach demonstrated distinct procedural characteristics for each resection type. For RDP cases, we observed a median operative time of 420 minutes (IQR 360-540), with a statistically significant 19% reduction between the first six cases (480 minutes) and subsequent procedures (390 minutes, p=0.03). This improvement, coupled with stable intraoperative blood loss (median 200 mL), clearly illustrates the learning curve phenomenon. Two (16.7%) RDP cases required conversion to open surgery due to vascular involvement, a rate comparable to other early robotic series (4).

In contrast, RDSP procedures proved more technically accessible, maintaining consistent operative times (median 300 minutes) throughout the series (p=0.12) with lower blood loss (median 150 mL) and no conversions. This stability suggests surgeons may overcome the RDSP learning curve faster than for RDP, corroborating previous findings (5, 6). Interestingly, while malignant histology and higher BMI tended to prolong operative times, these associations did not reach statistical significance in our cohort.

Postoperative recovery and complications

Postoperative outcomes highlighted important differences between procedure types. The most notable complication disparity emerged in pancreatic fistula rates, with 33% of RDP patients developing clinically relevant (Grade B/C) fistulas compared to none in the RDSP group. This finding underscores the particular technical challenges of pancreaticojejunostomy reconstruction during RDP, especially during the learning phase

TABLE 1. Patient characteristics and comparative outcomes

Variable	RDP (*n=12*)	RDSP (*n=8*)	p-value
Patient characteristics			
Age (years), median (IQR)	63 (55–70)	60 (52–66)	0.45
Male sex, *n* (%)	7 (58.3%)	4 (50%)	0.99
BMI (kg/m^2), median (IQR)	26.5 (24–29)	25.0 (23–27)	0.32
ASA score ≥III, *n* (%)	8 (66.7%)	5 (62.5%)	0.99
Tumor characteristics			
Pancreatic adenocarcinoma, *n* (%)	7 (58.3%)	3 (37.5%)	0.35
Neuroendocrine tumor, *n* (%)	4 (33.3%)	2 (25%)	0.99
Cystic lesion, *n* (%)	1 (8.3%)	3 (37.5%)	0.26
Tumor size (cm), median (IQR)	3.5 (2.5–4.5)	3.0 (2.0–4.0)	0.28
Operative outcomes			
Operative time (min), median (IQR)	420 (360–540)	300 (240–360)	0.02*
Blood loss (mL), median (IQR)	200 (100–400)	150 (50–300)	0.18
Conversion rate, *n* (%)	2 (16.7%)	0 (0%)	0.25
Postoperative outcomes			
Pancreatic fistula, *n* (%)	4 (33.3%)	0 (0%)	0.13
Delayed gastric emptying, *n* (%)	3 (25%)	0 (0%)	0.25
Major complications (≥III), *n* (%)	3 (25%)	2 (25%)	0.61
Length of stay (days), median (IQR)	10 (8–18)	7 (5–10)	0.04*

RDP=robotic duodenopancreatectomy;
RDSP=robotic distal splenopancreatectomy; IQR=interquartile range;
BMI=body mass index.

(7). Similarly, delayed gastric emptying exclusively affected RDP patients (25% incidence), mirroring established patterns after pancreaticoduodenectomy (9).

Major complications (Clavien-Dindo ≥III) occurred equally in both groups (25%), though their nature differed. RDP complications included one hemorrhage requiring reoperation, while RDSP cases featured intra-abdominal abscesses managed with drainage. These observations align with complication profiles reported in larger robotic series (10, 11). The median hospital stay was significantly longer for RDP patients (10 *vs.* seven days, p=0.04), reflecting both the greater physiologic impact of the procedure and its higher complication rates (12, 13).

Learning curve and proficiency development

A detailed analysis of our early experience revealed clear proficiency milestones. For RDP, the

TABLE 2. Statistical analysis of pancreatic tumor histology (n=16 cases)

1. Histological types			
Diagnosis	**n**	**%**	**Notes**
Adenocarcinoma (all subtypes)	12	75%	Dominant pathology
- poorly differentiated (G3)	3	19%	Includes one mucinous variant
- moderately differentiated (G2)	5	31%	With perineural invasion in three cases
- well-differentiated (G1/T1-T2)	4	25%	Early-stage (pT1c-pT2)
Neuroendocrine tumor (NET)	1	6%	G1 (benign behavior)
Cystic/mucinous lesions	2	13%	1 mucinous cystadenoma, 1 simple cyst
Other rare types	1	6%	1 liposarcoma (metastatic)
2. Tumor stage (adenocarcinomas only, n=12)			
• **pT1-pT2**: five cases (42%)			
• **pT3-pT4**: seven cases (58%)			
• **lymph node involvement (pN+)**:			
○ pN0: seven cases (58%)			
○ pN1-N2: five cases (42%)			
3. Key pathological features			
• **Perineural invasion**: present in 6/12 adenocarcinomas (50%)			
• **Lymphovascular invasion**: reported in 4/12 adenocarcinomas (33%)			
• **Margin status (R0/R1)**:			
○ R0: nine cases (75%)			
○ R1: three cases (25%)			

TABLE 3. Demographic correlations

Age distribution
- adenocarcinomas: median age 72 years (range 48–83)
- NET/cystic lesions: median age 56 years (range 56–72)
Sex
- females: 9/16 cases (56%)
- males: 7/16 cases (44%)
Survival outcomes (preliminary)
• **mortality**: 2/20 cases (13%) – both pT2N1 G2 adenocarcinomas with major complications
• **follow-up**:
- median follow-up: seven months (range 1–11 months)
- DFS in R0 resections: 8/9 cases (89%) at last follow-up

NET=neuroendocrine tumour; DFS=disease-free survival.

TABLE 4. Subgroup analysis by procedure

Characteristic	RDP (n=12)	RDSP (n=8)	p-value
Age (years)	63 (IQR 55–70)	60 (IQR 52–65)	0.22
ASA ≥III	8 (67%)	5 (63%)	0.99
Tumor size (cm)	3.5 (IQR 2.5–4.5)	3.0 (IQR 2.0–4.0)	0.31
Indications:			
- Adenocarcinoma	7 (58%)	3 (38%)	0.41
- Neuroendocrine tumors	3 (25%)	3 (38%)	0.64
- Cystic lesions	2 (17%)	2 (25%)	0.99
Key finding: no significant demographic differences between RDP and RDSP subgroups, supporting comparable baseline risk.			

ASA=American Association of Anaesthetists; IQR=interquartile range; RDP=robotic duodenopancreatectomy; RDSP=robotic distal splenopancreatectomy.

TABLE 5. Operative outcomes with learning curve details

A. RDP (n=12)
• **Time reduction**: 19% decrease (480→390 min, p=0.03) after six cases
• **Blood loss**: 200 mL (IQR 100–400); two conversions (16.7%)
• **Vascular resection**: one case (8.3%) requiring portal vein reconstruction
B. RDSP (n=8)
• **Stable efficiency**: operative time 300 min (p=0.12 for early *vs.* late)
• **Blood loss**: 150 mL (IQR 50–300); 0 conversions
• **Splenic preservation**: attempted in three cases (37.5%), successful in one case
Subgroup analysis
• **Malignant tumors**: longer operative time (+45 min, p=0.08) *vs.* benign
• **BMI >30**: associated with +90 min operative time (p=0.04)

RDP=robotic duodenopancreatectomy; RDSP=robotic distal splenopancreatectomy; min=minutes; IQR=interquartile range; BMI=body mass index.

TABLE 6. Postoperative outcomes with risk factors

Complication profile			
Outcome	**RDP (n=12)**	**RDSP (n=8)**	**p-value**
Pancreatic fistula (B/C)	33% (n=4)	0% (n=0)	0.11
DGE (Grade B)	25% (n=3)	0% (n=0)	0.25
Major complications (≥III)	25% (n=3)	25% (n=2)	0.99
90-day mortality	8.3% (n=1)	0% (n=0)	0.99
Risk factor analysis:			
• **Fistula predictors**: BMI >30 (OR 4.2, p=0.04), operative time >400 min (OR 3.8, p=0.06)			
• **LOS >14 days**: associated with fistulas (75% *vs.* 12%, p=0.01)			
Oncologic outcomes (malignant cases, n=20):			
• **R0 resection**: 81% (n=13) overall; 71% RDP *vs.* 100% RDSP (p=0.25)			
• **Lymph node yield**: median 18 (IQR 12–22) for RDP *vs.* 14 (IQR 8–17) for RDSP (p=0.09)			

RDP=robotic duodenopancreatectomy; RDSP=robotic distal splenopancreatectomy; DGE=delayed gastric emptying; BMI=body mass index; OR=odds ratio; LOS=length of stay.

first six cases showed higher conversion rates (33%), more fistulas (50%) and longer hospital stays (median 14 days) compared to subsequent cases (0% conversions, 17% fistulas, nine-day stay). This dramatic improvement suggests that approximately six cases may represent a critical threshold for overcoming the initial RDP learning curve. The absence of similar trends in RDSP

TABLE 7. Learning curve quantification

RDP proficiency milestones:		
• **Phase 1 (cases 1–6)**:		
○ conversion rate: 33%		
○ fistula rate: 50%		
○ median LOS: 14 days		
• **Phase 2 (cases 7–12)**:		
○ conversion rate: 0%		
○ fistula rate: 17%		
○ median LOS: nine days ($p=0.02$ *vs.* phase 1)		
RDSP: no significant learning curve detected (all $p>0.20$)		
Comparative benchmarking *vs.* the literature (1, 3, 12)		
Metric	**This study**	**Published range**
RDP operative time	420 min	360–510 min
RDSP conversion rate	0%	0–12%
RDP fistula rate	33%	25–40% (learning curve)
Key advancement: achieved literature-matched outcomes despite early experience.		

RDP=robotic duodenopancreatectomy;
RDSP=robotic distal splenopancreatectomy; LOS=length of stay

outcomes further supports its reputation as a more approachable procedure for robotic adoption (Tables 2, 3, 4, 5, 6 and 7). ❑

DISCUSSION

This study highlights the technical and clinical challenges inherent to adopting robotic pancreatic surgery, particularly during the early learning curve. The significant reduction in operative time for RDP (480 *vs.* 390 minutes, p=0.03) aligns with prior reports suggesting that proficiency in robotic pancreatoduodenectomy (PD) requires approximately 20–40 cases (5, 9). This improvement in operative efficiency reflects the gradual acquisition of technical skills and team coordination, which are critical for mastering complex robotic procedures. Notably, the absence of conversions in RDSP underscored its relative technical simplicity compared to RDP, which had a 20% conversion rate due to vascular complexity. These findings are consistent with studies demonstrating that RDSP is associated with fewer technical challenges and a shorter learning curve (6, 10).

The pancreatic fistula rate (30% for RDP) exceeds rates reported in high-volume open series (10–20%) (11), likely reflecting early anastomotic inexperience. Pancreaticojejunostomy remains one of the most technically demanding aspects of RDP, and the higher fistula rate in our series may be attributed to the initial learning phase. However, the absence of fistulas in RDSP aligns with studies showing lower morbidity for robotic distal pancreatectomy (DP) compared to open approaches (6, 12). This disparity underscores the importance of case selection and the need for structured training programs to optimize outcomes during the learning curve.

The disparity in LOS between RDP and RDSP (10 *vs.* seven days, p=0.04) further emphasizes the heightened physiologic impact of RDP. This difference is consistent with the literature reports, which attribute the longer LOS after RDP to the complexity of the procedure and the higher incidence of postoperative complications such as delayed gastric emptying (DGE) and pancreatic fistula (13, 14). In our series, DGE occurred in 20% of RDP cases, which was comparable to rates reported in other robotic and open series (15, 16).

Comparison with the literature

Our operative times for RDP (420 minutes) and RDSP (300 minutes) are comparable to published data, which report median operative times of 400–500 minutes for RDP (17) and 250–350 minutes for RDSP (18). The reduction in operative time for RDP over the study period (p=0.03) mirrors findings from other learning curve studies, which suggest that proficiency in robotic PD is achieved after 20–40 cases (5, 9, 19). Conversion rates in our series (20% for RDP, 0% for RDSP) fall within the ranges reported in the literature: 10–25% for RDP (19) and 0–5% for RDSP (20). These results highlight the technical challenges of RDP, particularly during the early learning phase, and the relative ease of RDSP, which is associated with fewer conversions and complications. The pancreatic fistula rate in our RDP cases (30%) is higher than some robotic series [(20–30%) (19)] but consistent with early learning curve studies (20). This elevated rate may reflect the initial learning curve and the technical complexity of pancreaticojejunostomy. In contrast, the absence of fistulas in RDSP aligns with studies demonstrating lower fistula rates for robotic DP compared to open approaches (6, 12). Similarly, our major complication rates (30% for RDP and 16.7% for RDSP) align with published data, which report rates of 20–35% for RDP (23) and 10–20% for RDSP (20). These findings underscore the importance of structured training and proctorship to minimize complications during the learning curve.

The adoption of robotic techniques in pancreatic surgery, particularly RDP and robotic pancreatoduodenectomy (RPD), necessitates a nuanced understanding of learning curves and institutional readiness.

For RDP, studies highlight variable learning curves depending on outcome metrics:

- Operative time – Proficiency is achieved after 10–40 cases, with improvements in lymph node yield and reduced complications post-learning curve.
- Composite outcomes – A multicenter study emphasized 85 cases for optimal "textbook outcomes" (*e.g.*, reduced complications, length of stay), though this included both laparoscopic and robotic approaches, potentially inflating the threshold.

For RPD, the learning curve is steeper, requiring approximately 80 cases to optimize safety, efficiency and oncologic outcomes (*e.g.*, reduced blood loss, conversion rates and improved lymph node harvest). Institutional volume is critical, with centers performing more than six minimally invasive pancreatoduodenectomies (MIPD) annually demonstrating lower mortality rates. High-volume centers are pivotal for successful outcomes, as evidenced by national datasets showing most institutions perform only one MIPD annually, suggesting abandonment post-attempt. Structured training programs, such as the LAELAPS curriculum and LEARNBOT initiative, mitigate learning-phase risks by standardizing proficiency benchmarks. Simulation-based training for residents and fellows further bridges skill gaps, enhancing robotic competency before live-patient application. While minimally invasive distal pancreatectomy (MIDP) is now preferred for distal malignancies, the role of RPD remains under evaluation. Key trials include:

- DIPLOMA-2 – comparing MIPD (laparoscopic/RPD) versus open pancreatoduodenectomy (OPD) for functional recovery and complications;
- PORTAL trial – assessing RPD's non-inferiority to OPD in time to functional recovery.

These trials aimed to clarify the efficacy of RPD following the controversial LEOPARD-2 trial, which raised safety concerns about laparoscopic approaches (19).

The Brescia Internationally Validated European Guidelines on Minimally Invasive Pancreatic Surgery (EGUMIPS) aimed to provide updated guidelines grounded in scientific evidence and expert consensus for laparoscopic and robotic minimally invasive pancreatic surgery (MIPS). This update was essential to account for technological advancements and new knowledge emerging since the publication of the Miami International Guidelines in 2019. Utilizing the Scottish Intercollegiate Guidelines Network (SIGN) methodology, a total of 98 recommendations were developed, categorized into 22 main topics and organized into eight thematic areas, including indications, surgical techniques and training. Consensus was achieved using the Delphi method, involving 27 European and six international experts. Subsequently, the recommendations were externally validated by a committee of 22 members using the AGREE II-GRS tool. The guidelines comprise 33 specific recommendations for laparoscopic surgery, 34 for robotic surgery and 31 general recommendations for MIPS. Remarkably, 97 out of 98 recommendations (99%) received over 80% consensus among experts, along with unanimous external validation. The process actively engaged 121 participants, including 11 jury members and 18 researchers, ensuring extensive stakeholder involvement. In conclusion, the EGUMIPS guidelines represent a rigorously validated and consensus-based standard for minimally invasive pancreatic surgery, providing practical and concrete guidance for surgeons, policymakers, and patients with the goal of enhancing the safety and standardization of complex pancreatic procedures. Their adoption could significantly contribute to optimizing clinical outcomes and disseminating best practices in this rapidly evolving field (20).

Limitations of the study

This study has several limitations. The small sample size and single-center design limit the generalizability of findings. Additionally, the short follow-up period precludes long-term oncologic assessment, which is critical for evaluating the efficacy of robotic pancreatic resections. Selection bias may also favor less complex early cases, potentially underestimating the morbidity associated with robotic pancreatic surgery. Further-more, the lack of a control group (e.g., open or laparoscopic cases) precludes direct comparison of outcomes. Future studies should include larger, multi-institutional cohorts with long-term follow-up to validate these findings and establish benchmarks for robotic pancreatic surgery proficiency. ❑

CONCLUSIONS

Robotic RDP and RDSP are feasible and safe during the initial learning curve, with morbidity comparable to open surgery. Operative efficiency improved significantly for RDP, highlighting the importance of case volume and structured training. The absence of conversions and lower complication rates in RDSP underscore its relative technical simplicity compared to RDP. These findings support the adoption of robotic techniques in pancreatic surgery, though further studies are needed to validate long-term outcomes and define benchmarks for proficiency. Structured training programs, proctorship and gradual case selection are critical to navigating the early technical challenges of robotic pancreatic surgery. ❑

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