



## Original Article

# Perioperative outcomes of robot-assisted pancreatoduodenectomy (PD) and totally laparoscopic PD after overcoming learning curves with comparison of oncologic outcomes between open PD and minimally invasive PD

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**Backgrounds/Aims:** Minimally invasive pancreatoduodenectomy (MIPD), such as totally laparoscopic pancreatoduodenectomy (TLPD) or robot-assisted pancreatoduodenectomy (RAPD), is increasingly performed worldwide. This study aimed to compare the perioperative outcomes of TLPD and RAPD, and compare the oncologic outcomes between MIPD and open pancreatoduodenectomy (OPD) for malignant disease.

**Methods:** This retrospective study was conducted at two hospitals that followed similar oncological surgical principles, including the extent of resection. RAPD was performed at Seoul National University Hospital, and TLPD at Seoul National University Bundang Hospital. Patient demographics, perioperative outcomes, and oncological outcomes were analyzed. Propensity score matching (PSM) analysis was performed to compare oncologic outcomes between MIPD and OPD.

**Results:** Between 2015 and 2020, 332 RAPD and 178 TLPD were performed. The rates of Clavien–Dindo grade  $\geq 3$  complications (19.3% vs. 20.2%,  $p = 0.816$ ), clinically relevant postoperative pancreatic fistula (9.9% vs. 11.8%,  $p = 0.647$ ), and open conversions (6.6% vs. 10.5%,  $p = 0.163$ ) were comparable between the two groups. The mean operation time (341 minutes vs. 414 minutes,  $p < 0.001$ ) and postoperative hospital stay were shorter in the RAPD group (11 days vs. 14 days,  $p = 0.034$ ). After PSM, the 5-year overall survival rate was comparable between MIPD and OPD for overall malignant disease (58.4% vs. 55.5%,  $p = 0.180$ ).

**Conclusions:** Both RAPD and TLPD are safe and feasible, and MIPD has clinical outcomes that are comparable to those of OPD. Although RAPD exhibits some advantages, its perioperative outcomes are similar to those associated with TLPD. A surgical method may be selected based on the convenience of surgical movements, medical costs, and operator experience.

**Key Words:** Pancreaticoduodenectomy; Robotic surgical procedures; Laparoscopy

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## INTRODUCTION

Pancreatoduodenectomy (PD) is the standard surgical treatment for benign and malignant periampullary tumors. Minimally invasive PD (MIPD) was performed relatively late compared to other minimally invasive surgeries, because of the laborious procedures related to anatomical complexity, and technically difficult anastomoses. With technical and instrumental developments, minimally invasive pancreatic surgery has gained increasing applications, and the indications have been expanded [1,2]. The perioperative outcomes were reported to be comparable between laparoscopic PD (LPD) and open PD (OPD) [3,4]. However, a recent randomized controlled study (RCT) (the LEOPARD-2 trial) was terminated due to data monitoring results indicating a higher 90-day mortality in individuals receiving LPD [5].

Recently, robotic surgical systems have been widely used in various surgeries. In addition to the advantages of laparoscopic surgery, they provide special functions that help surgeons perform precise movements, wrist movement, stabilization of hand tremor, and a magnified three-dimensional surgical view [6,7]. In previous reports, the robot-assisted PD (RAPD) showed perioperative outcomes comparable to those of OPD [8,9].

Although many have compared the perioperative outcomes between LPD and OPD, or between RAPD and OPD, most studies enrolled cohorts with heterogeneity in terms of the surgical extent, oncological surgery principles, or surgical indication. In addition, few studies have directly compared totally laparoscopic PD (TLPD) with RAPD. Furthermore, few small-scale studies have compared the oncologic outcomes between MIPD and OPD that are specific to malignant disease. Therefore, the present study aimed to compare the perioperative outcomes between RAPD and TLPD in tertiary academic institutes following the same oncological principles, including surgical extent and postoperative protocols, and to evaluate the feasibility and oncologic outcomes of MIPD (RAPD and TLPD), compared with those of OPD, in pathologically confirmed malignant periampullary tumors.

## MATERIALS AND METHODS

### Study cohorts

This retrospective study analyzed prospectively collected medical data of patients who had undergone RAPD and TLPD due to benign or malignant periampullary tumors between January 2015 and December 2020. The RAPDs were performed at Seoul National University Hospital, and the TLPD at Seoul National University Bundang Hospital. All perioperative outcomes included in this study were derived from surgeries conducted in the post-learning curve period. The surgeons responsible for RAPD, and TLPD, respectively, have demonstrated proficiency beyond the learning curves associated with OPD

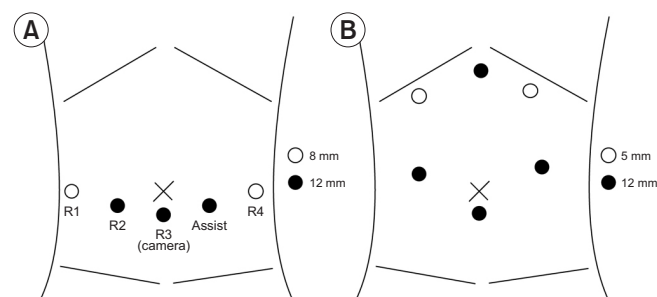
and MIPD, consistently performing over 100 PD cases annually. Patients who underwent OPD during the study period at Seoul National University Hospital were enrolled as the control group. This study was approved by the institutional review board in Seoul National University Hospital (no. 2010-063-1163), and the requirement for informed consent was waived.

### Data sources

The assessed clinical variables included preoperative demographics (age, sex, body mass index, and neoadjuvant treatment), intraoperative findings (operation time, estimated blood loss [EBL], main pancreatic duct diameter), postoperative outcomes (open conversion, complications, postoperative pancreatic fistula [POPF], and postoperative hospital stay duration), pathologic outcomes (disease location, pathologically confirmed diagnosis, R0 resection rate, number of harvested regional lymph nodes [LNs]), and total medical cost during the hospitalized period (USD \$). R0 resection status was defined as tumor-free on microscopic evaluation of the pancreas transection margin and superior mesenteric groove. All patients underwent routine computed tomography scans 4 or 5 days postoperatively to evaluate complications, and only complications with Clavian–Dindo classification  $\geq 3$  were evaluated. POPF grade was evaluated based on the International Surgery Group on Pancreatic Surgery definition [10]. The total hospitalization cost was defined as all expenses from admission to discharge, including those associated with medications, procedures, supplies, operation costs, instrument costs, and/or the cost of the robotic platform. Malignant lesions were assessed using the eighth edition of the American Joint Committee on Cancer (AJCC) staging system [11].

### Surgical procedures

Whether MIPD or OPD was performed was determined based on the possibility of major vessel resection and anastomosis, or combined major organ resection. The surgical extents of OPD, RAPD, and LPD were similar, followed by the extent of lymphadenectomy being as described in a previous multi-institutional Korean RCT, wherein D1 and D2+ $\alpha$  indicated the



**Fig. 1.** Port replacement. (A) Robot-assisted pancreatoduodenectomy, (B) totally laparoscopic pancreatoduodenectomy.

extent of lymphadenectomy in benign and malignant lesions, respectively [12]. Detailed operative procedures have been previously described [13,14]. Fig. 1 shows the port replacement of each procedure. Briefly, specimen dissection was performed with laparoscopic instruments in both RAPD and TLPD, and pancreaticojejunostomy (PJ) and hepaticojejunostomy (HJ) were performed with the da Vinci Xi system (Intuitive) in RAPD, and with laparoscopic instruments in TLPD. The duodenojejunostomy (or gastrojejunostomy) was extracorporeally performed through the extended umbilical port site after the removal of the specimen.

### Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows (version 25.0; IBM Corp.). Categorical variables were compared using the chi-squared test. Continuous variables were compared using the Student's *t*-test. Survival outcomes were calculated using the Kaplan–Meier method, and compared using log–rank tests. Statistical significance was set at  $p < 0.050$  in two-tailed tests.

Survival analyses were performed only for patients with malignant disease. Because the indications for OPD and MIPD were not comparable, 1:1 propensity score matching (PSM) analysis was performed to reduce the selection bias between

OPD and MIPD patients with malignant disease. Age, sex, neoadjuvant treatment, disease location, combined vessel resection, AJCC T and N stages, and resection margin status were included in the PSM analysis. AJCC 8th T and N stage-matched analyses were performed to evaluate the survival outcomes according to each disease.

## RESULTS

### Comparisons of demographics between RAPD and TLPD

A total of 332 RAPDs and 178 TLPDs were performed at the two hospitals. Table 1 shows the detailed patient demographics and perioperative outcomes. In the RAPD group, pancreatic disease was the most frequent ( $n = 188$ , 56.6%), followed by the ampulla of Vater ( $n = 81$ , 24.4%), and distal common bile duct (CBD;  $n = 52$ , 15.7%). In the TLPD group, distal CBD disease was the most frequent ( $n = 70$ , 39.3%), followed by the ampulla of Vater ( $n = 66$ , 37.1%), and pancreas ( $n = 36$ , 20.2%). The TLPD group showed a higher distribution of malignant diseases than the RAPD group (84.8% vs. 50.3%,  $p < 0.001$ ). The mean number of harvested LNs in pancreatic head cancer was comparable between the RAPD and TLPD (24 vs. 19,  $p = 0.157$ ), and that in non-pancreatic cancer was comparable (16 vs. 16,  $p = 0.534$ ).

**Table 1.** Patients' demographics and perioperative outcomes between RAPD and TLPD patients

|                                            | RAPD (n = 332) | TLPD (n = 178) | <i>p</i> -value |
|--------------------------------------------|----------------|----------------|-----------------|
| Demographics                               |                |                |                 |
| Age (yr)                                   | 63.6 ± 12.1    | 67.5 ± 11.8    | < 0.001         |
| Male sex                                   | 185 (55.7)     | 94 (52.8)      | 0.576           |
| BMI (kg/m <sup>2</sup> )                   | 23.5 ± 2.6     | 24.3 ± 2.9     | 0.003           |
| Neoadjuvant treatment                      | 8 (2.4)        | 0 (0)          | 0.055           |
| Disease location                           |                |                | < 0.001         |
| Pancreas                                   | 188 (56.6)     | 36 (20.2)      |                 |
| Non-pancreas                               | 144 (43.4)     | 142 (79.8)     |                 |
| Malignant disease                          | 167 (50.3)     | 151 (84.8)     | < 0.001         |
| Intraoperative findings                    |                |                |                 |
| Operation time (min)                       | 341 ± 84       | 414 ± 56       | < 0.001         |
| Estimated blood loss (mL)                  | 347 ± 232      | 326 ± 227      | 0.326           |
| MPD diameter (mm)                          | 2.6 ± 1.8      | 3.1 ± 1.6      | 0.003           |
| Postoperative outcomes                     |                |                |                 |
| R0 resection                               | 321 (96.7)     | 177 (99.4)     | 0.060           |
| Open conversion                            | 22 (6.6)       | 18 (10.5)      | 0.163           |
| Complication (C–D grade ≥ 3)               | 64 (19.3)      | 36 (20.2)      | 0.816           |
| CR-POPF                                    | 33 (9.9)       | 20 (11.8)      | 0.647           |
| 30 days mortality                          | 5 (1.5)        | 2 (1.1)        | 0.723           |
| Postoperative hospital stay duration (day) | 11 ± 10        | 14 ± 15        | 0.034           |
| Total hospitalization cost, mean (USD)     | 19,020         | 15,860         | < 0.001         |

Values are presented as mean ± standard deviation or number (%).

RAPD, robot-assisted pancreatoduodenectomy; TLPD, totally laparoscopic pancreatoduodenectomy; BMI, body mass index; MPD, main pancreatic duct; C–D, Clavian–Dindo; CR-POPF, clinically-relevant postoperative pancreatic fistula.

### Intraoperative and postoperative outcomes

Operative times were shorter in the RAPD group than in the TLPD group (341 minutes vs. 414 minutes,  $p < 0.001$ ). EBL (347 mL vs. 326 mL,  $p = 0.326$ ), open conversion rate (6.6% vs. 10.5%,  $p = 0.163$ ), complication rate of Clavian–Dindo classification grade  $\geq 3$  (19.3% vs. 20.2%,  $p = 0.816$ ), 30-day mortality rate (1.5% vs. 1.1%,  $p = 0.723$ ), and clinically relevant POPF rate (9.9% vs. 11.8%,  $p = 0.647$ ) were comparable between RAPD and TLPD. Most of the reasons for open conversion were severe inflammation and adhesion in the RAPD ( $n = 16$ ), as was the case in the TLPD ( $n = 8$ ). The mean postoperative hospital stay was shorter in the RAPD group than in the TLPD group (11 days vs. 14 days,  $p = 0.034$ ). The total hospitalization cost was statistically higher in the RAPD group (USD \$19,020 vs. \$15,860,  $p < 0.001$ ).

### Comparisons of perioperative and oncologic outcomes of malignant patients between the OPD and MIPD groups

To evaluate the oncologic outcomes of MIPD compared with those of OPD, 318 patients who underwent MIPD (167 with RAPD and 151 with TLPD) for malignant periampullary tumors were selected. Patients who underwent OPD for ma-

lignant tumors during the same period were assigned to the control group ( $n = 722$ ), and 1:1 PSM was performed (Table 2). After PSM, the age, sex, preoperative location, neoadjuvant treatment, combined vessel resection, AJCC T stage, node positivity, and R0 resection rates were comparable between the two groups.

With regard to the perioperative outcomes, complication rates (22.2% vs. 17.5%,  $p = 0.165$ ) and Grade B or C POPF rates (12.5% vs. 9.4%,  $p = 0.254$ ) were comparable after PSM. The duration of postoperative hospital stay was shorter in patients with MIPD after PSM (13 days vs. 15 days,  $p = 0.004$ ).

Overall, the median follow-up period for the patients with malignant disease was 56 months. Five-year overall survival (OS) rates of patients with malignant disease were significantly different between the MIPD and open PD groups before PSM (58.4% vs. 43.6%,  $p < 0.001$ ; Fig. 2A). However, they were comparable after PSM (58.4% vs. 55.5%,  $p = 0.180$ ; Fig. 2B). In subgroup analysis according to disease location, the 5-year OS rates of pancreatic cancer were better in MIPD patients (53.4% vs. 19.3%,  $p = 0.046$ ; Fig. 3A), while those of distal CBD cancer were comparable between MIPD and OPD (52.6% vs. 61.7%,  $p = 0.645$ ; Fig. 3B).

**Table 2.** Patient demographics and perioperative outcomes between MIPD and OPD in malignant disease

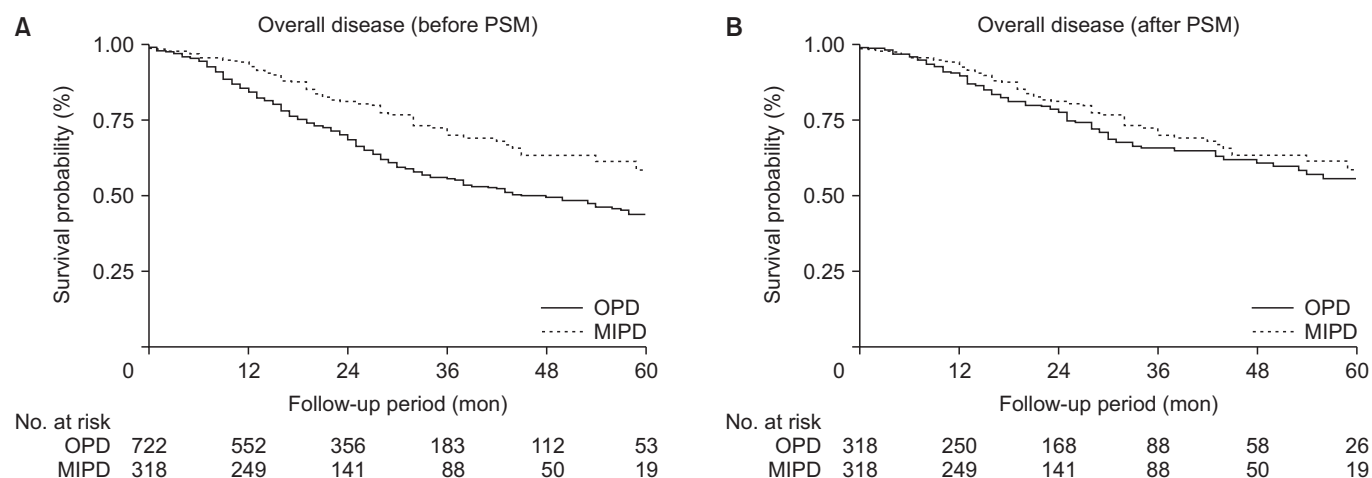
|                                            | MIPD (n = 318)  | Before PSM     |                       | After PSM      |                       |
|--------------------------------------------|-----------------|----------------|-----------------------|----------------|-----------------------|
|                                            |                 | OPD (n = 722)  | p-value <sup>a)</sup> | OPD (n = 318)  | p-value <sup>b)</sup> |
| Age (yr)                                   | 67.4 $\pm$ 10.4 | 65.7 $\pm$ 9.6 | 0.010                 | 67.0 $\pm$ 9.4 | 0.656                 |
| Male sex                                   | 171 (53.8)      | 443 (61.4)     | 0.024                 | 181 (56.9)     | 0.473                 |
| Preoperative location                      |                 |                | < 0.001               |                | < 0.001               |
| Pancreatic cancer                          | 71 (22.3)       | 365 (50.6)     |                       | 100 (31.4)     |                       |
| Non-pancreatic cancer                      | 247 (77.7)      | 357 (49.4)     |                       | 218 (68.6)     |                       |
| Neoadjuvant treatment                      | 5 (1.6)         | 133 (18.4)     | < 0.001               | 6 (1.9)        | 0.999                 |
| Combined vessel resection                  | 7 (2.2)         | 135 (18.7)     | < 0.001               | 7 (2.2)        | 0.999                 |
| Number of harvested regional LN            | 18 $\pm$ 10     | 20 $\pm$ 11    | 0.001                 | 17 $\pm$ 10    | 0.693                 |
| AJCC 8th T stage                           |                 |                | < 0.001               |                | 0.932                 |
| 1, 2                                       | 216 (67.9)      | 396 (54.8)     |                       | 217 (68.2)     |                       |
| 3, 4                                       | 102 (32.1)      | 326 (45.2)     |                       | 101 (31.8)     |                       |
| Regional LN positivity                     | 121 (38.1)      | 384 (53.2)     | < 0.001               | 128 (40.3)     | 0.569                 |
| R0 resection                               | 306 (96.2)      | 634 (87.8)     | < 0.001               | 306 (96.2)     | 0.999                 |
| Operation time (min)                       | 379 $\pm$ 84    | 300 $\pm$ 84   | < 0.001               | 249 $\pm$ 80   | < 0.001               |
| Estimated blood loss (mL)                  | 504 $\pm$ 787   | 543 $\pm$ 454  | 0.406                 | 478 $\pm$ 379  | 0.602                 |
| MPD diameter (mm)                          | 2.8 $\pm$ 1.6   | 3.1 $\pm$ 2.0  | 0.013                 | 2.6 $\pm$ 1.6  | 0.305                 |
| Complication                               |                 |                |                       |                |                       |
| C–D grade $\geq 3$                         | 70 (22.0)       | 128 (17.7)     | 0.125                 | 63 (19.8)      | 0.559                 |
| Grade B or C POPF                          | 39 (12.3)       | 56 (7.8)       | 0.021                 | 32 (10.1)      | 0.378                 |
| Postoperative hospital stay duration (day) | 13 $\pm$ 14     | 15 $\pm$ 11    | 0.004                 | 15 $\pm$ 11    | 0.004                 |

Values are presented as mean  $\pm$  standard deviation or number (%).

MIPD, minimally-invasive pancreatoduodenectomy; OPD, open pancreatoduodenectomy; PSM, propensity score matching; MPD, main pancreatic duct; C–D, Clavian–Dindo; POPF, postoperative pancreatic fistula; LN, lymph node; AJCC, American Joint Committee on Cancer.

<sup>a)</sup>p-value from MIPD and OPD before PSM.

<sup>b)</sup>p-value from MIPD and OPD after PSM.



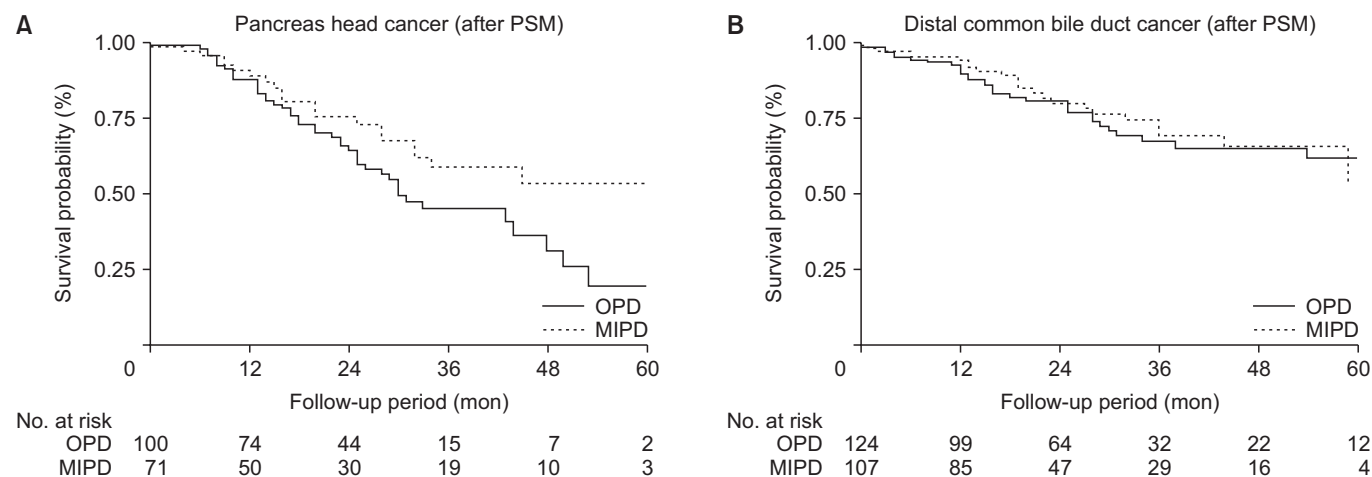
**Fig. 2.** Comparisons of the 5-year overall survival outcomes between MIPD and OPD in all malignant periampullary tumors, (A) before PSM ( $p < 0.001$ ), (B) after PSM ( $p = 0.180$ ). MIPD, minimally invasive pancreatoduodenectomy; OPD, open pancreatoduodenectomy; PSM, propensity score matching.

## DISCUSSION

Although the first LPD was introduced in 1994, MIPD was only performed in limited high-volume centers, because PD entailed two major hurdles: pancreatic uncinate process dissection attached to the superior mesenteric artery and vein, and pancreato-enteric and biliary reconstruction [15,16]. According to some studies, at least 30–60 MIPD cases were required to mature the surgical skills and overcome the learning curves, and the surgical outcomes were influenced by whether the learning curve was overcome [14,17].

Owing to the development of surgical skills, laparoscopic instruments, and collaborative educational programs, MIPDs have become popular [18]. Various types of MIPD exist; laparoscopy-assisted, totally laparoscopic, robot-assisted, and

totally robotic, and the institutions selected the safest and most feasible minimally invasive method at the time, considering their manpower and facilities. The term ‘robot-assisted PD’ is widely used, because even though the resection method differs from surgeon to surgeon, all PJ and HJ anastomoses are performed using robotic surgical systems [19]. The present study evaluated and compared the perioperative outcomes of two MIPD methods (RAPD and TLPD) at two high-volume centers in Korea that perform  $\geq 30$  MIPDs and  $\geq 100$  OPDs annually [1,14]. Compared with previous studies that were small-scale or investigated nationwide databases, the present study enrolled patients who underwent OPD or MIPD in the same period by surgeons following similar oncological surgical principles. In addition, the surgeons overcame the learning curves, and performed the MIPDs safely and feasibly.



**Fig. 3.** Comparisons of the 5-year overall survival outcomes between MIPD and OPD after PSM according to the diagnosis. (A) Pancreatic cancer. (B) Distal common bile duct cancer. MIPD, minimally invasive pancreatoduodenectomy; OPD, open pancreatoduodenectomy; PSM, propensity score matching.

Although we did not evaluate the duration of resection and anastomosis separately, the difference in the mean operation time of (341 minutes vs. 414 minutes,  $p < 0.001$ ) between the RAPD and TLPD might be due to the different pancreatic and biliary reconstruction times. Among studies on learning curves associated with MIPD, some reported that fewer cases were required to overcome the learning curve of robotic PD, compared with that of LPD [20,21]. With regard to simulation-based education for intracorporeal suturing, even novice surgeons can perform complex suturing using a robotic surgical system in a shorter time and can overcome the learning curve in fewer cases, compared with the laparoscopic surgical system [22]. Because robotic surgery can demonstrate wrist movement with stabilized hand tremor, surgeons can perform the anastomosis more comfortably with shorter procedure time and less possibility of anastomosis-related risk. In this study, the laparoscopic surgeons who participated were already experts, thereby demonstrating that the perioperative outcomes of TLPD, except for operation time, were comparable with those of RAPD (Table 1). However, unskilled laparoscopic surgeons may experience more operation-related complications than unskilled robotic surgeons will, and may thus require more cases and efforts to overcome the learning curves. Several studies reporting comparable postoperative outcomes between LPD and OPD compared the outcomes of experienced laparoscopic surgeons [3,4]. The reason for the higher mortality rate in the LPD group in the LEOPARD-2 trial may be because both skilled and unskilled surgeons participated [5].

In the previous study, the time required for robotic surgery was reported to be long due to docking time or idle time [23], but in this paper, the robotic surgery time was reported to be relatively short. One of the reasons for this is the establishment of standardized procedures for each step of the surgery, and the thorough training of the assistants to ensure that they are well-versed in these procedures. Additionally, a hybrid approach was implemented instead of a totally robotic surgery; specifically, laparoscopic surgery was performed during the resection phase.

The total costs of robot-assisted surgeries are generally higher than those of laparoscopic surgeries in general surgery [24]. Studies in the United States reported that the total cost of robotic PD in enhanced recovery after surgery and LPD was approximately USD \$20,300 and \$12,300, respectively [25,26]. In this study, the total hospitalization cost was higher in the RAPD group than in the TLPD group (USD \$19,020 vs. \$15,860,  $p < 0.001$ ). Because the resection was performed with similar laparoscopic instruments in both the RAPD and TLPD, difference in cost occurred due to the additional use of the robotic surgical system. In addition, it is important to highlight the distinctive features of the cost structure within the Korean medical system. Laparoscopic surgery costs in Korea are covered by the National Health Insurance, and are represented by a fixed fee, irrespective of factors such as room charge, profes-

sional fee, labor cost, or time duration. In contrast, robotic surgery is not currently included in the national health insurance coverage. As a result, each hospital has the flexibility to establish its own robotic surgery fee, considering factors such as the cost of equipment and procedural complexity. Given that the total medical costs of robotic surgery align closely with those reported in a comparable study conducted in the United States, it can be inferred that the cost associated with robotic surgery is reasonably comparable, and not deemed excessively expensive.

Because surgeons still prefer to select cases with a lower possibility of vascular reconstruction and combined other organ resection and less severe lesions when performing MIPD, patients who underwent OPD had more neoadjuvant treatment and more advanced pathologic staging (Table 2). To minimize these biases, PSM was conducted. After PSM, the complication rate (22.0% vs. 19.8%,  $p = 0.559$ ) and grade B or C POPF rate (12.3% vs. 10.1%,  $p = 0.378$ ) were comparable between MIPD and OPD. The mean duration of postoperative hospital stay was shorter in the MIPD group (13 days vs. 15 days,  $p = 0.004$ ). The R0 resection rate in MIPD was 96.2%, and the mean number of harvested regional LNs was 18. Other studies that investigated a nationwide database or enrolled multicenter patients demonstrated that perioperative outcomes were equivalent between MIPD and OPD in pancreatic cancer patients [2,27]. Therefore, MIPD is safe and feasible for patients with malignant periampullary diseases.

In contrast to the higher 5-year OS rate in MIPD before PSM, the 5-year OS rate was comparable between MIPD and OPD in all periampullary malignant diseases after PSM (58.4% vs. 55.5%,  $p = 0.180$ ; Fig. 2B). Several studies have reported comparable long-term outcomes between MIPD and OPD in pancreatic cancer [28,29], distal CBD cancer [30], and ampulla-of-Vater cancer [31]. In this study, the five-year OS rates after PSM were better in pancreatic cancer (53.4% vs. 19.3%,  $p = 0.046$ ; Fig. 3A), and comparable in distal CBD cancer (52.6% vs. 61.7%,  $p = 0.645$ ; Fig. 3B). The reason for the survival difference in pancreatic cancer may be the selection bias that when performing MIPD, the surgeons tended not to select borderline-resectable or locally advanced pancreatic cancer, thereby there being a different distribution of stage between MIPD and OPD patients, even with PSM matching. Considering that MIPD showed earlier recovery, and that earlier adjuvant treatment might induce better outcomes [1], MIPD may be helpful for patients who require early adjuvant treatment.

Although this study had some limitations regarding its retrospective nature, it directly compared the LPD, RAPD, OPD, and MIPD in medical colleges following similar protocols pertaining to the surgical extent, perioperative management, and oncological principles, and demonstrated similar oncologic and perioperative outcomes.

In conclusion, both RAPD and TLPD are safe and feasible procedures in high-volume institutions. Because the short- and

long-term outcomes were comparable between MIPD and OPD in malignant diseases, surgeons can select the most appropriate surgical method according to the convenience of surgical movements, medical costs, and operator experience. To reduce operation-related morbidities in the initial period, a training program for novice surgeons is needed.

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## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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