THE MEDICAL BULLETIN OF
SISLI ETFAL HOSPITAL

DOI: 10.14744/SEMB.2021.75350
Med Bull Sisli Etfal Hosp 2022;56(2):238–243

Original Research

Minimally Invasive Pancreaticoduodenectomy: Similar Morbidity and No Mortality in the Learning Period

Erol Piskin, Volkan Oter, Muhammet Kadri Colakoglu, Yigit Mehmet Ozgun, Osman Aydin, Erdal Birol Bostanci

Department of Gastroenterological Surgery, Ankara City Hospital, Ankara, Turkey

Abstract

Objectives: Pancreaticoduodenectomy (PD) is one of the most challenging operations in gastrointestinal system due to the difficulty of dissection areas and the need for complex reconstruction. The aim of this study is to compare the morbidity, post-operative pancreatic fistula (POPF), and mortality rates of the cases we have from the learning period for minimally invasive PD and our previous open PD cases with similar fistula risk scores (FRSs).

Methods: Patients with similar age, ASA score, pre-operative drainage, and FRS were included in the study. A total of 71 patients, 48 of whom were operated with open surgery and 23 with minimally invasive methods, were included in the study.

Results: When the statistical analysis performed, no statistically significant difference was found between open surgery and minimally invasive surgery groups in terms of age, gender, ASA score, pre-operative drainage, pancreatic texture, and treatment of pancreatic leakage (p=0.27, p=0.09, p=0.4, p=0.39, p=0.76, and p=0.36, respectively). There was a statistically significant difference between two groups in terms of clinically relevant pancreatic anastomotic leakage (Grade-B and Grade-C fistula) (p=0.11). The rate of Grade-BL and B leakage was higher in the minimally invasive surgery group, while Grade-C fistula was not observed in any patient (p=0.002). However, there was no statistically significant difference between the two groups in terms of the management of pancreatic leakage and related morbidity (p=0.36). There was no significant difference between the two groups in terms of tumor size, number of lymph nodes removed, FRS, amount of intraoperative bleeding, and diameter of Wirsung and common bile duct (p=0.15, p=0.20, p=0.145, p=0.80, and p=0.073, respectively). Considering the operation time, it was found that the operation time was longer in patients who received minimally invasive surgical treatment and this was statistically significant (p<0.0001).

Conclusion: As a result, we believe that minimally invasive PD operation can be performed with similar morbidity and acceptable CR-POPF rates when compared with the open PD with similar FRS at the learning stage.

Keywords: Learning period, minimally invasive surgery, pancreaticoduodenectomy

Please cite this article as "Piskin E, Oter V, Colakoglu MK, Ozgun YM, Aydin O, Bostanci EB. Minimally Invasive Pancreaticoduodenectomy: Similar Morbidity and No Mortality in the Learning Period. Med Bull Sisli Etfal Hosp 2022;56(2):238–243".

Pancreaticoduodenectomy (PD) is one of the most challenging operations in gastrointestinal system due to the difficulty of dissection areas and the need for complex reconstruction. The close relationship of the pancreatic head with the main vascular structures such as the superior mesenteric vein and superior mesenteric artery (SMA), features of the tumor, pancreatitis-related adhesions, and especially the presence of variational anatomy create difficulties for the surgeon during dissection. In addition, the pancreatic anastomosis part of the procedure, known as the "Achilles

Address for correspondence: Erol Piskin, MD. Ankara Sehir Hastanesi, Gastroenterolojik Cerrahi Klinigi, Ankara, Turkey
Phone: +90 505 336 63 33 **E-mail:** erol279@yahoo.com

Submitted Date: June 17, 2021 **Accepted Date:** July 30, 2021 **Available Online Date:** June 28, 2022

Tendon" of this surgery, is one of the difficulties that can be encountered in minimally invasive surgery and requires a technically challenging reconstruction process after careful resection. This anastomosis also constitutes the most important part of the operation for post-operative pancreatic fistula (POPF), which is one of the main determinants of morbidity after laparoscopic PD (LPD).

Minimally invasive PD was first performed by Gagner and Pomp in 1994, and after the description of this procedure, there has been a growing interest in the technique.[1] As with any new surgical technique, there have been successive publications comparing the efficacy and safety of minimally invasive PD. Kendrick and Cusati published his series of 65 cases in 2010, and a study presented the post-operative pancreatic fistula rate as 18%, and mortality was reported in only one patient.[2] In the first prospective randomized study compared with the open technique, LPD resulted in a shorter hospital stay and less blood loss. Post-operative complications were calculated at a similar rate in both groups. In addition, R0 resection rates were similar in the two groups, and the number of harvested lymph nodes was higher in the LPD group.[3] Although these results show that this technique can be performed in experienced centers, the multicenter prospective LEOPARD-2 study was terminated pre-term due to the high mortality rate associated with complications and the inability to obtain the expected functional recovery results.[4] This study concluded that further studies about experience, learning curve, and annual patient volume are needed and that these issues should be focused.

Similarly, the trend toward minimally invasive PD is increasing in our country. This study is the first study in Turkey that compares minimally invasive PD and open PD. The aim of this study is to compare the morbidity, POPF, and mortality rates of the cases we have from the learning period for minimally invasive PD and our previous open PD cases with similar fistula risk scores (FRSs).

Methods

Approval was obtained from the Ethics Committee of the Ankara City Hospital Hospital for this retrospective study with the file number E1-21-1618.

Patient Population

Twenty-six minimally invasive PD patients who were operated between June 1, 2018, and February 1, 2021, and all open PD patients (805 patients) operated in our center between April 1999 and August 2019 were reviewed and evaluated retrospectively. Fourteen laparoscopic, three robotic, and six hybrid (laparoscopic resection and robotic reconstruction) surgeries were performed in the minimally invasive surgery group. There were three patients who were not included in the minimally invasive group, and two of them were excluded from the study because of hemorrhage during dissection on the SMA and converted to open surgery and one patient required conversion to open surgery due to portal vein invasion (total 11.5% conversion rate). To include cases with similar FRS in the analysis, a total of 48 patients were selected from the patients in the open PD group by case match method. Patients with similar median values for FRS parameters defined in the next section were case matched. The study population consisted of 48 open and 23 minimally invasive PD patients. Among these groups, age, gender, and ASA scores were compared in terms of demographic characteristics. In addition, pre-operative biliary drainage, tumor marker levels, intraoperative blood loss, pancreatic texture, diameter of pancreatic duct, post-operative complications (according to Clavien-Dindo classification), POPF, and post-operative additional radiological and surgical interventions were evaluated between the two groups.

Definition of POPF and FRS

Post-operative complications were grouped according to Clavien-Dindo classification and complication score ≥3 was considered as major complication.[5] POPF was defined according to the International Study Group (ISGPS) definition and grading.[6] According to this definition, patients with 3 times higher drain amylase levels on the post-operative 3rd day but do not require additional treatment are defined as biochemical leakage (BL); persistent drainage longer than 3 weeks, management change in POPF, percutaneous endoscopic drainage, angiographic procedures for bleeding, or signs of infection without organ failure are defined as Grade B leak; and reoperation, organ failure, and mortality were defined as Grade C leak.

Many fistula risk scoring systems have been developed by examining predictive factors for POPF.[7-9] The scoring system developed by Callery et al. is the most widely used and validated scoring system.[7] Therefore, this system was used for FRS in the study and treated pathology, pancreatic texture, diameter of pancreatic duct, and intraoperative blood loss which were evaluated.

Surgical Technique

All laparoscopic and robotic surgery were performed by the same two surgeons. In all presented minimally invasive PD patients, all resections and reconstructions were completed minimally invasively, and three patients who were converted to open surgery were not included in the evaluation. Resection with bilioenteric (BE) and pancreaticoje-

junal (PJ) anastomoses was performed laparoscopically in patients undergoing LPD (Fig. 1). In the hybrid PD (HPD) group, the resection part was performed laparoscopically, while BE and PJ anastomoses were performed robotically. In the robotic PD (RPD) group, resection with BE and PJ anastomoses was performed robotically (Fig. 2).

Reconstruction was started with BE anastomosis first. In this way, the jejunum became more stable while performing PJ anastomosis. In two patients with a common bile duct diameter of 6 mm, the posterior wall was sutured with continue fashion and the anterior wall was sutured with interrupted sutures, while the posterior wall and anterior wall anastomosis was performed with continue sutures in patients with a common bile duct diameter of 8 mm or larger. Pancreatic reconstruction was performed using the end-to-side duct-to-mucosa method when the pancreatic duct was visible, and using the end-to-side dunking method, if the duct was not visible. As the outer layer, the posterior wall was sutured with sutures between the pancreatic capsule/parenchyma and the jejunum, and the anterior wall was sutured by placing individual sutures. In all PJ anastomoses, a pediatric feeding tube of 6–7 cm was placed extending into the Wirsung and jejunum for internal drainage. At the end of the operation, two Jackson-Pratt drains were placed, extending posterior to the BE anastomosis and under the PJ anastomosis. Oral feeding of the patients was started on the 2nd post-operative day and gradually increased according to tolerance. Drain amylase levels were monitored on post-operative days 1–3 and 5. Drains of patients with normal drain amylase values were removed on the 5th post-operative day. The drains of patients with high drain amylase level were followed and waited until the drainage amount fell below 50 ml. Post-operative abdominal computed tomography (CT) imaging was performed in patients with clinical deterioration, fever, leukocytosis, and elevated C-reactive protein level, and patients with intra-abdominal collections were undergone percutaneous drainage in the interventional radiology unit.

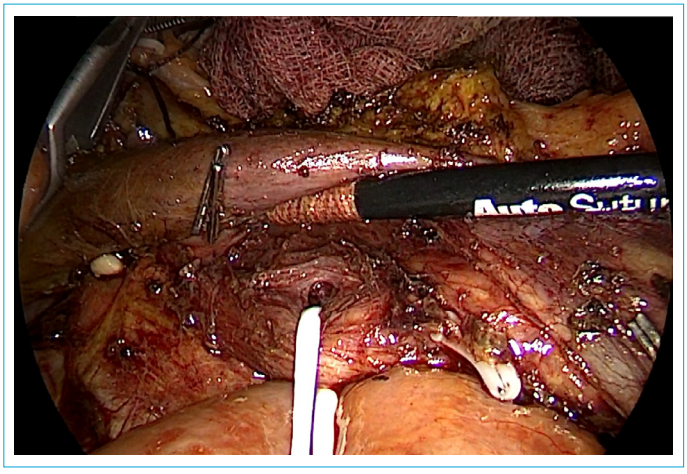

Figure 1. Laparoscopic pancreaticoduodenectomy (after resection of the pancreas).

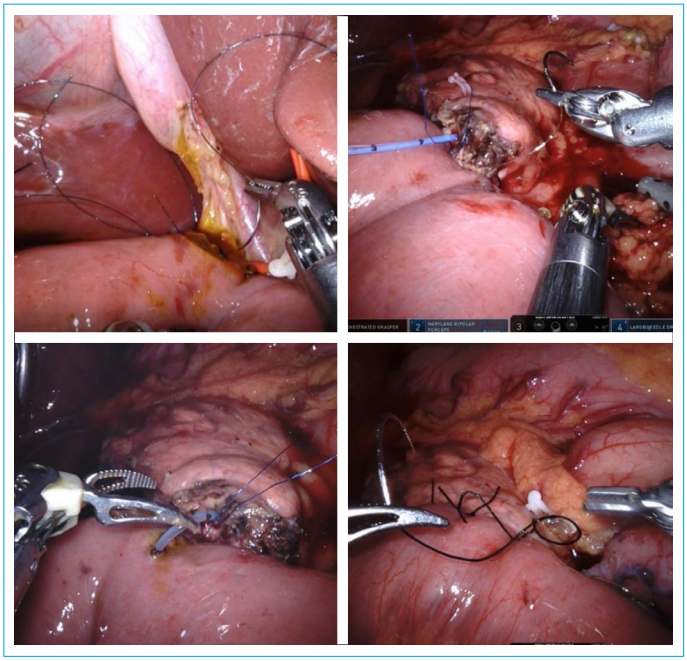

Figure 2. Robotic pancreaticoduodenectomy (steps of the resection and reconstruction).

Statistical Analysis

The data were exit to IBM SPSS Statistics program v. 20 IBM Corp: Armonk, NY, USA, for analysis. When evaluating the study data, distribution of frequency (number and percentages) was used for categorical variables and descriptive statistics (median, minimum, and maximum) used for numerical variables regarding to the results of the Kolmogorov–Smirnov test. Continuous variables were expressed as mean ± standard deviation or median (minimum-maximum) where applicable. Mann–Whitney U-test and Fisher's exact test were used where applicable. The Chi-square test performed to examine the relationship between two categorical variables. $P<0.05$ was considered statistically significant.

Results

A total of 71 patients, 48 of whom were operated with open surgery and 23 with minimally invasive methods, were included in the study. The patients who underwent open surgery were selected from the patients who were reviewed retrospectively by case match method. Patients with similar age, ASA score, pre-operative drainage, and FRS were included in the study.

While the mean age of 48 patients in the open group was 53±8.87/year, 27 (56.2%) of the patients were male. The

median CA-19-9 level of the patients was 62.05 mg/dl (range 0.80–1224.40 mg/dl). Pre-operative drainage was performed in 36 (75%) of the patients. Sixteen (33.3%) of the patients were ASA I and 32 (66.7%) were ASA II. While the mean operation time of the patients in this group was 379.79±91.34/min, Wirsung-jejunostomy anastomosis was performed in 18 (37.5%) patients and pancreaticojejunostomy anastomosis was performed in 30 (62.5%) patients. While the standard Whipple procedure was performed to 38 (79.2%) patients, 10 (20.8%) patients undergone pylorus-sparing Whipple procedure.

Again in the open group, the mean common bile duct diameter of the patients was 10.96±3.84 mm, while the mean Wirsung diameter was 2.54±1.07 mm. In the assessment of pancreatic texture, it was observed that 41 (85.4%) of the patients had soft pancreatic texture and 7 (14.6%) of them had a hard pancreatic texture. The mean intraoperative bleeding was 245 (range, 100–500) ml. When the post-operative pathology results were evaluated, it was observed that 28 (58.3%) of the patients had ampullary tumor, 17 (35.4%) had pancreatic head tumor, and 3 (6.2%) had duodenal tumors. The mean tumor size of the patients was 2.78±0.74 cm. The mean number of lymph nodes excised was 13 (range, 1–30). While 23 (47.9%) of the patients were determined as N0, it was observed that 25 (52.1%) of them were N1. In the post-operative period, Grade BL fistula was observed in 9 (18.8%) of the patients, Grade B fistula in 4 (8.3%), and Grade C fistula in 3 (6.2%) patients, while the remaining 32 (66.7%) patients had no pancreatic fistula. The median pancreatic FRS in the open surgery group was 5.21 (range 1–8).

While the mean age of 23 patients in the minimally invasive surgery group was 55±11.75/year, 8 (34.8%) of the patients were male. The median CA-19-9 value of the patients was 17.40 mg/dl (range 0.10–1904 mg/dl). Pre-operative drainage was performed in 15 (65.2%) of the patients. While 16 (69.6%) of the patients were ASA I, 7 (30.4%) were ASA II. The mean operative time of the patients in this group was 473.91±69.80 min. Wirsung-jejunostomy anastomosis was performed in 21 (91.3%) patients and pancreaticojejunostomy anastomosis was performed in 2 (8.7%) patients. While the standard Whipple procedure was performed to 4 (17.4%) patients, 19 (82.6%) patients undergone the pylorus-sparing Whipple procedure.

While the mean common bile duct diameter of the patients was 13.09±4.74 mm, the mean Wirsung diameter was 2.65±1.66 mm. In the evaluation of pancreatic texture, it was observed that 19 (82.6%) of the patients had soft pancreatic texture and 4 (17.4%) of them had hard pancreatic texture. The mean intraoperative bleeding was 200 (range; 50–500) ml. (There were two patients who were not included in the minimally invasive group, and two of them were excluded from the study because of hemorrhage during dissection was also excluded from the intraoperative bleeding calculation). Considering the post-operative pathology results, 14 of the patients (60.8%) had ampullary tumor, 1 (8.6%) had pancreatic neuroendocrine tumor and one had papillary neuroendocrine tumor, 2 (8.6%) had intraductal papillary mucinous neoplasia, 1 (4.3%) had pancreatic adenocarcinoma, 1 (4.3%) had mixed adenoneuroendocrine carcinoma, 1 (4.3%) had distal cholangiocellular carcinoma, and 2 (8.6%) had distal cholangiocellular carcinoma and two patients were operated due to stenosis in the distal common bile duct. The mean tumor diameter of the patients was 2.52±0.77 cm. The mean number of lymph nodes excised was 16.5 (range; 7–25). While 13 (52.1%) of the patients were determined as N0, it was observed that 9 (%) were N1 and 1 (%) patient was N2. In the post-operative period, Grade BL fistula was observed in 10 (18.8%) of the patients and Grade B fistula was observed in 7 (30.4%) of the patients, and Grade C fistula was not observed in this group. Pancreatic fistula was not detected in the remaining 6 (26.1%) patients. The median pancreatic FRS in the minimally invasive surgery group was 5.54 (range 1–9).

In the statistical analysis performed, no statistically significant difference was found between open surgery and minimally invasive surgery groups in terms of age, gender, ASA score, pre-operative drainage, pancreatic texture, and treatment of pancreatic leakage (p=0.27, p=0.09, p=0.4, p=0.39, p=0.76, and p=0.36, respectively). There was a statistically significant difference between two groups in terms of clinically relevant pancreatic anastomotic leakage (Grade B and Grade C fistula) (p=0.11). The rate of Grades BL and B leakage was higher in the minimally invasive surgery group, while Grade C fistula was not observed in any patient (p=0.002). However, there was no statistically significant difference between the two groups in terms of the management of pancreatic leakage and related morbidity (p=0.36).

In the minimally invasive surgery group, percutaneous drainage catheters were inserted in two patients due to pancreatic fistula. In one patient, intra-abdominal collection was aspirated with a fine needle due to pancreatic leak. In this group, complication of delayed gastric emptying was observed in two patients in the post-operative period. While one of them regressed with medical treatment, the other patient was treated with endoscopic balloon dilatation due to pyloric stenosis. One patient with chylous fistula was treated with medical follow-up and a medium chain amino acid diet. In this group, wound infection developed at the place where the specimen was removed in

only one patient. This patient was treated with antibiotic therapy, wound debridement, and wound dressing.

Complications developed in patients underwent open surgery were; wound infection in 14 patients, intra-abdominal collection that did not require drainage and treated with medical therapy in four patients, pancreatic fistula treated with percutaneous drainage in five patients, upper gastrointestinal bleeding regressed with medical treatment in one patient, delayed gastric emptying regressed with medical treatment in one patient, intra-abdominal hematoma regressed with interventional drainage procedure and medical treatment in one patient, and minor leakage from gastrojejunostomy anastomosis detected radiologically and treated medically in one patient.

According to Clavien-Dindo classification, there was no statistically significant difference between the minimally invasive and open surgery groups (p=0.054). In terms of Grade 3 and higher complications, again, there was no statistical difference between groups (p=0.42).

There was no significant difference between the two groups in terms of tumor size, number of lymph nodes removed, FRS, amount of intraoperative bleeding, diameter of Wirsung, and common bile duct (p=0.15, p=0.20, p=0.145, p=0.80, and p=0.073, respectively). Considering the operation time, it was found that the operation time was longer in patients who received minimally invasive surgical treatment and this was statistically significant (p<0.0001).

Discussion

This study is the first study in Turkey that compares minimally invasive PD and open PD. In this period, 3 patients (11.5%) other than 23 patients had conversion to open PD and the reasons for conversion were hemorrhage during dissection on SMA in two patients and portal vein invasion in one patient. The reason why these patients were not included in the analysis is that the reconstruction procedure was performed openly, and therefore, it is thought that it is more appropriate not to be included in the intention-to-treat analysis. As the initial case selection in minimally invasive PD, we preferred more benign-borderline or ampullary tumor with an earlier stage. We did not planned minimally invasive PD for patients with vascular invasion. In most of these patients, the pancreas was soft and the duct diameter was narrow. Therefore, although initial minimally invasive PD cases are easier in terms of resection, patients scored high for FRS at their initial selection regardless of surgery.

Two patients whose pathologies were reported as benign had stenosis in the distal common bile duct, and the decision for surgery was made after being examined by the multidisciplinary council. The brush cytology of these patients was examined in terms of cholangiopathies and surgical decisions were made in these councils because they did not receive any other diagnoses and the risk of malignancy. In terms of POPF, the rate of BL and Grade B fistula was significantly higher in minimally invasive PD. The learning period for LPD has been defined in various studies and it has been stated that the learning period is completed after 10–60 cases.[10-14] In our study, minimally invasive PD was planned for 26 cases, and 23 cases were completed minimally invasively. We know that we are still in the learning period. In 119 patients analyzed by Kim et al., serious post-operative complications and POPF were reported to decrease significantly after 84 cases,[15] and we believe that our clinically relevant post-operative pancreatic fistula (CR-POPF) rate will decrease in the following phases.

There was no significant difference between the two groups in terms of tumor size, number of lymph nodes removed, FRS, amount of intraoperative bleeding, and diameter of Wirsung and common bile duct. In the minimally invasive PD group, we completed BE and PJ anastomoses intracorporeally from the initial case and did not perform open reconstruction. Mortality was not observed in any of our patients.

In the study of Lee et al., when risk stratification was made for FRS, no difference was found between open PD and LPD in terms of CR-POPF in low-risk and high-risk patients. However, in patients with intermediate risk, higher CR-POPF was observed in the LPD group.[16] In the study of Dokmak et al., LPD was recommended for patients at low risk for POPF; minimally invasive PD is not recommended, especially in patients with high risk of POPF caused by periampullary tumors. They reported higher POPF and severe complications in these patients.[17] In our series, no statistically significant difference was found between the two groups in terms of Clavien-Dindo score 3 or more serious complications.

The total and annual number of open and laparoscopic/robotic PDs for our center were 70 and 10–15, respectively. Despite the low number of patients in this study, we believe that advanced laparoscopic interventions and advanced surgical procedures that are performed a lot in our center accelerate our learning curve, and therefore, the morbidity is lower than expected.

This study has many limitations. Retrospective nature of the study, non-randomization of the patients, and the operation with three different minimally invasive techniques (LPD, HPD, and RPD) are some of them. Although LEOPARD-2 study, a multicenter prospective randomized controlled study, was terminated early due to serious post-operative complications, no mortality and Grade C fistula

were observed in our study.[5] When the unpublished data for open PD are examined in our center, we have a total of 805 open cases of experience. There are also PD operations with major venous and arterial resection for some of these cases. Our experience with open cases may have provided these results.

Conclusion

As a result, we believe that advanced laparoscopic interventions and advanced surgical procedures that are performed a lot in our center accelerate our learning curve, and therefore, the morbidity is lower than expected. In our opinion; minimally invasive PD operations can be performed with similar morbidity and acceptable CR-POPF rates when compared with the open PD with similar FRS after the learning period was finished.

Disclosures

Ethics Committee Approval: Approval was obtained from the Ethics Committee of our hospital for this retrospective study with the file number E1-21-1618.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – E.P.; Design – E.P.; Supervision – E.B.B.; Materials – V.Ö.; Data collection &/or processing – O.A., Y.M.Ö.; Analysis and/or interpretation – M.K.Ç., V.Ö.; Literature search – E.P.; Writing – E.P.; Critical review – M.K.Ç.

References

1. Gagner M, Pomp A. Laparoscopic pylorus-preserving pancreatoduodenectomy. Surg Endosc 1994;8:408–10. [CrossRef]
2. Kendrick ML, Cusati D. Total laparoscopic pancreaticoduodenectomy: feasibility and outcome in an early experience. Arch Surg 2010;145:19–23. [CrossRef]
3. Palanivelu C, Senthilnathan P, Sabnis SC, Babu NS, Srivatsan Gurumurthy S, Anand Vijai N, et al. Randomized clinical trial of laparoscopic versus open pancreatoduodenectomy for periampullary tumours. Br J Surg 2017;104:1443–50. [CrossRef]
4. van Hilst J, de Rooij T, Bosscha K, Brinkman DJ, van Dieren S, Dijkgraaf MG, et al; Dutch Pancreatic Cancer Group. Laparoscopic versus open pancreatoduodenectomy for pancreatic or periampullary tumours (LEOPARD-2): a multicentre, patient-blinded, randomised controlled phase 2/3 trial. Lancet Gastroenterol Hepatol 2019;4:199–207. [CrossRef]
5. Clavien PA, Barkun J, de Oliveira ML, Vauthey JN, Dindo D, Schulick RD, et al. The Clavien-Dindo classification of surgical complications: five-year experience. Ann Surg 2009;250:187–96. [CrossRef]
6. Bassi C, Marchegiani G, Dervenis C, Sarr M, Abu Hilal M, Adham M, et al; International Study Group on Pancreatic Surgery (ISGPS). The 2016 update of the International Study Group (ISGPS) definition and grading of postoperative pancreatic fistula: 11 Years After. Surgery 2017;161:584–91. [CrossRef]
7. Callery MP, Pratt WB, Kent TS, Chaikof EL, Vollmer CM Jr. A prospectively validated clinical risk score accurately predicts pancreatic fistula after pancreatoduodenectomy. J Am Coll Surg 2013;216:1–14. [CrossRef]
8. Mungroop TH, van Rijssen LB, van Klaveren D, Smits FJ, van Woerden V, Linnemann RJ, et al; Dutch Pancreatic Cancer Group. Alternative fistula risk score for pancreatoduodenectomy (a-FRS): design and ınternational external validation. Ann Surg 2019;269:937–43. [CrossRef]
9. Mungroop TH, Klompmaker S, Wellner UF, Steyerberg EW, Coratti A, D'Hondt M, et al; European Consortium on Minimally Invasive Pancreatic Surgery (E-MIPS). Updated alternative fistula risk score (ua-FRS) to include minimally ınvasive pancreatoduodenectomy: pan-European validation. Ann Surg 2021;273:334–40. [CrossRef]
10. Lu C, Jin W, Mou YP, Zhou J, Xu X, Xia T, et al. Analysis of learning curve for laparoscopic pancreaticoduodenectomy. J Vis Surg 2016;2:145. [CrossRef]
11. Speicher PJ, Nussbaum DP, White RR, Zani S, Mosca PJ, Blazer DG 3rd, et al. Defining the learning curve for team-based laparoscopic pancreaticoduodenectomy. Ann Surg Oncol 2014;21:4014–9.
12. Wang M, Meng L, Cai Y, Li Y, Wang X, Zhang Z, et al. Learning curve for laparoscopic pancreaticoduodenectomy: a CUSUM analysis. J Gastrointest Surg 2016;20:924–35. [CrossRef]
13. Kim SC, Song KB, Jung YS, Kim YH, Park DH, Lee SS, et al. Short-term clinical outcomes for 100 consecutive cases of laparoscopic pylorus-preserving pancreatoduodenectomy: improvement with surgical experience. Surg Endosc 2013;27:95–103. [CrossRef]
14. Nagakawa Y, Nakamura Y, Honda G, Gotoh Y, Ohtsuka T, Ban D, et al. Learning curve and surgical factors influencing the surgical outcomes during the initial experience with laparoscopic pancreaticoduodenectomy. J Hepatobiliary Pancreat Sci 2018;25:498–507. [CrossRef]
15. Kim S, Yoon YS, Han HS, Cho JY, Choi Y, Lee B. Evaluation of a single surgeon's learning curve of laparoscopic pancreaticoduodenectomy: risk-adjusted cumulative summation analysis. Surg Endosc 2021;35:2870–78. [CrossRef]
16. Lee B, Yoon YS, Kang CM, Choi M, Lee JS, Hwang HK, et al. Fistula risk score-adjusted comparison of postoperative pancreatic fistula following laparoscopic vs open pancreatoduodenectomy. J Hepatobiliary Pancreat Sci 2021;28:1089–97. [CrossRef]
17. Dokmak S, Ftériche FS, Aussilhou B, Bensafta Y, Lévy P, Ruszniewski P, et al. Laparoscopic pancreaticoduodenectomy should not be routine for resection of periampullary tumors. J Am Coll Surg 2015;220:831–8. [CrossRef]