Modified Frailty Index to Assess Risk in Elderly Patients Undergoing Distal Pancreatectomy: A Retrospective Single-Center Study

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Abstract

Background To compare the postoperative course of elderly patients (≥70 years) submitted to minimally invasive (MIDP) versus open distal pancreatectomy (ODP) and to evaluate if the modified Frailty Index (mFI) predicts the surgical course of elderly patients submitted to DP.

Methods Data of patients aged ≥70 who underwent DP at a single institution between March 2011 and December 2019 were retrospectively retrieved. A 2:1 propensity score matching (PSM) was used to correct for differences in baseline characteristics. Then, postoperative complications were compared between the two groups (MIDP vs. ODP). Additionally, the entire cohort of DP elderly patients was stratified according to the mFI into three groups: non-frail (mFI = 0), mildly frail (mFI = 1/2), or severely frail (mFI = 3) and then compared.

Results A total of 204 patients were analyzed. After PSM, 40 MIDP and 80 ODP patients were identified. The complications considered stratified homogenously between the two groups, with no statistically significant differences. The severity of the postoperative course increased as mFI did among the three groups regarding any complication (p = 0.022), abdominal collection (p = 0.014), pulmonary complication (p = 0.001), postoperative confusion (p = 0.047), Clavien-Dindo severity ≥3 events (p = 0.036), and length of stay (p = 0.018).

Conclusions Elderly patients can be safely submitted to MIDP. The mFI identifies frail elderly patients more prone to develop surgical and non-surgical complications after DP.

Introduction

Minimally invasive distal pancreatectomy (MIDP) is gaining favor over open distal pancreatectomy (ODP) to treat the pancreas’ body-tail neoplasms [1]. An international cohort study showed less major morbidity after MIDP, with predicted better outcomes as the conversion rate decreases following the implementation of the technique [2, 3].

Thanks to intervention in health, political, and socioeconomic aspects, lifespan, and healthspan are expected to increase in the next decades [4, 5], at least in developed countries. This scenario and the incidence of pancreatic tumors that increase with age—with a mean age of 70 years [5]—are responsible for the frequent facing with elderly
patients by pancreatic surgeons. Current literature reports controversial results regarding the impact of advanced age on surgical outcomes after pancreatic surgery. In 2012, a meta-analysis reported that elderly patients experience higher rates of postoperative complications and mortality [6]. Other manuscripts, afterward, found that pancreatic surgery has similar safety and efficacy profiles in elderly versus non-elderly [7–10]. Regarding minimally invasive pancreaticoduodenectomy, data analysis on 1768 elderly patients submitted to laparoscopic versus open pancreaticoduodenectomy from the United States National Cancer Database showed that minimally invasive cases experience lower mortality rates [11]. Few manuscripts have compared MIDP versus ODP in elderly patients. In particular, four retrospective, non-case-matched studies, enrolling a total of 248 patients, reported that MIDP has the same safety profile that ODP in elderly patients [12–14] and that some postoperative outcomes, such as confusion, length of stay, and intraoperative blood loss, are even better for MIDP [15]. Certainly, there is a proper patient selection beyond these surgical cohorts, so maybe the fittest ones were chosen. A recent meta-analysis pooled the results of these studies and confirmed the conclusions, indicating not only that MIDP is not contraindicated in the elderly but even that some postoperative outcomes are better in this subset of patients [16].

Not all elderly patients are the same, and to offer the same surgical approach to each one would be wrong. In particular, the selection of patients is of utmost importance to optimize surgical and oncological outcomes. Several indexes have been elaborated to predict poor postoperative outcomes in elderly patients undergoing pancreatic resection. The Frailty Index [17, 18], and its simplified form, the modified Frailty Index (mFI) [19] proved to predict major complications and mortality after pancreatic surgery effectively [20, 21]. Of note, it seems that frail patients (mFI ≥1) benefit from MIDP, experiencing less severe complications than ODP patients [22].

This study aimed to compare surgical outcomes between MIDP and ODP in elderly patients using propensity-score matching analysis. Secondarily, the efficacy of mFI in predicting postoperative outcomes of DP elderly patients was evaluated.

Methods

Study population

The index population for this study was obtained from the electronic Institutional prospectively maintained database of patients submitted to pancreatic resection at the General and Pancreatic Surgery Unit of the Pancreas Institute of the University of Verona, Verona, Italy. The database was queried for patients ≥70 years of age submitted to MIDP (index population), either laparoscopic and robot-assisted, with or without splenectomy, for any disease from March 2011 to December 2019. The database was then queried for patients ≥70 years who underwent ODP (control group) during the same period.

Data collected

Demographic, clinical, surgical, pathological, and postoperative data were extracted. Demographic and clinical variables included age, gender, smoking habit, body mass index (BMI), albumin, hemoglobin, and leukocyte values, presence of diabetes or other relevant comorbidities, American Society of Anesthesiologist Physical Status Classification System (ASA) score, Charlson Age Comorbidity index (CACI) [23]. When the final diagnosis was of malignancy, Ca 19–9 values and neoadjuvant therapy were added. According to the mFI, patients were stratified into non-frail (mFI = 0), mildly frail (mFI = 1–2), or severely-frail (mFI > 2), as proposed by Konstantinidis et al. [22]. This stratification was applied to the whole cohort of patients ≥70 years who underwent distal pancreatectomy, and matching was not used due to the small sample size of the MIDP group.

Intraoperative variables included intraoperative blood loss (mL), duration of surgery (min), additional resections (yes/no), conversion to ODP, level of pancreatic transection (pancreatic neck/ gastroduodenal artery level/left aortic border), transection technique (stapler/ultrasonic device/ handsewn), splenic preservation.

Ninety-day postoperative surgical data included pancreatic fistula (POPF) [24], delayed gastric emptying (DGE) [25], post-pancreatectomy hemorrhage (PPH) [26], infected abdominal collections treated with percutaneous drainage or antibiotic therapy, chyle leak [27], surgical site infections (SSI), pulmonary or cardiologic complications, and postoperative confusion. Postoperative pathologic data included final diagnosis, tumor diameter, lymph nodes harvested, lymph node status and the number of metastatic nodes (if any), and R-status.

Surgical procedures

For the description of the Institutional laparoscopic and robot-assisted techniques adopted, previously published material can be considered [28–30]. The decision to submit patients to MIDP and the choice of the laparoscopic or the robot-assisted approach was mostly made on a collegial basis at a dedicated preoperative surgical meeting [31]. The level of transection was made based on the presumed diagnosis (at the pancreatic neck for malignant or
intermediate-malignant lesion vs. at the projection of the left border of the aorta for benign lesions, when tumor dimensions allowed it). Regarding the technique of transection, two devices were adopted in the vast majority of cases; the triple row stapler reinforced with a PGA felt (NEOVEIL Endo GIA Reinforced Reload with Tri-Staple® Technology 60 mm, Covidien, North Haven, CT, USA), or an ultrasonic scalpel [32, 33]. Typically, for ODP, two Penrose-type capillary drains were placed at the end of the surgery, one close to the pancreatic stump, the other in the splenic fossa. After MIDP, one Penrose-type capillary drain was placed, close to the pancreatic stump and passing through the splenic fossa. When the patient was enrolled in the DIPLOMA trial (MIDP vs. ODP in patients with pancreatic cancer, #ISRCTN44897265), two drains were placed, one to the left into the splenic fossa and one to the right close to the pancreatic stump. Early drains removal was frequently performed based on the quality and

Table 1 Preoperative, intraoperative, and pathological data

| Study Population N = 204 | Total n (%) | Open DP 162 (79%) | MI-DP 42 (21%) | p-value |
|--------------------------|-------------|-------------------|----------------|---------|
| **Preoperative data**    |             |                   |                |         |
| Age (years, DS)          | 74 ± 4      | 75 ± 4            | 74 ± 4         | 0.032   |
| Sex (Female)             | 108 (53%)   | 87 (54%)          | 21 (50%)       | 0.399   |
| BMI (Kg/m², DS)          | 25 ± 4      | 25 ± 4            | 25 ± 4         | 0.567   |
| Previous abdominal surgery | 114 (56%) | 92 (57%)          | 22 (52%)       | 0.351   |
| ASA score > III          | 61 (30%)    | 53 (33%)          | 8 (19%)        | 0.059   |
| Charlson Age > 4         | 78 (38%)    | 68 (42%)          | 10 (24%)       | 0.022   |
| Neoadjuvant therapy      | 30 (15%)    | 25 (15%)          | 5 (12%)        | 0.383   |
| Frailty index > 0        | 150 (74%)   | 120 (74%)         | 30 (71%)       | 0.433   |
| **Intraoperative data**  |             |                   |                |         |
| Spleen preserving        | 11 (5%)     | 5 (3%)            | 6 (14%)        | 0.011   |
| Additional ressections    | 68 (33%)    | 59 (36%)          | 9 (21%)        | 0.046   |
| Vascular ressections      | 31 (15%)    | 28 (17%)          | 3 (7%)         | 0.076   |
| Transection level         |             |                   |                | <0.001  |
| Pancreatic neck           | 165 (81%)   | 130 (80%)         | 35 (83%)       |         |
| GDA level                 | 29 (14%)    | 29 (18%)          | 0 (0%)         |         |
| Left aortic border        | 10 (5%)     | 3 (2%)            | 7 (17%)        |         |
| Management Stump          |             |                   |                | 0.001   |
| Stapler                   | 85 (44%)    | 67 (44%)          | 18 (43%)       |         |
| Ultrasonic scalpel        | 64 (33%)    | 42 (28%)          | 22 (52%)       |         |
| Handsewn                  | 45 (23%)    | 43 (28%)          | 2 (5%)         |         |
| Duration of Surgery (minutes, DS) | 260 ± 93 | 258 ± 88 | 267 ± 95 | 0.175 |
| EBL (cc, IQR)             | 200 [100–400] | 250 [100–400] | 200 [150–300] | 0.998 |
| **Pathological data**     |             |                   |                | <0.001  |
| Final Pathology, No. (%)  |             |                   |                |         |
| PDAC                      | 119 (58%)   | 102 (63%)         | 17 (41%)       |         |
| pNET                      | 33 (16%)    | 16 (10%)          | 17 (40%)       |         |
| IPMN                      | 27 (13%)    | 23 (14%)          | 4 (10%)        |         |
| MCN/SCN                   | 11 (6%)     | 8 (5%)            | 3 (7%)         |         |
| Other                     | 14 (7%)     | 13 (8%)           | 1 (2%)         |         |
| Tumor Size (mm, IQR)      | 29 [20–45]  | 30 [20–45]        | 26 [18–40]     | 0.372   |
| Harvest Lymph nodes (IQR) | 28 [19–37]  | 32 [23–40]        | 24 [13–33]     | 0.001   |
| R0 Status                 | 159 (81%)   | 125 (80%)         | 34 (81%)       | 0.300   |

Bold values indicate statistical significance at the p < 0.05 level

BMI Body mass index; ASA American society of Anesthesiology; EBL Estimated blood loss; PDAC Pancreatic ductal adenocarcinoma; pNET pancreatic neuroendocrine tumor; IPMN Intraductal pancreatic mucinous neoplasm; MCN Mucinous cystic neoplasm; SCN Serous cystic neoplasm
quantity of the output, its richness in amylase, and the occurrence of postoperative acute pancreatitis [34]. Generally, in the presence of a non-amylase-rich fluid (e.g., ≤2000 U/L) and the absence of a sinister appearance or postoperative acute pancreatitis, the removal was performed on postoperative day three.

**Statistical analysis and case-matching**

According to the normality tests, values were expressed as median and interquartile range, mean and standard deviation (SD), or percentage. Student’s t-test, Mann-Whitney U-test, Kruskal–Wallis test, and \( \chi^2 \) test were used as appropriate.

A PSM analysis was performed using the preliminary univariate analysis on the entire cohort. The not balanced variables identified were chosen to compare the MIDP (index) group and the ODP (control) group. The MIDP elderly patients were randomly matched with ODP elderly patients according to a 1:2 matching, with a 0.1 caliper and an average treatment effect (ATE), by the approach (MIDP vs. ODP) as the independent variable. Variables considered for propensity score estimation included: age, CACI, splenectomy, additional resections, pancreatic transection level, management of the pancreatic stump, and presence of malignancy at the final pathology. Balance on covariates between MIDP and ODP groups was assessed and reported using absolute standardized differences (ASD) [35]. An ASD value <0.2 indicates a small difference between the two groups, identifying an excellent balance. An ASD value between 0.2 and 0.5 shows a difference, implying a good balance. An ASD value between 0.5 and 0.8 indicates a high difference, meaning sub-optimal balance. An ASD value >0.8 resulted in a remarkable difference, suggesting a poor balance between the two groups (Supplementary Fig. 1) [36]. Statistical analyses were performed using SPSS software ver. 22 (IBM, Chicago, IL, United States) and R software (R Foundation for Statistical Computing, Vienna, Austria).

**Results**

A total of 204 patients aged ≥70 years was submitted to distal pancreatectomy during the study period. Forty-six patients were candidates to receive MIDP, and four (7.7%) were converted to open surgery. The preoperative, intraoperative, and pathological data are shown in Table 1. The two groups resulted imbalanced in age, CACI, splenectomy, additional resections, pancreatic transection level, management of the pancreatic stump, and presence of malignancy at the final pathology (\( p < 0.05 \)).

The postoperative outcomes of the series are outlined in Table 2. The postoperative clinical course of the entire cohort was comparable (\( p > 0.05 \)). Notably, the ODP group had a higher mean length of stay than the MIDP (15 vs. 10 days, respectively, \( p = 0.042 \)).

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**Table 2 Postoperative data**

| Study Population N\(^{2} = 204\) | Total n\(^{2} (%)\) | Open DP 162 (79%) | MI-DP 42 (21%) | p-value |
|---------------------------------|---------------------|-------------------|----------------|---------|
| Any complications               | 118 (58%)           | 93 (57%)          | 25 (60%)       | 0.473   |
| POPF                            | 38 (19%)            | 28 (17%)          | 10 (24%)       | 0.204   |
| Abdominal collections           | 70 (34%)            | 53 (33%)          | 17 (41%)       | 0.222   |
| DGE                             | 5 (3%)              | 5 (3%)            | 0 (0%)         | 0.312   |
| PPH                             | 25 (12%)            | 20 (12%)          | 5 (12%)        | 0.589   |
| SSI                             | 18 (9%)             | 15 (9%)           | 3 (7%)         | 0.470   |
| Pulmonary complications         | 53 (26%)            | 43 (27%)          | 10 (24%)       | 0.443   |
| Cardiovascular complications    | 18 (9%)             | 17 (11%)          | 1 (2%)         | 0.080   |
| Postoperative Confusion         | 8 (4%)              | 8 (5%)            | 0 (0%)         | 0.152   |
| ICU Admission                   | 17 (8%)             | 15 (9%)           | 2 (5%)         | 0.274   |
| Clavien-Dindo > 3               | 27 (13%)            | 22 (14%)          | 5 (12%)        | 0.503   |
| Length of Stay (days, DS)       | 13 ± 6              | 15 ± 6            | 10 ± 7         | 0.042   |
| Reoperations                    | 11 (5%)             | 8 (5%)            | 3 (7%)         | 0.403   |
| Readmissions                    | 14 (7%)             | 10 (6%)           | 4 (9%)         | 0.323   |
| Mortality                       | 2 (1%)              | 2 (1%)            | 0 (0%)         | 0.628   |

*Bold value indicates statistical significance at the \( p < 0.05 \) level*

POPF Postoperative pancreatic fistula; DGE Delayed gastric empty; PPH Post pancreatectomy hemorrhage; ICU Intensive care unit.
After matching, 40 and 80 patients constituted the MIDP group and ODP group, respectively.

**MIDP versus ODP after matching: baseline, surgical, pathology, and postoperative results**

No differences were found in the patients’ baseline characteristics between MIDP and ODP groups after propensity score weighting was found (Table 3). The pancreatic transection was more frequently on the left aortic border in the MIDP group ($p = 0.005$).

None of the postoperative variables considered stratified differently from a statistical standpoint between the two groups (Table 4). Remarkably, the ODP group still had a higher mean length of stay than the MIDP (16 vs. 10 days, respectively, $p = 0.046$).

**Baseline, surgical, and pathology results and postoperative outcome according to mFI**

Among the baseline features, BMI and ASA score were higher in severely frail patients ($p = 0.001$ and $p < 0.001$, respectively).
respectively), as shown in Table 5. Surgery’s duration increased as the severity of frailty did \((p = 0.013)\). No differences were found in pathology data among the three groups.

Increasing and statistically significant rates of many complications were found among the three groups, where the severely frail patients worsen, compared to mildly frail and no frail ones (Table 6). In particular, this refers to any complication \((76\% \text{ vs. } 60\% \text{ vs. } 44\%, \; p = 0.022)\), abdominal collection \((52\% \text{ vs. } 37\% \text{ vs. } 20\%, \; p = 0.014)\), pulmonary complication \((54\% \text{ vs. } 24\% \text{ vs. } 17\%, \; p = 0.001)\), postoperative confusion \((12\% \text{ vs. } 3\% \text{ vs. } 2\%, \; p = 0.047)\), and Clavien-Dindo severity \(\geq 3\) events \((24\% \text{ vs. } 14\% \text{ vs. } 6\%, \; p = 0.036)\). The length of stay was significantly longer in severely frail patients \((16 \text{ vs. } 13 \text{ vs. } 12 \text{ days}, \; p = 0.018)\).

### Discussion

Reduced functional reserve and stress response and high prevalence of comorbidities are typical features of the elderly. Thus, this population of patients may benefit the most from minimally invasive surgery. However, only four reports compared surgical outcomes of MIDP versus ODP in elderly patients \([12–15]\). All studies concluded that MIDP is at least as safe as ODP. These results were pooled in a meta-analysis that reported an overall benefit for MIDP over ODP regarding length of stay and intraoperative blood loss \([16]\). The results of this study corroborate these previous findings, namely that MIDP in elderly patients can be safely performed, as no differences were found in terms of postoperative outcomes. In particular, major complications, surgical and non-surgical complications (e.g., cardio-pulmonary events) occurred homogeneously between the index and control groups, and the length of stay was similar. It must be noted that this study’s findings are the result of a careful selection of cases to treat with MIDP, deriving from proper preoperative evaluation and collegial discussion.

Noteworthily, the duration of hospitalization of MIDP patients (median 8, IQR 7–12) was lower than the one institutionally reported for MIDP (10 days, IQR 6–10), deriving from a cohort of 103 patients with a mean age of 52 years [IQR 40–62]) \([37]\). This finding gain strength considering that all patients are discharged home in our institution rather than going to health care facilities. So, a patient goes home when the spouse or the relatives/care-givers (usually the children) are ready to accommodate him, which may take longer when the patient is elderly.

Despite desirable, a preoperative geriatric assessment may not be feasible for each elder patient. Thus, the possibility to use the mFI to identify elderly patients at higher risk of postoperative complications is an interesting opportunity. After applying the mFI to the whole cohort of patients \(\geq 70\) years submitted to DP, the baseline features analysis showed that BMI was proportionally higher for mildly and severely frail patients than non-frail ones. They were also more frequently classified as ASA \(\geq 3\), probably

**Table 4** Postoperative outcomes after propensity score matching

| Study Population N\(^2\) = 120 | Total n\(^2\) (%) | Open DP 80 (67%) | MI-DP 40 (33%) | \(p\)-value |
|---------------------------------|------------------|------------------|----------------|-------------|
| Any complications               | 71 (59%)         | 48 (59%)         | 23 (59%)       | 0.565       |
| POPF                            | 25 (21%)         | 16 (20%)         | 9 (24%)        | 0.396       |
| Abdominal collections           | 46 (38%)         | 30 (37%)         | 16 (41%)       | 0.411       |
| DGE                             | 4 (3%)           | 4 (5%)           | 0 (0%)         | 0.203       |
| PPH                             | 16 (13%)         | 11 (14%)         | 5 (13%)        | 0.578       |
| SSI                             | 11 (9%)          | 8 (10%)          | 3 (8%)         | 0.493       |
| Pulmonary complications         | 29 (24%)         | 20 (25%)         | 9 (23%)        | 0.519       |
| Cardiovascular complications    | 10 (8%)          | 9 (11%)          | 1 (3%)         | 0.104       |
| Postoperative Confusion         | 3 (3%)           | 3 (4%)           | 0 (0%)         | 0.304       |
| ICU Admission                   | 8 (7%)           | 6 (7%)           | 2 (5%)         | 0.486       |
| Clavien-Dindo \(> 3\)           | 16 (13%)         | 12 (15%)         | 4 (10%)        | 0.353       |
| Length of Stay (days, DS)       | 13 ± 14          | 16 ± 20          | 10 ± 7         | \(\text{0.046}\) |
| Reoperations                    | 7 (6%)           | 5 (6%)           | 2 (5%)         | 0.590       |
| Readmissions                    | 10 (8%)          | 6 (8%)           | 4 (10%)        | 0.425       |
| Mortality                       | 1 (1%)           | 1 (1%)           | 0 (0%)         | 0.672       |

**Bold value indicates statistical significance at the \(p < 0.05\) level**

POPF Postoperative pancreatic fistula; DGE Delayed gastric empty; PPH Post pancreatectomy hemorrhage; ICU Intensive care unit
due to more systemic diseases (e.g., diabetes, hypertension, cardiovascular problems). The duration of surgery increased proportionally to the grade of frailty. We do not have an explanation for this. This may be due to the surgeon’s attitude toward performing a more precise and safe surgery in the presence of a severely frail patient, which carries serious comorbidities. However, this is just speculation.

As already reported [22, 38], the mFI predicted some postoperative complications and, in general, a worse postoperative course, as demonstrated by a longer length of stay. In detail, higher rates of any complication, abdominal collection, and Clavien-Dindo ≥3 complications were found in mild and severely frail patients, compared to non-frail ones. Noteworthily, the mFI also predicted non-surgical postoperative complications, such as postoperative confusion and pulmonary complications. These results show that surgical and non-surgical risk prediction may be obtained using an easy tool such as the mFI.

It must be noted that, interestingly, after DP, some postoperative complications, such as pancreatic fistula, post-pancreatectomy hemorrhage, and the reoperation rate, are not superior in frail patients. We believe that they are hardly favored by the cardiovascular comorbidities and the poor functional reserve that may be present in a frail patient. Rather, they are the result of properly pancreas-
and surgery-specific factors (e.g., pancreatic texture, transection technique, level of transection, and drain management policy).

In general, our findings demonstrate that MIDP is not inferior to ODP in selected elderly patients, and that fragile elderly patients are at higher risk for postoperative complications after DP, with a proportionate increase. In the absence of a geriatric assessment, the application of the mFI may be useful to identify patients to whom dedicate tailored perioperative management to improve the postoperative outcome (e.g., nutritional assessment and intervention, pre-habilitation, routine access to intensive care unit after surgery). We deliberately choose not to include the mFI among the crucial variables in the PSM since previous literature on mFI and distal pancreatectomy was not robust enough. The present results give consistency to mFI as a variable to include in the baseline assessment of elderly patients receiving DP.

This manuscript’s strength is that for the first time, the comparison between MIDP and ODP in elderly patients was performed through a propensity score matching to reduce the selection bias. This study is also the first to apply the mFI to a single-center, homogeneous cohort of elderly patients undergoing DP (the report by Konstantinidis et al. [22] is a registry-based study). Some limitations may flaw the results and the considerations: (i) the sample size of elderly who underwent MIDP is small; (ii) a selection bias (the percentage of elderly submitted to MIDP is approximately only 20 percent of the total of elderly underwent DP during the study period).

To conclude, MIDP in elderly patients seems to be safe in experienced hands and high-volume centers. Fragile (mFI > 0) elderly patients undergoing DP are more prone to experience postoperative complications, longer hospitalization, and worse postoperative course as the mFI increases. Age per sé is not an expression of poor functional reserve or difficult recovery after surgery. Age and frailty, instead, can be so.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The institutional review board approved the study (approval number for the retrospective data collection, PAD-R #1101CESC).

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00268-021-06436-2.

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Table 6 Postoperative outcomes of the series stratified according to the modified Frailty Index

| Study Population N° = 204 | No Frailty 54 (26%) | Mild Frailty 125 (26%) | Severe Frailty 25 (74%) | p-value |
|-------------------------|-------------------|----------------------|----------------------|--------|
| Any complications       | 24 (44%)          | 75 (60%)             | 19 (76%)             | 0.022  |
| POPF                    | 7 (13%)           | 27 (22%)             | 4 (16%)              | 0.824  |
| Abdominal collections   | 11 (20%)          | 46 (37%)             | 13 (52%)             | 0.014  |
| DGE                     | 0 (0%)            | 4 (3%)               | 1 (4%)               | 0.387  |
| PPH                     | 5 (9%)            | 16 (13%)             | 4 (16%)              | 0.667  |
| SSI                     | 5 (9%)            | 10 (8%)              | 3 (12%)              | 0.806  |
| Pulmonary complications | 9 (17%)           | 30 (24%)             | 14 (54%)             | 0.001  |
| Cardiovascular complications | 1 (2%)       | 14 (11%)             | 3 (12%)              | 0.108  |
| Postoperative Confusion | 1 (2%)            | 4 (3%)               | 3 (12%)              | 0.047  |
| ICU Admission           | 2 (4%)            | 12 (10%)             | 3 (12%)              | 0.327  |
| Clavien-Dindo > 3       | 3 (6%)            | 18 (14%)             | 6 (24%)              | 0.036  |
| Length of Stay (days, DS)| 12 ± 6           | 13 ± 9               | 16 ± 12              | 0.018  |
| Reoperations            | 2 (4%)            | 7 (6%)               | 2 (8%)               | 0.724  |
| Readmissions            | 4 (7%)            | 7 (6%)               | 3 (12%)              | 0.512  |
| Mortality               | 0 (0%)            | 2 (2%)               | 0 (0%)               | 0.525  |

Bold values indicate statistical significance at the p < 0.05 level.

POPF Postoperative pancreatic fistula; DGE Delayed gastric empty; PPH Post pancreatectomy hemorrhage; ICU Intensive care unit.
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