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Original article

Comparison of 90-Day Mortality After Open Pancreaticoduodenectomy in Low-Volume VS High-Volume groups: A Retrospective Analysis

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Abstract
Hospital volume is an important factor in outcomes of complex surgeries like pancreaticoduodenectomy. High-volume centers generally report lower mortality due to surgical experience, multidisciplinary teams, and structured postoperative care [1,2]. To compare 90-day postoperative mortality after open pancreaticoduodenectomy between a low-volume group in Libya (AlSaqya clinic) and a high-volume Belgian group (Hospital S7, data from RIZIV/INAMI Convention, Belgian Cancer Registry Team)." A retrospective review was performed for patients undergoing open pancreaticoduodenectomy between 2019 and 2023. Low-volume group data included 21 patients from Alsaqya Hospital, Libya, while the high-volume Belgian group included 2,572 patients. Only open surgery cases were included for mortality comparisons. Patient characteristics, including age, sex, ASA, ECOG, Charlson Comorbidity Index, tumor type (malignant and neuroendocrine), and surgical approach, were recorded. Mortality was analyzed using Relative Risk (RR), 95% Confidence Intervals (CI), and Fisher's Exact Test. The 90-day mortality rate was 9.5% for the low-volume group and 5.0% in the high-volume group (RR = 1.89, 95% CI: 0.46–7.76; p = 0.36). Patients in the low-volume group had higher comorbidities (mean Charlson Index 4.71 vs. 1.33) and predominantly malignant tumors (20/21), while the high-volume group included both malignant and neuroendocrine tumors. All patients in both groups underwent open surgery. Age, sex distribution, ASA classification, and ECOG performance status were similar between the two groups. Mortality was higher in the low-volume group, but the difference was not statistically significant. These findings highlight the importance of hospital experience, multidisciplinary care, and structured perioperative management. Establishing specialized centers and centralizing complex pancreatic surgery, alongside collaboration with high-volume groups and optimization of local protocols, may further improve outcomes in low-volume settings.
Keywords. 90-Day Mortality, Open Pancreaticoduodenectomy, Retrospective Analysis.

Introduction

Pancreaticoduodenectomy, or the Whipple procedure, is a complex surgery performed to treat tumors near the head of the pancreas. It involves removing the head of the pancreas, the first part of the small intestine, the gallbladder, and part of the bile duct. Although essential for treating pancreatic cancer, it carries a significant risk of complications and mortality, which ranges from 2% to 16% worldwide [1,2]. Hospital and surgeon experience play a major role in patient outcomes. High-volume hospitals typically report lower mortality, fewer complications, and improved overall survival [3–5]. In contrast, hospitals performing fewer than three Whipple procedures per year often show variable results, leading to discussions about centralizing these surgeries at specialized high-volume centers to improve patient safety [4,6,11]. This threshold is supported by prior studies defining low-volume hospitals in pancreatic surgery [6-11].

Several studies support this volume–outcome relationship. Birkmeyer et al. [1,6] showed significantly lower operative mortality in high-volume hospitals and among experienced surgeons. Similarly, Olthof et al. [4] and Hunger et al. [5] found that hospitals performing more than 20 procedures per year had better short-term survival. However, some low-volume hospitals with skilled surgeons, structured perioperative care, and adequate resources can achieve outcomes similar to high-volume centers [7,8].

Centralizing complex surgeries can be challenging, especially in low-resource or rural areas. Geographic, economic, and logistical barriers may limit patient access, raising concerns about equity and timely care [9,10]. Understanding how hospital volume affects real-world outcomes is crucial for developing strategies to improve care and reduce mortality.

This study aims to compare 90-day postoperative mortality after open pancreaticoduodenectomy between a low-volume hospital in Libya and high-volume Belgian centers. We also assess patient characteristics, comorbidities, tumor type, and surgical approach to identify factors that may influence outcomes and guide improvements in low-volume settings.

Methods

This study looked back at patients who had open pancreaticoduodenectomy between 2019 and 2023 at two types of hospitals: a low-volume hospital in Libya (Alsaqya Hospital, n = 21) and high-volume Belgian centers

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(n = 2,572). Only patients who had open surgery were included so that the groups could be compared fairly. The large difference in sample sizes between the two groups is acknowledged as a study limitation and was considered when interpreting the results.

We collected information on patients' age, sex, comorbidities (Charlson Comorbidity Index), ASA physical status, ECOG performance status, surgical approach, antithrombotic therapy, 90-day mortality, and tumor type. Tumors were classified as either malignant or neuroendocrine. For the low-volume hospital, each patient's tumor type was taken from their pathology report. For the high-volume centers, we calculated the percentages of malignant and neuroendocrine tumors based on the total number of open cases, using data from hospital reports and the Belgian Cancer Registry. Other tumor types (such as benign or cystic neoplasms) were excluded to allow comparison with the low-volume cohort and maintain consistency between datasets; this restriction is recognized as a limitation of the study. Only these two tumor types were included in the comparison to make the groups comparable.

Continuous variables are reported as mean ± standard deviation, and categorical variables as counts and percentages. Mortality rates were compared between the two groups using Relative Risk (RR) with 95% Confidence Intervals (CI), and Fisher's Exact Test, which is suitable for small sample sizes. Effect sizes and confidence intervals were reported to provide a standardized measure of differences between groups. A p-value <0.05 was considered statistically significant. Statistical analyses were performed using SPSS version 26.

Results

Table 1 compares 90-day postoperative mortality after open pancreaticoduodenectomy between a low-volume hospital (Alsaqya Hospital, Libya) and high-volume Belgian centers. In the low-volume hospital, 2 out of 21 patients died within 90 days, resulting in a mortality rate of 9.5%. In high-volume centers, 129 out of 2,572 patients died within 90 days, giving a mortality rate of 5.0%. The Relative Risk (RR) of death in the low-volume hospital was 1.89, which means patients there had almost twice the chance of dying within 90 days compared to patients in high-volume centers. The 95% Confidence Interval (0.46–7.76) is wide because the low-volume hospital had only a small number of patients. The Fisher's Exact Test gave a p-value of 0.36, indicating that the difference was not statistically significant.

Table 1. Comparison of Mortality Rates Between Low- and High-Volume Hospitals (2019–2023)

Variables	No. of Patients	Died within 90 days	Mortality Rate (%)	Relative Risk (95% CI)	p-value (Fisher)
Low-volume hospital	21	2	9.5	1.89 (0.46–7.76)	0.36
High-volume hospitals	2,572	129	5	-	–

Table 2 shows that patients in the low- and high-volume hospitals were similar in age and sex. Most patients in both groups were in good general health based on ASA and ECOG scores. However, patients in the low-volume hospital had significantly more comorbidities, reflected by a higher Charlson Comorbidity Index (4.71 vs 1.33, p < 0.001). Regarding tumor type, the low-volume hospital included predominantly malignant tumors (95.2%), whereas the high-volume centers had a lower proportion of malignant tumors (73.9%), and this difference was statistically significant (p = 0.03). These differences in comorbidity burden and tumor type distribution are important potential confounders when interpreting mortality outcomes. All patients in both groups underwent open surgery. Age, sex, ASA, and ECOG were similar between groups, indicating that general fitness and functional status were not major contributors to mortality differences.

Table 2. Patient Characteristics and 90-Day Mortality in Low- and High-Volume Hospitals (2019–2023)

Variable	Low-volume Hospital (n=21)	High-volume Hospitals (n=2,572)	p-value
Age (mean ± SD)	67 ± 4.4	69 ± 5.9	0.28
Male	54.50%	55%	0.97
Female	45.50%	45%	0.97
Charlson Index (mean ± SD)	4.714 ± 0.950	1.33 ± 1.65	<0.001 **
ASA I–II / III–V	90.9% / 9.1%	58.8% / 41.2%	0.71
ECOG I–II / ≥III	90.9% / 9.1%	89.2% / 10.8%	0.52
Tumor Type: Malignant (Adenocarcinoma)	95.20%	1517 / 2052 (73.9%)	0.03 *
Tumor Type: Neuroendocrine	4.80%	535 / 2052 (26.1%)	0.12
Open surgery (%)	100%	100%	–

Discussion

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Our study shows that patients in the low-volume hospital (Alsaqya Hospital, Libya) had a higher 90-day mortality (9.5%) compared to high-volume Belgian centers (5%). The Relative Risk of 1.89 suggests that patients in the low-volume hospital had almost twice the likelihood of dying within 90 days. The 95% Confidence Interval (0.46–7.76) and Fisher's Exact Test p-value of 0.36 reflect the small number of patients in the low-volume group.

An important finding is that patients in the low-volume hospital had significantly higher comorbidities, reflected by a higher Charlson Comorbidity Index (4.71 vs 1.33, $p < 0.001$). In addition, the distribution of tumor types differed significantly between groups, with a predominance of malignant tumors in the low-volume hospital (95.2% vs 73.9%, $p = 0.03$). These differences represent important confounders that may have contributed to the observed mortality gap.

The higher mortality in the low-volume hospital may therefore be related not only to hospital volume but also to patient-related risk factors and disease severity, while all patients underwent open surgery. Age, sex, ASA, and ECOG scores were comparable, suggesting that general preoperative health and functional status were not the main factors.

The large imbalance in sample size between the two groups (21 vs 2,572 patients) is another important limitation, which reduces statistical power and explains the wide confidence interval. Furthermore, tumor classification was limited to malignant and neuroendocrine tumors to ensure comparability between datasets; however, excluding other tumor types may limit the generalizability of the findings.

These results support previous studies showing that high-volume hospitals achieve better outcomes after pancreaticoduodenectomy [1–6]. They emphasize the importance of hospital experience, surgical skill, multidisciplinary care, and structured perioperative management. Collaboration with high-volume centers, improvement of local protocols, and careful patient selection could help optimize outcomes in low-volume hospitals. Centralizing pancreatic surgery in specialized centers could further reduce risks and improve survival.

Conclusion

Mortality after Whipple surgery was higher in the low-volume hospital compared to high-volume centers. Outcomes were influenced by hospital experience, patient comorbidities, and tumor type distribution, in addition to surgical factors. Strengthening perioperative care, collaborating with high-volume centers, and establishing specialized or centralized pancreatic surgery centers can help improve results.

Conflict of interest. Nil

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