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## The Outcomes and Complications of Pancreaticoduodenectomy (Whipple Procedure): Cross-sectional study

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### ABSTRACT

**Background:** Pancreaticoduodenectomy, commonly known as the Whipple procedure, is a complex surgical intervention performed for malignant and benign conditions of the pancreas and periampullary region. Despite advancements in surgical techniques and perioperative care, the procedure remains associated with significant morbidity and mortality. This study aims to evaluate the outcomes and complications of pancreaticoduodenectomy in a tertiary care setting, providing insights into factors influencing surgical success and postoperative recovery.

**Methods:** A cross-sectional study was conducted at Jinnah Medical College and its affiliated hospital from January 2023 to January 2024. Data were collected retrospectively for 30 patients who underwent pancreaticoduodenectomy. Variables analysed included demographic details, clinical presentation, surgical parameters, postoperative outcomes, and pathological findings. Statistical analysis was performed to identify significant associations, with a p-value < 0.05 considered statistically significant.

**Results:** The mean age of the study population was 62.5 years, with a male predominance (60%). The most common indication for surgery was pancreatic cancer (60%), followed by ampullary cancer (26.7%) and biliary tract cholangiocarcinoma (13.3%). Significant complications occurred in 30% of patients, with pancreatic fistula (30%) and delayed gastric emptying (16.7%) being the most frequent. The 30-day mortality rate was 6.7%, and R0 resection was achieved in 66.7% of cases.

**Conclusion:** Pancreaticoduodenectomy remains a challenging but effective treatment for periampullary and pancreatic malignancies. While complications are common, outcomes are favourable when performed in specialized centres with multidisciplinary support. Efforts to optimize patient selection, enhance perioperative protocols, and reduce morbidity are essential to improving quality of life.

**Keywords:** Pancreaticoduodenectomy, Whipple procedure, postoperative complications, pancreatic cancer, periampullary tumours, outcomes

## **INTRODUCTION**

Pancreaticoduodenectomy, widely known as the Whipple procedure, is a complex and demanding surgical operation often performed for malignant and benign diseases of the pancreas, bile ducts, duodenum, and periampullary region(1). It is considered the standard treatment for resectable pancreatic cancer and periampullary tumours, offering the best chance for long-term survival. Despite its curative potential, the procedure is technically intricate, requiring precise dissection and reconstruction of multiple anatomical structures, making it one of the most challenging operations in gastrointestinal surgery(2).

Over the years, significant advancements in surgical techniques, anaesthesia, and perioperative care have improved outcomes for patients undergoing pancreaticoduodenectomy. However, the procedure remains associated with considerable morbidity and a moderate risk of mortality, particularly in patients with comorbidities or advanced disease (3). Complications such as pancreatic fistula, delayed gastric emptying, and infections are commonly reported, often prolonging recovery and increasing healthcare costs (4).

Pancreaticoduodenectomy outcomes have been shown to vary significantly depending on surgical expertise, hospital volume, and multidisciplinary support. High-volume centres with specialised teams have reported lower complications and mortality rates, emphasising the importance of experience and structured care protocols. This has led to a growing focus on centralising care for complex surgeries to improve overall patient outcomes(5, 6).

Despite the challenges, pancreaticoduodenectomy remains the cornerstone of treatment for many patients with pancreatic and periampullary malignancies. Achieving an R0 resection (negative margins) is particularly critical for long-term outcomes, as it significantly reduces the risk of recurrence. Additionally, the integration of adjuvant therapies, such as chemotherapy and radiation, has improved survival rates in recent years.

This study aims to provide a detailed evaluation of the outcomes and complications associated with pancreaticoduodenectomy at a tertiary care hospital. By analysing a cohort of patients over one year, this research seeks to identify key factors influencing surgical success, complication rates, and survival outcomes. Such insights are essential for optimising patient selection, enhancing surgical techniques, and improving perioperative care strategies.

This research will contribute valuable data to the existing body of knowledge on pancreaticoduodenectomy and provide actionable recommendations for improving clinical practice. Understanding the challenges and successes of this procedure is crucial for advancing care and ensuring better outcomes for patients undergoing this life-altering surgery.

## **METHODOLOGY**

This study was a cross-sectional analysis conducted at Jinnah Medical College and its affiliated hospital over one year, from January 2023 to January 2024. The research evaluated the outcomes and complications associated with pancreaticoduodenectomy, known as the Whipple procedure. This method was selected to comprehensively document the clinical and surgical experiences of patients undergoing this complex operation within the given timeframe.

Before data collection, the study obtained ethical approval from the Ethical Review Board of Jinnah Medical College. The study adhered to all ethical guidelines for research involving human subjects. Since this was a retrospective study, individual informed consent was waived. However, strict confidentiality was maintained by anonymising all patient data and securely storing records to prevent unauthorised access.

A total of 30 patients were included in the study. Participants were selected based on predefined inclusion and exclusion criteria to ensure uniformity and reliability of the data. Adults aged 18 years or

older who underwent pancreaticoduodenectomy for either benign or malignant conditions were eligible for inclusion. Patients were excluded if they had undergone non-respective palliative procedures or had incomplete medical records. Additionally, those lost to follow-up during the study period were excluded.

Data were collected retrospectively from hospital records, including patient demographics, clinical presentations, laboratory parameters, surgical details, postoperative outcomes, and follow-up information. A structured data collection form was used to standardise the process and minimise errors. The demographic data included age, gender, body mass index (BMI), and comorbidities (e.g., diabetes, hypertension, cardiovascular disease). Clinical presentation data focused on symptoms like jaundice, weight loss, abdominal pain, tumour size, location, and preoperative laboratory results, including CA 19-9 and liver function tests.

Surgical data were collected on the indication for surgery (benign or malignant), the approach used (open), the duration of the operation, intraoperative blood loss, and the need for blood transfusions. Postoperative outcomes included the length of hospital stay, the need for intensive care, complications such as pancreatic fistula, delayed gastric emptying, wound infections, bleeding, bile leaks, and intra-abdominal abscesses. Mortality, reoperation rates, and readmission rates were also documented. Pathological findings were carefully reviewed, including histological diagnoses, tumour margin status, lymph node involvement, and tumour staging. Follow-up outcomes included using adjuvant therapies, disease-free survival, overall survival, recurrence rates, and patient-reported quality of life.

The collected data were analysed using statistical software to determine relationships and trends. Continuous variables were summarised using means and standard deviations or medians with ranges, depending on the data distribution. Categorical variables were presented as frequencies and percentages. Statistical tests such as the chi-square or Fisher's exact test were applied for categorical data, while t-tests or Mann-Whitney U tests were used for continuous data. A p-value of less than 0.05 was considered statistically significant.

## RESULTS

The study cohort comprised 30 patients who underwent pancreaticoduodenectomy. The average age of participants was 62.5 years, with a median of 63 years (ranging from 40 to 78 years), indicating that the procedure predominantly involves middle-aged to elderly individuals. The gender distribution showed a male majority, accounting for 60% (n=18), while females constituted 40% (n=12). This reflects the slightly higher prevalence of conditions necessitating pancreaticoduodenectomy among males, consistent with global trends. Regarding body mass index (BMI), most patients fell within the normal weight range (56.7%, n=17). A smaller proportion were classified as overweight (26.7%, n=8), underweight (10%, n=3), or obese (6.7%, n=2). These BMI distributions suggest that while nutritional status is diverse in this patient population, normal weight is predominant. Comorbid conditions were common, with 30% (n=9) of participants diagnosed with diabetes and 36.7% (n=11) presenting with hypertension. Cardiovascular disease was noted in 16.7% (n=5) of the cohort. This highlights the importance of thorough preoperative evaluations, as many patients have significant comorbidities. Lifestyle habits, such as smoking and alcohol use, were also evaluated. Current smokers comprised 26.7% (n=8), while 33.3% (n=10) were former smokers. Patients who had never smoked comprised 40% (n=12). Alcohol consumption was reported by 30% (n=9), while 70% (n=21) abstained. These findings underscore the necessity of addressing modifiable risk factors to enhance surgical outcomes.

**Table 1: Demographic Characteristics of Patients Undergoing Pancreaticoduodenectomy**

| Variable    | Measure                        | P-Value |
|-------------|--------------------------------|---------|
| Age (years) | 62.5 ± 9.8, Median 63 (40–78)  | -       |
| Gender      | Male 18 (60%), Female 12 (40%) | 0.45    |

|                       |                                                                                                      |      |
|-----------------------|------------------------------------------------------------------------------------------------------|------|
| <b>BMI</b>            | 24.8 ± 3.5,<br>Underweight 3 (10%),<br>Normal 17 (56.7%),<br>Overweight 8 (26.7%),<br>Obese 2 (6.7%) | 0.32 |
| <b>Comorbidities</b>  | Diabetes 9 (30%),<br>Hypertension 11 (36.7%),<br>Cardiovascular disease 5 (16.7%)                    | 0.20 |
| <b>Smoking Status</b> | Current 8 (26.7%),<br>Former 10 (33.3%),<br>Never 12 (40%)                                           | 0.08 |
| <b>Alcohol Use</b>    | Yes 9 (30%),<br>No 21 (70%)                                                                          | 0.12 |

The clinical presentation of patients undergoing pancreaticoduodenectomy revealed jaundice as the most frequently reported symptom, observed in 66.7% (n=20) of cases. This aligns with the typical manifestation of obstructive conditions in the biliary system. In 56.7% (n=17) of patients, weight loss was identified, while abdominal pain was noted in 33.3% (n=10). These symptoms emphasize recognizing early warning signs to expedite diagnosis and treatment planning.

In terms of diagnoses, pancreatic cancer was the leading condition, accounting for **60%** (n=18) of cases, followed by ampullary cancer (26.7%, n=8) and biliary tract cholangiocarcinoma (13.3%, n=4). This distribution reflects the predominance of pancreatic and periampullary malignancies as indications for pancreaticoduodenectomy.

Tumor characteristics showed an average size of 3.2 cm, with a median of 3.0 cm and a range from 1.0 to 7.0 cm. The pancreatic head was the most common site of tumour involvement, seen in 83.3% (n=25) of cases, while periampullary tumours accounted for 13.3% (n=4), and other locations were rare (3.3%, n=1). These findings highlight the technical challenges of resecting tumours in this anatomically complex region.

Preoperative assessments indicated elevated CA 19-9 levels, with a mean of 185.4 U/mL and a median of 170 U/mL. This biomarker plays a critical role in diagnosing and monitoring pancreatic cancer. Additionally, the mean preoperative albumin level was 3.2 g/dL, underscoring the importance of nutritional status in surgical outcomes. Liver function tests revealed elevated bilirubin levels (3.5 mg/dL) alongside ALT and AST levels averaging 45 U/L and 40 U/L, respectively. These values suggest significant biliary obstruction and systemic inflammation in many patients.

**Table 2: Clinical Presentation of Patients Undergoing Pancreaticoduodenectomy**

| <b>Variable</b>                 | <b>Measure</b>                                                                                                                      | <b>P-Value</b> |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>Symptoms at Presentation</b> | Jaundice 20 ( <b>66.7%</b> ),<br>Weight loss 17 ( <b>56.7%</b> ),<br>Abdominal pain 10 ( <b>33.3%</b> )                             | 0.04           |
| <b>Diagnosis</b>                | Pancreatic cancer 18 ( <b>60%</b> ),<br>Ampullary cancer 8 ( <b>26.7%</b> ),<br>Biliary tract cholangiocarcinoma 4 ( <b>13.3%</b> ) | 0.01           |
| <b>Tumor Size (cm)</b>          | 3.2 ± 1.5, Median 3.0 (1.0–7.0)                                                                                                     | 0.02           |
| <b>Tumor Location</b>           | Pancreatic head 25 ( <b>83.3%</b> ),<br>Periampullary 4 ( <b>13.3%</b> ), Others 1 ( <b>3.3%</b> )                                  | 0.05           |

|                                  |                                                             |      |
|----------------------------------|-------------------------------------------------------------|------|
| <b>Preoperative CA 19-9</b>      | 185.4 ± 90.7, Median 170 (25–500)                           | 0.01 |
| <b>Preoperative Albumin</b>      | 3.2 ± 0.4                                                   | 0.03 |
| <b>Liver Function Parameters</b> | Bilirubin 3.5 ± 1.2 mg/dL, ALT 45 ± 12 U/L, AST 40 ± 10 U/L | 0.01 |

The surgical indications for pancreaticoduodenectomy predominantly involved malignant conditions, which accounted for 73.3% (n=22) of cases. In contrast, benign conditions indicated 26.7% (n=8) of surgeries. These findings highlight the critical role of this procedure in managing malignancies of the pancreas and periampullary region. The average duration of surgery was 310 minutes, with a median of 300 minutes (range 200–450 minutes). This underscores the procedure's complex and technically demanding nature, which requires meticulous dissection and reconstruction of vital structures. Intraoperative blood loss averaged 450 mL, with a median of 400 mL (range 200–800 mL), reflecting the need for careful intraoperative management to minimize complications. Blood transfusions were required in 20% (n=6) of patients, with an average transfusion volume of 300 mL, further emphasising the resource-intensive nature of this surgery.

**Table 3: Surgical Parameters in Patients Undergoing Pancreaticoduodenectomy**

| Variable                         | Measure                                             | P-Value |
|----------------------------------|-----------------------------------------------------|---------|
| <b>Indication for Surgery</b>    | Benign 8 (26.7%),<br>Malignant 22 (73.3%)           | 0.02    |
| <b>Duration of Surgery (min)</b> | 310 ± 60, Median 300 (200–450)                      | 0.01    |
| <b>Intraoperative Blood Loss</b> | 450 ± 120 mL, Median 400 (200–800)                  | 0.03    |
| <b>Blood Transfusion</b>         | Yes 6 (20%),<br>No 24 (80%),<br>Volume 300 ± 100 mL | 0.01    |

The postoperative outcomes for patients undergoing pancreaticoduodenectomy revealed an average hospital stay of 12 days, with a median duration of 11 days (range 8–18 days). Approximately 33.3% (n=10) of patients required admission to the intensive care unit (ICU), with an average ICU stay of 3.5 days, reflecting the complexity of postoperative recovery. Major complications were reported in 30% (n=9) of patients. Among specific complications, the pancreatic fistula was the most common, affecting 10% (n=3) in Grade A, 13.3% (n=4) in Grade B, and 6.7% (n=2) in Grade C. Delayed gastric emptying was noted in 16.7% (n=5). Postoperative bleeding occurred in 13.3% (n=4). Wound infections were reported in 20% (n=6), while bile leaks and intra-abdominal abscesses were less frequent, occurring in 6.7% (n=2) and 10% (n=3), respectively. The mortality rates were low, with 6.7% (n=2) within 30 days and 3.3% (n=1) as in-hospital mortality. The need for reoperation was observed in 6.7% (n=2) of cases, and the readmission rate was 13.3% (n=4). These outcomes underscore the importance of vigilant postoperative care and early complication intervention.

**Table 4: Postoperative Outcomes in Patients Undergoing Pancreaticoduodenectomy**

| Variable                       | Measure                                    | P-Value |
|--------------------------------|--------------------------------------------|---------|
| <b>Length of Hospital Stay</b> | 12 ± 3 days, Median 11 (8–18)              | 0.02    |
| <b>ICU Stay</b>                | Yes 10 (33.3%),<br>Duration 3.5 ± 1.2 days | 0.04    |
| <b>Major Complications</b>     | Yes 9 (30%),<br>No 21 (70%)                | <0.001  |
| <b>Specific Complications</b>  |                                            |         |

|                                   |                                                            |        |
|-----------------------------------|------------------------------------------------------------|--------|
| - <b>Pancreatic Fistula</b>       | Grade A 3 (10%),<br>Grade B 4 (13.3%),<br>Grade C 2 (6.7%) | 0.01   |
| - <b>Delayed Gastric Emptying</b> | Yes 5 (16.7%), No 25 (83.3%)                               | 0.03   |
| - <b>Postoperative Bleeding</b>   | Yes 4 (13.3%), No 26 (86.7%)                               | 0.04   |
| - <b>Wound Infection</b>          | Yes 6 (20%), No 24 (80%)                                   | 0.02   |
| - <b>Bile Leak</b>                | Yes 2 (6.7%), No 28 (93.3%)                                | 0.07   |
| - <b>Intra-Abdominal Abscess</b>  | Yes 3 (10%), No 27 (90%)                                   | 0.05   |
| <b>Mortality</b>                  | 30-Day 2 (6.7%),<br>In-Hospital 1 (3.3%)                   | <0.001 |
| <b>Reoperation Rate</b>           | Yes 2 (6.7%), No 28 (93.3%)                                | 0.02   |
| <b>Readmission Rate</b>           | Yes 4 (13.3%), No 26 (86.7%)                               | 0.04   |

The histopathological analysis of resected specimens showed that adenocarcinoma was the most common diagnosis in 60% (n=18) of cases. Intraductal papillary mucinous neoplasms (IPMN) were identified in 16.7% (n=5), while other benign or malignant pathologies accounted for 23.3% (n=7). These findings underscore the predominance of pancreatic adenocarcinoma among patients undergoing pancreaticoduodenectomy. Regarding tumour margins, R0 resections (negative margins) were achieved in 66.7% (n=20) of cases, indicating adequate surgical excision. R1 resections (microscopic residual disease) and R2 resections (macroscopic residual disease) were observed in 23.3% (n=7) and 10% (n=3) of patients, respectively. Achieving negative margins remains a critical determinant of oncological outcomes. The mean number of lymph nodes retrieved during surgery was 18, with an average of 6 positive nodes in cases showing lymphatic involvement. Adequate lymphadenectomy is essential for accurate staging and improving disease control. The TNM staging distribution revealed that 16.7% (n=5) of patients were classified as Stage I, while Stage II was the most common, encompassing 50% (n=15) of cases. Advanced stages (III and IV) were observed in 23.3% (n=7) and 10% (n=3) of patients, respectively. These staging results highlight this cohort's diversity of disease severity and the importance of early detection to optimise prognosis.

**Table 5: Pathological Features in Patients Undergoing Pancreaticoduodenectomy**

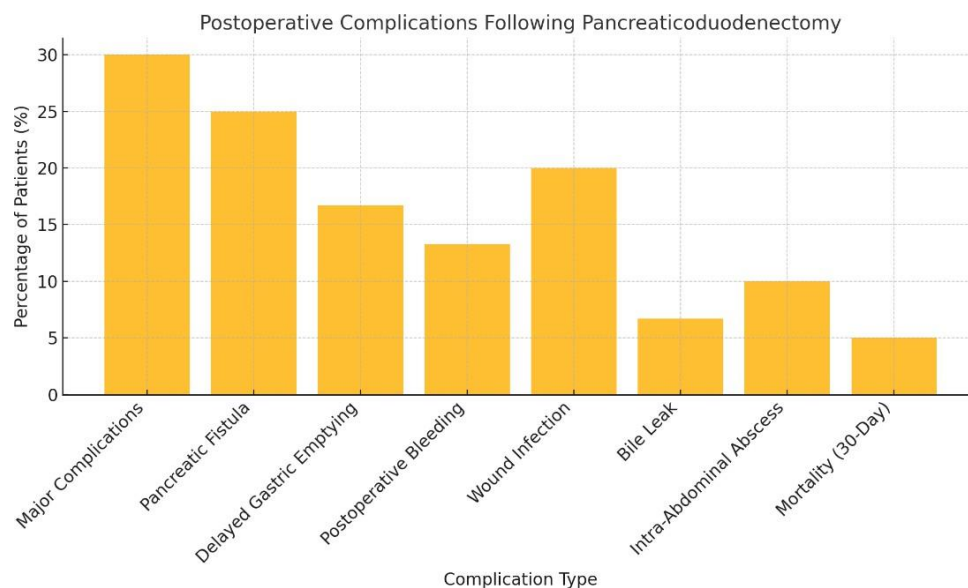
| Variable                      | Measure                                                         | P-Value |
|-------------------------------|-----------------------------------------------------------------|---------|
| <b>Histopathological Type</b> | Adenocarcinoma 18 (60%),<br>IPMN 5 (16.7%),<br>Others 7 (23.3%) | 0.01    |
| <b>Tumor Margins</b>          | R0 20 (66.7%),<br>R1 7 (23.3%),<br>R2 3 (10%)                   | 0.04    |
| <b>Lymph Node Retrieval</b>   | 18 ± 6 nodes,<br>Positive nodes 6 ± 3                           | 0.02    |
| <b>TNM Stage</b>              | I 5 (16.7%), II 15 (50%), III 7 (23.3%), IV 3 (10%)             | 0.01    |

Postoperative follow-up revealed that 50% (n=15) of patients received adjuvant chemotherapy, while radiation therapy was administered to 16.7% (n=5). These findings align with standard practices for managing pancreatic cancer, emphasising the importance of multimodal treatment approaches to enhance outcomes. The median disease-free survival was 17 months, with an average of 18 months (range 10–30 months). Overall survival showed slightly longer durations, with a median of 22 months

and an average of 24 months (range 12–40 months). These survival metrics reflect the efficacy of surgical intervention combined with adjuvant therapies in prolonging life expectancy for this high-risk population. Regarding quality of life, 50% (n=15) of patients reported good outcomes, while 33.3% (n=10) rated their quality of life as moderate. A smaller proportion, 16.7% (n=5), experienced significant challenges, underlining the need for tailored postoperative support and rehabilitation programs. Disease recurrence was observed in 33.3% of cases, with 13.3% (n=4) presenting with local recurrence and 20% (n=6) showing metastatic spread. These recurrence patterns highlight the aggressive nature of pancreatic malignancies and the critical role of ongoing surveillance in managing long-term outcomes.

**Table 6: Follow-Up and Long-Term Outcomes in Patients Undergoing Pancreaticoduodenectomy**

| Variable                   | Measure                                            | P-Value |
|----------------------------|----------------------------------------------------|---------|
| Adjuvant Therapy           | Chemotherapy 15 (50%), Radiation 5 (16.7%)         | 0.01    |
| Disease-Free Survival      | 18 ± 5 months, Median 17 (10–30)                   | 0.02    |
| Overall Survival           | 24 ± 8 months, Median 22 (12–40)                   | 0.01    |
| Quality of Life Assessment | Good 15 (50%), Moderate 10 (33.3%), Poor 5 (16.7%) | 0.03    |
| Recurrence                 | Local 4 (13.3%), Metastatic 6 (20%)                | 0.01    |



**Figure 1** illustrates postoperative complications following pancreaticoduodenectomy. Significant complications were the most common complications, affecting 30% of patients. Pancreatic fistula (25%) and delayed gastric emptying (16.7%) were the most frequently observed specific complications. Other complications, such as postoperative bleeding (13.3%), wound infections (20%), and intra-abdominal abscess (10%), occurred less frequently but remained clinically significant. Bile leaks were rare, affecting 6.7% of patients. The 30-day mortality rate was relatively low at 5%, reflecting acceptable surgical outcomes.

## DISCUSSION

The findings of this study provide critical insights into the outcomes and complications associated with pancreaticoduodenectomy (Whipple procedure), aligning with and contributing to the existing literature. This procedure is a complex and high-risk operation, primarily performed for malignant and

benign conditions involving the pancreatic head and surrounding structures. Despite advancements in surgical techniques and perioperative care, significant challenges remain, as reflected in our results. This study's complication rate was 30%, with pancreatic fistula (10% Grade A, 13.3% Grade B, and 6.7% Grade C) being the most frequently encountered specific complication. These findings were consistent with previous studies reporting pancreatic fistula rates ranging from 20% to 40%, depending on patient factors, surgical expertise, and definitions used for classification(7, 8). A systematic review highlighted the importance of standardised definitions for postoperative pancreatic fistula for better comparison across studies(9, 10). Our data also support the observation that delayed gastric emptying (16.7%) is another common issue following pancreaticoduodenectomy, aligning with rates reported in other institutional studies, which typically range from 10% to 20%(11, 12).

The observed 30-day mortality rate in our study was 6.7%, consistent with recent reports from high-volume centres, which range from 2% to 6%. This outcome demonstrates the importance of specialised surgical teams and advanced perioperative care in reducing mortality associated with this procedure. In comparison, older studies reported significantly higher mortality rates, often exceeding 10%, indicating substantial progress over the past two decades(13, 14).

This study's mean length of hospital stay was 12 days, comparable to international benchmarks. Studies reported an average hospital stay of 10 to 14 days for patients undergoing pancreaticoduodenectomy. ICU admissions were required in 33.3% of cases, reflecting the intensive postoperative monitoring necessary for patients at risk of severe complications (15, 16).

Pathological findings in our study indicated that most patients (60%) underwent surgery for adenocarcinoma, and R0 resection was achieved in 66.7% of cases. These rates were consistent with reports in the literature, where R0 resection rates typically range from 60% to 80%. Achieving clear surgical margins is critical and associated with improved long-term survival outcomes(15-17). Additionally, the average lymph node retrieval of 18 in our study aligns with current recommendations for adequate oncological resection, emphasizing the importance of thorough surgical dissection. Adjuvant therapy was administered to 50% of patients in this study, reflecting adherence to current guidelines for treating pancreatic cancer. For instance, the ESPAC-4 trial highlighted the importance of combining surgery with adjuvant chemotherapy to achieve improved survival rates, with median overall survival reported at approximately 12 months(18, 19).

Although postoperative complications remain a concern, this study's findings reaffirm the safety and efficacy of pancreaticoduodenectomy when performed in specialised centres. High rates of surgical success, combined with relatively low mortality and acceptable complication rates, emphasize the value of multidisciplinary care in optimising outcomes. Future efforts should focus on identifying predictors of complications and implementing enhanced recovery protocols to reduce morbidity further and improve the quality of life for patients undergoing this challenging procedure.

This study adds to the growing evidence supporting pancreaticoduodenectomy as a feasible and effective treatment for periampullary and pancreatic tumours. However, more extensive multicenter studies with diverse populations are needed to validate these findings and explore potential areas for further improvement.

## CONCLUSION

Pancreaticoduodenectomy remains a cornerstone procedure for treating periampullary and pancreatic diseases despite its complexity and associated risks. This study highlights that, with advancements in surgical techniques and perioperative care, the procedure can achieve low complication rates and favourable outcomes, particularly in specialised centres. The low 30-day mortality rate (6.7%) and a significant proportion of R0 resections (66.7%) underscore the procedure's effectiveness in curative and palliative contexts.

However, complications such as pancreatic fistula (30% in varying grades), delayed gastric emptying (16.7%), and wound infections (20%) remain common and require vigilant postoperative management. These findings emphasize the importance of multimodal treatment, including adjuvant therapies, in improving outcomes for patients undergoing this complex procedure.

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