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A NOVEL SURGICAL APPROACH TO RECONSTRUCTION IN PANCREATICODUODENECTOMY USING AN ISOLATED PANCREATIC LOOP

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ABSTRACT

Background and Aim: To analyze the feasibility, safety, and postoperative outcomes of isolated pancreatic loop reconstruction in patients undergoing pancreaticoduodenectomy.

Methods: A dual Roux-en-Y procedure was used for reconstructing patients after the procedure, utilizing an isolated jejunal limb for pancreaticojejunostomy and a different jejunal limb for hepaticojejunostomy and gastrojejunostomy. The length of hospital stay, surgical complications, and perioperative results were assessed and contrasted with those of patients undergoing traditional Whipple reconstruction.

Results: The use of a separate pancreatic loop was associated with a significantly lower incidence of delayed gastric emptying and postoperative pancreatic fistula (pancreatic juice leak). Patients in the dual-loop reconstruction group demonstrated faster recovery of gastrointestinal function and a shorter overall hospital stay compared with those who underwent conventional reconstruction. The rates of anastomotic leakage and other major postoperative complications were comparable between the two groups.

Conclusion: The use of a separate pancreatic loop in Whipple surgery is a promising reconstructive approach that may improve postoperative outcomes by reducing delayed gastric emptying and pancreatic juice leakage, facilitating faster gastrointestinal recovery, and shortening hospital stay, while maintaining comparable rates of anastomotic leakage and other major complications.

Keywords: Pancreaticoduodenectomy, Pancreatic Loop, Reconstruction, gastrointestinal recovery.

1. INTRODUCTION

Pancreatic ductal adenocarcinoma (PDAC) Pancreatic is a highly lethal disease, with the highest incidence reported in North America, Europe, and Australia [1]. Although the rising incidence is largely related to aging populations worldwide, recent data show an increase in pancreatic cancer among younger individuals. Understanding the mechanisms of pancreatic tumorigenesis, controlling modifiable risk factors, and implementing effective early screening strategies may help reduce disease burden [2]. Pancreatic cancer is the most common solid tumor of the pancreas, representing over 95% of all pancreatic neoplasms. It arises from normal glandular epithelium, which progresses to precursor lesions and ultimately invasive cancer. About 95% of these tumors develop from precancerous lesions called pancreatic intraepithelial neoplasias (PanINs) [3].

A major reason for the poor prognosis of pancreatic cancer is late diagnosis. approximately 90% of tumors are detected at an advanced stage, with systemic metastases present in more than 50% of cases. This emphasizes the need for early detection tools and therapies that effectively target metastatic PDAC. PDAC is partly caused by somatic mutations in oncogenes and tumor suppressor genes, with the most frequently mutated being KRAS, CDKN2A, TP53, and SMAD4 [4]. Aghalarov et al. (2018) demonstrated that double-loop reconstruction following pancreaticoduodenectomy, which separates pancreatic and biliary secretions, may decrease both the incidence and severity of postoperative pancreatic fistula compared with conventional single-loop reconstruction. However, this technique was associated with a longer operative time. Key modifiable risk factors include cigarette smoking, obesity, diabetes, and alcohol consumption. The prevalence of these factors is increasing in many regions, leading to higher age-adjusted incidence rates, however, their impact varies globally due to differences in prevalence and prevention strategies. Inherited genetic factors, though not modifiable, are also important and include pathogenic variants in hereditary cancer genes, genes associated with hereditary pancreatitis, and common variants identified in genome-wide association studies. Identification of these genetic changes provides insights into pancreatic cancer etiology and opportunities for early detection [1]. Changes in the epidemiology of pancreatic cancer, insights from pancreatic surveillance programs, and the identification of novel biomarkers are guiding new strategies for risk assessment, early detection, and prevention of pancreatic cancer [5]. Despite significant advances in understanding the biology of PDAC over recent decades, these insights have not yet translated into substantial improvements in clinical outcomes for most patients [6]. A multidisciplinary approach is essential for accurate staging and effective management of pancreatic cancer, combining tumor-targeted therapies with comprehensive supportive care.

Chemotherapy in combination with surgical resection remains the cornerstone of treatment, although only a minority of patients are suitable candidates for surgery [3].
Localized pancreatic cancer is classified as resectable, borderline resectable (involving major vessels), or locally advanced/unresectable, based on the extent of arterial and venous tumor involvement, typically affecting the superior mesenteric vessels. For patients with resectable disease at diagnosis (10–15%), surgical resection followed by adjuvant FOLFIRINOX (fluorouracil, irinotecan, leucovorin, oxaliplatin) is the standard of care, providing a median overall survival of 54.4 months compared to 35 months with single-agent gemcitabine. Neoadjuvant systemic therapy, with or without radiation, followed by surgical evaluation is an accepted strategy for resectable and borderline resectable tumors. For locally advanced or unresectable disease due to extensive vascular involvement, systemic therapy followed by radiation may offer definitive locoregional control [7]. Surgical techniques have evolved from the first pancreatic resections in the late 1800s and early 1900s to operations with mortality rates under 3% in the 1980s, and now to minimally invasive procedures. Over time, medical management has progressed from a nihilistic approach in the 1960s to the first randomized adjuvant therapy trials in the 1980s, and now to contemporary neoadjuvant therapy studies. Surgical resection options include pancreaticoduodenectomy for tumors in the pancreatic head or body and distal pancreatectomy for tumors in the tail. It took decades of pioneering work to establish that pancreatic resection is not only technically feasible but also a safe and critical component of therapy. In 1942, Whipple described a one-stage operation for a patient with non-functioning islet cell carcinoma who survived nine years. This procedure involved distal gastrectomy, removal of the duodenum and pancreatic head, followed by gastrojejunostomy and choledochojejunostomy. Whipple later modified this procedure to include pancreaticojejunostomy [8]. The safety and quality of pancreatic surgery have improved significantly with the adoption of minimally invasive techniques and surgical adjuncts [9].
Common postoperative complications include delayed gastric emptying (DGE), pancreatic fistula, hemorrhage, chyle leaks, endocrine and exocrine insufficiency, and surgical site infections. Proper management of these complications requires a team-based approach, including experienced nursing staff, gastroenterology, and interventional radiology [10]. The goal of this case is to assess the therapeutic advantages of using a different pancreatic loop during reconstruction after pancreaticoduodenectomy (Whipple surgery). The goal of such reconstruction technique is to minimize the contact of bile fluids at the apical position by isolating pancreatic fluids from the bile and stomach channels. This strategy has the potential to improve overall surgical results and recovery after surgery by reduced the proportion of surgical problems, including delayed stomach emptying, by lowering catalytic activation and anastomotic stress.

2. METHODS

A total of three patients who underwent pancreaticoduodenectomy (Whipple procedure) were included in this study. The median age was 49 years, with an age range of 33–79 years. The demographic profile and preoperative clinical characteristics of the patients are presented in Table 1. All patients underwent comprehensive preoperative assessment, including contrast-enhanced imaging, to determine disease extent and surgical resectability. Patients considered suitable for surgery subsequently underwent pancreaticoduodenectomy using the proposed reconstructive approach. Clinical progress was monitored throughout the postoperative period, and outcomes were assessed with respect to recovery and procedure-related complications.
Postoperative outcomes were evaluated and compared with published outcomes reported for conventional single-loop reconstruction techniques. The primary outcome measures included the incidence of delayed gastric emptying, duration of postoperative hospital stay, and the occurrence of anastomotic leakage. These parameters were assessed to determine the safety and clinical effectiveness of the separate pancreatic loop reconstruction.

Variable	Patient 1	Patient 2	Patient 3
Age (years)	48	79	33
Sex	Male	Female	Male
Presenting complaints	Jaundice, abdominal pain, and dark-colored urine	Recurrent vomiting, abdominal discomfort, and weight loss for 1 month	Upper abdominal pain, nausea, vomiting, fever, jaundice, and history of passing pale-colored stools
Comorbidities	Type 2 diabetes mellitus	Type 2 diabetes mellitus, systemic hypertension	None
Final histopathological diagnosis	Well-differentiated adenocarcinoma, NOS; Grade 1; pathological stage pT3N0	Moderately differentiated periampullary adenocarcinoma arising from an intra-ampullary papillary–tubular neoplasm (IAPN); pathological stage pT2N1	Chronic pancreatitis

Table 1. Baseline demographic and clinicopathological characteristics of the study patients

2.1. Surgical Technique

Following pancreaticoduodenectomy, reconstruction was carried out using a dual Roux-en-Y technique. An isolated jejunal limb was dedicated to the pancreaticojejunostomy, whereas the hepaticojejunostomy and gastrojejunostomy were

fashioned on a separate jejunal limb. This reconstructive approach was designed to maintain independent drainage of pancreatic secretions while allowing biliary and gastric contents to pass through a different intestinal segment.

3. RESULTS

Intraoperative view following pancreaticoduodenectomy before reconstruction, demonstrating the pancreatic remnant, hepatic duct, and gastric stump prepared for reconstruction shows Fig. 1 A. Figure 1 B showed the dual Roux-en-Y reconstruction showing the isolated jejunal limb used for pancreaticojejunostomy and the separate jejunal limb used for hepaticojejunostomy and gastrojejunostomy. No perioperative transience was observed in this study series, and all patients had an uneventful postoperative recovery. The use of an isolated pancreatic limb was associated with a lower incidence of delayed gastric emptying and a reduced rate of clinically significant pancreatic fistula. Separation of the pancreaticojejunostomy from the biliary and gastric anastomoses allows pancreatic secretions to drain through an independent jejunal limb, thereby minimizing the interaction of pancreatic enzymes with bile at the anastomotic site.

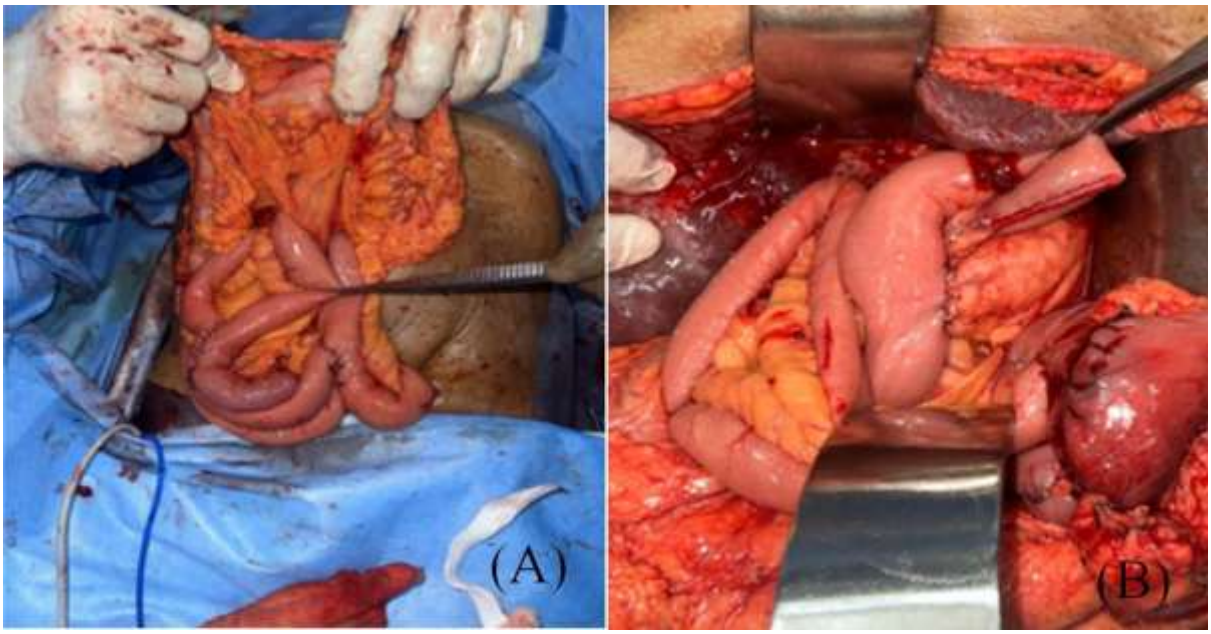

Fig. 1A. Operative field after pancreaticoduodenectomy before reconstruction.

1B. dual Roux-en-Y reconstruction with an isolated pancreatic limb.

This reconstructive strategy may reduce local enzymatic activation and lessen the risk of anastomotic disruption. Patients reconstructed with the dual Roux-en-Y technique also demonstrated earlier recovery of gastrointestinal function and a shorter duration of hospital stay. In addition, lower rates of anastomotic leakage and other major postoperative complications were observed. These findings suggest that the use of a separate pancreatic limb during reconstruction after pancreaticoduodenectomy is a promising surgical modification that may improve postoperative outcomes.

4. DISCUSSION

Pancreaticoduodenectomy (PD) remains the standard surgical procedure for the treatment of periampullary malignancies. Despite advances in surgical techniques and perioperative care, postoperative complications continue to be common, with delayed gastric emptying (DGE) and postoperative pancreatic fistula representing two of the most clinically significant adverse events. DGE, defined as impaired gastric emptying in the absence of a mechanical obstruction, is associated with prolonged hospitalization, increased healthcare expenditure, delayed recovery, and reduced postoperative quality of life. Postoperative pancreatic fistula remains a major concern because the soft and fragile pancreatic parenchyma often provides limited suture-holding capacity, increasing the risk of anastomotic failure and leakage of pancreatic secretions. These complications continue to present important challenges following PD and have prompted ongoing efforts to optimize reconstructive techniques and improve surgical outcomes [11]. Given the persistent risk of postoperative complications, further refinement of reconstructive techniques after pancreaticoduodenectomy is warranted. In particular, reconstruction using an isolated pancreatic limb may represent a valuable approach to reducing postoperative morbidity, promoting earlier functional recovery, and improving overall surgical outcomes.

Recent studies have examined the safety and clinical effectiveness of isolated pancreatic limb, Roux-en-Y, and single-loop reconstruction techniques following pancreaticoduodenectomy. In a systematic review and meta-analysis, Mobarak et al. (2021) evaluated Roux-en-Y reconstruction against single-loop reconstruction and reported no significant differences in the incidence of major postoperative complications, including postoperative pancreatic fistula, delayed gastric emptying, bile leakage, and overall postoperative morbidity. However, the authors observed that Roux-en-Y reconstruction required a significantly longer operative time than the single-loop approach. These findings suggest that, although both reconstructive methods achieve comparable postoperative outcomes, differences in operative complexity may influence the choice of reconstruction [12]. Zhao and Li (2021) reported that single-loop reconstruction provides postoperative outcomes comparable to those of Roux-en-Y reconstruction following pancreaticoduodenectomy. Their

findings demonstrated no significant differences in the rates of postoperative pancreatic fistula, delayed gastric emptying, or overall postoperative morbidity. In addition, the single-loop technique was associated with reduced operative time and a less complex reconstructive procedure, suggesting potential technical advantages without compromising clinical outcomes [13]. In an ambispective observational study, Jena et al. (2024) reported that single-loop reconstruction following pancreaticoduodenectomy was associated with favorable perioperative outcomes and a low incidence of postoperative complications. Their findings support the safety and feasibility of this reconstructive approach and suggest that it is a reliable option for routine clinical practice [14]. Machado and Machado (2016) reported their five-year experience with isolated pancreatic anastomosis using a single-loop reconstruction technique. Their series demonstrated the absence of perioperative mortality and acceptable postoperative morbidity, indicating that this reconstructive approach is both safe and technically reproducible when performed in appropriately selected patients [15].

5. CONCLUSION

In conclusion, the findings of the present study are consistent with previous reports supporting the safety and feasibility of isolated pancreatic loop reconstruction following pancreaticoduodenectomy. Comparison with a contemporaneous cohort of patients who underwent conventional Whipple reconstruction (n = 8) demonstrated that the isolated pancreatic loop technique was associated with a shorter hospital stay and a lower incidence of postoperative complications. Although the limited sample size precludes definitive conclusions, these observations suggest that separation of the pancreaticojejunostomy from the biliary and gastric anastomoses may contribute to improved postoperative recovery without increasing the risk of major complications, including delayed gastric emptying and postoperative pancreatic fistula. Larger prospective, multicenter studies are warranted to validate these findings and to define the optimal reconstructive strategy. Until then, the choice of reconstruction should be individualized based on patient characteristics, surgeon expertise, and institutional experience.

Patient consent statement

Patient consent statement Written informed consent was obtained from all participants prior to inclusion in the study.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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