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The Efficacy of Braun Enteroenterostomy in Pancreaticoduodenectomy: A Comprehensive Review

Omar Zohry[1*], Moatasem Elreedy[1], Ehab M. Sabry[2], Ashraf Abdelazeem[1], Tantawy Abdelnaeem[1], Saleh Khairy[1], Assaad Abdelrahman Abd El Aziz[1], Michael Remon[1]

1 Department of General Surgery, Faculty of Medicine, Minia University, Minia 61519, Egypt
2 Department of Surgical Oncology, Al-Maadi military compound, Cairo, 11728, Egypt

***Corresponding Author**
Department of General Surgery, Faculty of Medicine, Minia University, Minia 61519, Egypt; e-mails: Omr.zahry@mu.edu.eg

ABSTRACT

Braun enteroenterostomy (BEE) has been increasingly utilized as a reconstructive modification in pancreaticoduodenectomy (PD) to minimize postoperative complications, particularly delayed gastric emptying (DGE). This comprehensive review analyzes evidence from retrospective, prospective, and meta-analytic studies assessing the efficacy of BEE in PD. The findings demonstrate that BEE is associated with a significant reduction in clinically relevant DGE (Grades B/C), shorter hospital stays, and lower overall morbidity compared to conventional reconstructions. Mechanistically, BEE diverts biliary and pancreatic secretions away from the stomach, reducing bile reflux and improving gastric motility. While it marginally increases operative time, the benefits in postoperative recovery and complication reduction outweigh the procedural complexity. Current evidence supports incorporating BEE into standard PD reconstruction, especially within enhanced recovery protocols. However, further randomized controlled trials are warranted to confirm its long-term safety and functional outcomes.

KEYWORDS: Braun enteroenterostomy, pancreaticoduodenectomy, delayed gastric emptying

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INTRODUCTION AND SURGICAL CONTEXT

Pancreaticoduodenectomy (PD) remains one of the most complex abdominal surgical procedures, primarily for the treatment of pancreatic and periampullary malignancies. Despite the advancements in surgical techniques, perioperative care, and anesthesia, postoperative morbidity continues to affect 30-65% of patients (1). Among the most common and clinically significant complications is delayed gastric emptying (DGE), which occurs in 14-60% of patients depending on the definition used and patient population studied(2). While not typically life-threatening, DGE significantly prolongs hospital stays, increases medical costs, causes substantial patient discomfort, and potentially delays the initiation of adjuvant chemotherapy(3).

The mechanisms of DGE are multifactorial , involving disruption of neural pathways, alterations in hormonal secretion, impaired antral motility, and the presence of other intra-abdominal complications such as pancreatic fistula or intra-abdominal collections(4). Numerous technical modifications have been proposed to reduce the incidence of DGE, including pylorus preservation, antecolic versus retrocolic reconstruction, and various anastomotic techniques(1). Among these modifications, the additionJejunumraun enteroenterostomy (BEE), an anastomosis between the afferent and efferent limbs of the jejunum distal to the gastrojejunostomy—has been proposed as a method to reduce biliary reflux and potentially improve gastric emptying(1, 5).

First described over a century ago, Braun's original technique was designed to divert biliary and pancreatic secretions away from the stomach following gastric resection procedures(5). The application of this technique to pancreaticoduodenectomy has generated considerable debate in the hepatopancreatobiliary surgical community, with studies reporting conflicting results regarding its efficacy in reducing DGE and other postoperative complications(5). This review examines the current evidence regarding the efficacy of Braun enteroenterostomy in pancreaticoduodenectomy, with a specific focus on its impact on delayed gastric emptying, other postoperative outcomes, technical considerations, and future directions for research.

METHODOLOGICAL APPROACH TO LITERATURE

This review incorporates evidence from a comprehensive analysis of the available literature on Braun enteroenterostomy in pancreaticoduodenectomy. The included studies encompass various methodological designs, including prospective cohort studies, retrospective analyses, systematic reviews, and meta-analyses. Literature searches were conducted across major electronic databases including PubMed, EMBASE, Science Citation Index, Cochrane Library, and Chinese electronic databases (VIP database, WanFang database, and CNKI database)(6).

The quality assessment of included studies was evaluated using the Newcastle-Ottawa quality assessment scale, with studies

labeled with 6 stars or greater considered high quality. Meta-analyses were conducted using statistical models appropriate for the degree of heterogeneity observed among studies, with random-effects models employed when significant heterogeneity was present ($I^2 > 50\%$). Outcomes were typically reported as odds ratios (OR) or weighted mean differences (WMD) with 95% confidence intervals (CI)(2).

Table 1: Overview of Major Studies on Braun Enteroenterostomy in Pancreaticoduodenectomy

Study (Year)	Design	Sample Size (Braun/Non-Braun)	Primary Outcomes	Key Findings
Hochwald et al (2010)(5)	Retrospective	70/35	DGE rates, LOS	Significant reduction in DGE (7% vs 31%) and shorter LOS (10 vs 12 days)
Zhang et al (2014) (4)	Retrospective	347/48	DGE incidence	No significant difference in DGE (10.7% vs 16.7%, p=0.220)
Xu et al (2015) (2)	Meta-analysis	1614 patients (10 studies)	DGE, morbidity, mortality	Reduced DGE (OR 0.375), lower morbidity (OR 0.66), longer operative time
Prospective Study (2025) (7)	Prospective	25/72	DGE, POPF, LOS	Lower DGE (33.3% vs 46.8%), reduced POPF, shorter LOS (12.5 vs 15.7 days)
Carmel et al (2025) (1)	Retrospective	76/138	DGE in ERAS setting	Lower severe DGE (2.6% vs 15.9%), fewer major complications
Japanese Study (2022) (8)	Retrospective	51/94	DGE, endoscopic findings	No DGE difference (1.9% vs 7.4%), less bile reflux (0% vs 30.8%)

IMPACT ON DELAYED GASTRIC EMPTYING

Delayed gastric emptying represents one of the most common complications following pancreaticoduodenectomy, and its reduction is the primary theoretical benefit of adding Braun enteroenterostomy to the reconstruction. The collective evidence from multiple studies suggests that BEE may have a favorable impact on DGE incidence and severity, particularly for more clinically significant forms (Grades B and C).

The 2025 prospective study (n=97) demonstrated a significantly lower overall incidence of DGE in the Braun group (33.3%) compared to the non-Braun group (46.8%) (p=0.032)(7). Importantly, this study reported no Grade C DGE in either group, and Grade B DGE was less frequent in the Braun group(7). These findings are supported by a meta-analysis of 10 studies encompassing 1,614 patients, which found that BEE was associated with significantly lower rates of clinically relevant DGE (Grades B and C) (OR: 0.375, 95% CI: 0.164-0.858)(2). The same analysis also demonstrated reduced need for nasogastric tube reinsertion (OR: 0.436, 95% CI: 0.232-0.818) and less postoperative vomiting (OR: 0.444, 95% CI: 0.262-0.755) in patients who underwent Braun enteroenterostomy(2).

Hochwald et al. found even more dramatic reductions in DGE with BEE, reporting Grade B/C DGE rates of 7% in the Braun group compared to 31% in the non-Braun group (p=0.003)(5). This study also demonstrated earlier resumption of oral intake, with patients in the Braun group tolerating liquids at a median of 5 days versus 6 days (p=0.01) and solid foods at 7 days versus 9 days (p=0.01) compared to the non-Braun group(5).

The mechanistic rationale for these benefits appears to be related to the diversion of biliary and pancreatic secretions away from the stomach and through the Braun anastomosis into the efferent limb. This reduction in biliary reflux may contribute to improved gastric emptying and reduced vomiting, as evidenced by endoscopic findings showing significantly less bile reflux in patients with BEE (0% vs 30.8%, p=0.03)(9). However, it is worth noting that not all studies have demonstrated a beneficial effect of BEE on DGE. Zhang et al. found no significant difference in DGE rates between patients with and without BEE (10.7% vs 16.7%, p=0.220) in their retrospective analysis of 395 patients(4).

When examining DGE in the context of enhanced recovery after surgery (ERAS) protocols, a recent retrospective analysis of 214 patients found that while overall DGE rates were similar between groups (approximately 29%), severe DGE was significantly less common in the Braun group (2.6% versus 15.9%, P=0.003). This suggests that BEE may be particularly valuable in the setting of modern accelerated recovery protocols, where even modest reductions in complication severity can facilitate earlier discharge and recovery(1, 3)

OTHER POSTOPERATIVE OUTCOMES

Beyond its effects on delayed gastric emptying, Braun enteroenterostomy may influence various other postoperative outcomes

following pancreaticoduodenectomy. The available evidence suggests potential benefits in terms of overall morbidity, length of stay, and specific complications, though no significant differences have been observed for other outcomes.

The 2025 meta-analysis of 10 studies demonstrated a significantly lower overall morbidity rate in patients undergoing BEE (OR: 0.66, 95% CI: 0.49-0.91). This finding is supported by the recent retrospective study in the ERAS setting, which found significantly fewer major complications in the Braun group (17.1% versus 37%, P=0.002). Multivariate analysis from this study confirmed that BEE was independently associated with lower odds of major complications (OR 0.44, P=0.033)(3).

Multiple studies have consistently demonstrated a reduction in hospital length of stay for patients undergoing BEE. The prospective study reported a mean postoperative stay of 12.5 days in the Braun group versus 15.7 days in the non-Braun group (p=0.027)(7). Similarly, the meta-analysis found a weighted mean difference of -1.80 days (95% CI: -3.4 to -0.18, p=0.03) in favor of the Braun group(6, 10). Hochwald et al. also reported a significantly shorter median length of stay in their Braun group (10 days versus 12 days, p<0.05)(5).

Table 2: Impact of Braun Enteroenterostomy on Postoperative Outcomes

Outcome Measure	Effect Size	95% Confidence Interval	P-value	Reference
DGE (Grades B/C)	OR 0.375	0.164-0.858	<0.05	(2)
Overall Morbidity	OR 0.66	0.49-0.91	<0.05	(2)
Hospital Stay	WMD -1.80 days	-3.4 to -0.18	0.03	(6, 10)
Reoperation Rate	OR 0.380	0.149-0.968	<0.05	(2)
Operative Time	SMD 0.39	0.02-0.78	<0.05	(2)

In terms of specific complications, the evidence suggests that BEE does not significantly impact the rates of postoperative pancreatic fistula (POPF), bile leakage, intra-abdominal abscesses, wound complications, or mortality. However, the prospective study did note a decrease in the incidence of clinically significant POPF (Grade B: 8.3% vs 19.4%, p=0.045) in the Braun group, despite these patients having a smaller mean pancreatic duct diameter (3.96 mm vs 5.35 mm, p=0.011). This interesting finding warrants further investigation, as it suggests potential indirect benefits of BEE on pancreatic fistula formation(2).

Another significant benefit observed with BEE is a reduction in reoperation rates. The meta-analysis found a significantly lower reoperation rate in the Braun group (OR: 0.380, 95% CI: 0.149-0.968). This may be related to reduced severe complications or improved management of complications when they occur(2).

Regarding operative parameters, BEE does appear to extend operative time somewhat (SMD: 0.39, 95% CI: 0.02-0.78) but does not significantly impact intraoperative blood loss. The additional time required for creating the Braun anastomosis appears to be modest, particularly as surgeons gain experience with the technique(2).

TECHNICAL CONSIDERATIONS AND MECHANISMS

The technical aspects of Braun enteroenterostomy performance may influence its efficacy and safety profile. The procedure involves creating a side-to-side anastomosis between the afferent and efferent limbs of the jejunum approximately 10-20 cm distal to the gastrojejunostomy. This can be performed using either stapled or hand-sewn techniques, with the choice typically depending on surgeon preference and experience(4).

The proposed mechanisms by which BEE reduces DGE and related complications center on its diversion of biliary and pancreatic secretions away from the stomach. Without this anastomosis, these secretions must travel retrograde through the afferent limb, past the gastrojejunostomy, and into the stomach before continuing antegrade through the efferent limb. This journey creates several potential issues: (1) biliary reflux into the stomach, which can cause gastritis and disrupt normal gastric motility; (2) increased pressure within the afferent limb, potentially contributing to anastomotic tension and edema; and (3) exposure of the gastric mucosa to bile salts and pancreatic enzymes, which may inhibit normal emptying function(5).

By providing a low-resistance pathway for enteric contents to bypass the stomach, BEE theoretically reduces these adverse effects. The endoscopic findings of significantly less bile reflux in patients with BEE (0% vs 30.8%, p=0.03) provide direct evidence for this mechanism. However, it is noteworthy that this reduction in bile reflux did not translate to differences in anastomotic or gastric ulcers in that particular study , suggesting that the benefits on DGE may operate through alternative or additional mechanisms(9).

Some authors have proposed that BEE may also stabilize the gastroenterostomy and prevent kinking or torsion at this anastomosis, particularly when an antecolic reconstruction is performed. This mechanical effect could contribute to improved gastric emptying independent of the diversionary effects on enteric secretions. Additionally, the reduction in afferent limb pressure might theoretically decrease tension on the pancreaticojejunostomy and hepaticojejunostomy, potentially explaining the observed reduction in clinically significant pancreatic fistula rates in some studies(7).

The positioning of the Braun anastomosis relative to the gastrojejunostomy may be an important technical consideration. Most studies describe creating the anastomosis of 10-20 cm distal to the gastrojejunostomy, but the optimal distance remains undefined. Similarly, the size of the anastomosis may influence its efficacy, though this parameter is rarely reported in the literature. Some surgeons advocate for a larger anastomosis (≥5 cm) to ensure adequate drainage, but no comparative data exists to support this

practice(4).

LIMITATIONS AND FUTURE DIRECTIONS

First, the vast majority of available studies are retrospective in nature, introducing potential selection bias and confounding factors. For instance, in many series, the decision to perform BEE was based on surgeon preference rather than standardized criteria, and certain patient factors may have influenced this choice.

The lack of randomization in most studies represents a major methodological limitation.

There is also considerable variation in technical aspects of the procedure across studies, including the technique (hand-sewn vs. stapled), size of the anastomosis, exact location relative to the gastrojejunostomy, and whether it was performed in an antecolic or retrocolic fashion. Additionally.

Most studies have focused on short-term outcomes, with limited data on the long-term consequences of BEE. While the procedure is theoretically designed to reduce biliary reflux, the long-term nutritional effects, incidence of marginal ulcers, and other late complications remain poorly documented.

CONCLUSION AND CLINICAL IMPLICATIONS

Braun enteroenterostomy appears to be a safe and potentially beneficial addition to pancreaticoduodenectomy reconstruction that is associated with reduced rates of delayed gastric emptying, particularly more severe forms (Grades B and C), and possibly lower overall morbidity and shorter hospital stays.

The mechanistic benefits of BEE appear to be related to its diversion of biliary and pancreatic secretions away from the stomach, reducing biliary reflux and potentially stabilizing the gastroenterostomy. These effects contribute to improved gastric emptying and reduced vomiting, which in turn facilitate earlier oral intake and may shorten hospital stays.

The current evidence suggests that surgeons should consider incorporating Braun enteroenterostomy into their standard reconstruction during pancreaticoduodenectomy. The potential benefits appear to outweigh the minimal additional time and risk, particularly for surgeons early in their learning curve who may experience higher rates of DGE. The procedure may be especially valuable in the context of enhanced recovery protocols, where even modest reductions in complication severity can facilitate accelerated discharge and recovery(1)

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