

A NOVEL MODIFICATION IN WHIPPLE'S PROCEDURE: GRAVITY EFFECT

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ABSTRACT

Introduction: Whipple procedure is the most common method for pancreatic head tumors. Even though the pancreatoduodenectomy-related mortality rate has dramatically decreased in the last 70 years, the morbidity rate remains around 40%. We aimed to investigate the results of an additional anastomosis to reduce post-pancreaticojejunostomy fistula development's probability. To our knowledge, this modification was not described previously.

Materials and methods: In 168 patients, we performed a standard Whipple procedure. We added an anastomosis to the pancreaticojejunostomy route in the remaining 38 patients. We evaluated these patients regarding early postoperative pancreatic fistula (POPF), complications and the early mortality rate.

Results: The two groups were similar in demographic characteristics and comorbidities. No statistically significant difference was determined between the groups regarding POPF, bile leakage, and mortality rates. Thus, the additional anastomosis was determined not to prolong the operation's duration.

Conclusions: We determined reduced POPF and mortality rates due to pancreatic stump anastomosis added to the Whipple procedure. Thus, in cases with a high leakage risk due to pancreatic tissue's soft nature or a narrow canal, this new anastomosis might reduce the probability of POPF development and related complications.

Keywords: Postoperative pancreatic fistula, Whipple procedure, Anastomosis.

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Introduction

The Whipple procedure is the most commonly used method in pancreatic head tumors. Unfortunately, the pancreatoduodenectomy-related mortality rate has dramatically decreased in the last 70 years (from 20% to 3%), but the morbidity rate remains around 40%⁽¹⁻³⁾. Even though the Whipple procedure has numerous complications, the most dramatic and deadly ones are uncontrolled pancreatic leakage, leak-related sepsis, bleeding, and multi-organ failure. Modern intensive care practice, nutritional support, percutaneous catheter drainage techniques, and interventions for pseudoaneurysms have significantly reduced the

uncontrolled pancreatic leakage-related mortality rate; however, when such complications occur, the mortality rate rises to around 40%⁽⁴⁻⁶⁾. Efforts to reduce the 10%-25% incidence of pancreatic-enteric anastomotic leakage have promoted surgeons to find novel technical modifications related to this part of the procedure⁽⁷⁾. Numerous studies have been conducted to make pancreatic anastomosis risk-free. These studies have investigated suture techniques, pancreatic canal stenting methods, medications to reduce pancreatic secretions, local tissue adhesives, and external drainage methods⁽⁸⁾. There are numerous studies attempted to improve the outcome of pancreatic anastomosis which indicates that it is a major problem. The postoperative pancreatic

fistula (POPF) is considered to have three clinical stages. Stage 1 defines the patient group with no peripancreatic fluid collection on computed tomography (CT) and no need to change the patient management. On the other hand, Stage 2 represents the patient group with the moderate peripancreatic fluid collection and the need for close drainage follow-up. Finally, Stage 3 defines the severe peripancreatic fluid and diffuse intraabdominal fluid collections, necessitating percutaneous drainage or salvage surgery, together with the patients' intensive care follow-up⁽⁹⁾ (Table 1).

In this study, we aimed to investigate the results of performing an additional anastomosis that we defined intending to reduce the probability of post-pancreaticojejunostomy fistula development in the Whipple procedure. To our knowledge, this modification was not described in the literature previously.

Stage 1	Clinical features are absent	No peri-pancreatic fluid accumulation on CT; no need to change the patient management course
Stage 2	Clinical features are present	Peri-pancreatic fluid accumulation on CT; repositioning the drains or placing a new drain is required
Stage 3	Clinical features are severe	Severe pancreatic leakage on CT; the amount of accumulation indicating percutaneous drainage catheter placement; patient's intensive care follow-up is required; most likely, a new surgical procedure (salvage surgery or total pancreatectomy) is required

Table 1: The classification of Postoperative Pancreatic Fistula (POPF).

Materials and methods

This study involved the Whipple procedures performed in Adnan Menderes University Medical Faculty Department of General Surgery between 2016-2022. The same surgeon performed all procedures and made all the resections and anastomoses. A total of 210 patients underwent surgery for cancer of the distal common bile duct, papilla, or pancreatic head. Four patients underwent a total pancreatectomy because the canal could not be visualized after resection or the surgical margin was positive for the tumor. The remaining 206 patients underwent a Whipple procedure, either conventional or modified. The ethical approval was obtained from Adnan Menderes University University Ethics Committee with the protocol number of 2022/57.

Surgical technique (the anastomosis added to the conventional whipple procedure)

Of 206 patients, 168 (Group 1) underwent reconstructive surgery with four anastomoses involving a PJ, a hepaticojejunostomy (HJ), a gastroenterostomy, and a Braun anastomosis following the resection. The pancreatic anastomosis

was made with the modified Blumgart technique. A stent was used in addition to the conventional technique. By 2021, the surgical technique was modified in the remaining 38 patients (Group 2). In the modified technique, the jejunal part of the PJ loop was kept longer than the conventional Whipple procedure. That part of the loop was brought down to an infracolic location through the retrocolic route and was additionally anastomosed to the jejunal loop in close proximity to the Braun anastomosis with a 28-mm circular stapler.

Figures 1a and 1b show the consecutive intraoperative images related to performing the implemented additional anastomosis. The new additional anastomosis aimed the pancreatic fluid to enter the enteric system more quickly, avoid pancreatic fluid accumulation within the jejunal loop, and reduce the loop's pressure distal to the anastomosis. Thus, we hypothesized that the leakage rate of the pancreaticojejunostomy anastomosis would decrease.

Figures 2a and 2b illustrate the conventional Whipple procedure (Group 1) and the modified technique (Group 2) side by side.

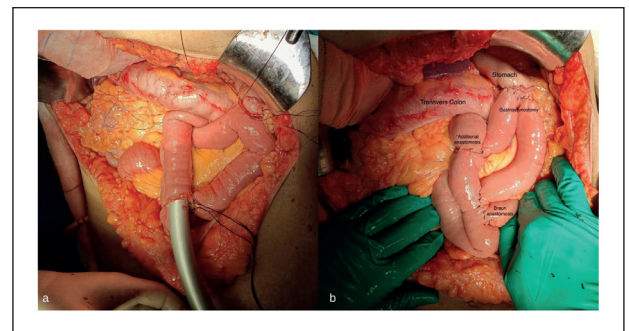


Figure 1: The intraoperative images of the modified Whipple procedure a) performing the anastomosis with the circular stapler b) after the additional anastomosis was completed.

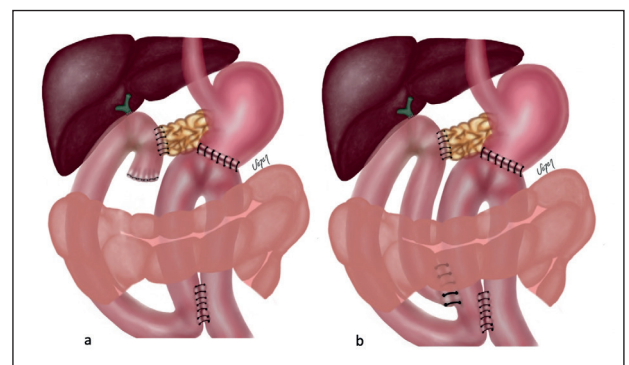


Figure 2: a) The conventional Whipple procedure; b) The modified Whipple procedure involving an additional anastomosis. The intestinal segments in the circles were brought by using the infracolic route.

Results

Groups 1 and 2 were determined to be similar in gender (p=0.650), the presence of coronary artery disease (CAD) (p=1.000), obesity (p=0.758), diabetes mellitus (DM) (p=1.000), hypertension (HT) (p=0.712), cerebrovascular accident (CVA) (p=0.459), arrhythmia (p=0.156), epilepsy, and rheumatoid arthritis (RA) (p=0.336). When the groups were compared regarding the tumor's localization, the hardness/softness of the pancreas, and the canal width (smaller or larger than 3 mm in diameter), no significant differences were determined (p=0.997, p=0.452, and p=529, respectively). In addition, the groups' mean operative times were also similar (314+61 min vs. 324+58 min, p=0,843).

The two groups were similar regarding the minor leakage rate (Group 1-14.3% vs. Group 2-13.2%) (p=0.857). On the other hand, the major leakage rate was determined in 14 (8.3%) patients in Group 1 and only one (2.6%) patient in Group 2. Even though the difference between the two groups was not statistically significant, in Group 1, the major leakage rate was lower in Group 2 than in Group 1 (2.6% vs. 8.3%). In addition, the two groups were similar regarding the rate of bile leakage (Group 1-3.6% vs. Group 2-2.6%), and no statistically significant inter-group difference was determined (p=1.000). While early postoperative mortality was determined in 11 patients in Group 1, in Group 2, only one patient encountered early postoperative mortality, and the cause was COVID-19. Even though statistically insignificant(p=0.700), Group 2 had a lower mortality rate than Group 1 (2.6% vs. 6.5%) (Table 2).

Discussion

Pancreatic surgery continues to be one of the most complex surgical procedures. While it is technically challenging and drudging, it necessitates extensive anatomical and pathophysiological knowledge and surgical skills. Despite recent developments in surgical techniques and advances in perioperative management, the postoperative morbidity rate continues to be high, with at least a 45% complication rate⁽¹⁰⁻¹²⁾. While most postoperative complications such as POPF Stage 2 and delayed gastric emptying can be managed conservatively, POPF Stage 3 is a nightmare for every pancreatic surgeon. According to the revised classification of ISGPS, POPF Stage 3 generally necessitates revision surgery and is associated with high morbidity and mortality rates.

One of the essential aspects of the Whipple procedure is the leakage of pancreatic anastomosis and associated complications. Therefore, numerous studies mainly conducted in the last two decades have aimed to describe techniques to reduce POPF development. In addition to various anastomosis techniques, the probability of POPF has been attempted to be reduced by various instruments and intervention techniques. In addition to numerous methods developed to avoid POPF, studies recommending tissue adhesive use have been published. However, a recently published review has confirmed that tissue adhesives did not prevent POPF⁽¹³⁾. Nevertheless, no conclusive evidence about any technique's superiority has been reported in the literature⁽¹¹⁾. In addition, there is no evidence supporting using stents, fibrin glue, or omental wrapping. The influence of standardizing the surgeon's anastomosis technique on improving the outcome has been indicated previously⁽¹⁴⁾.

The capability of the surgeon to achieve the standardization stage depends on one's ability to monitor the outcomes periodically and implement changes that will enable a reliable and reproducible anastomosis performance with a clinically low (<11%) POPF rate⁽¹⁵⁾. Moreover, pancreatic surgeons should be familiar with various strategies to reduce the severity of fistula and evidence supporting their use. The probability of POPF development has been tried to be reduced by using stents in pancreatico-enteric anastomoses. However, a study investigating whether using a stent affected POPF development did not conclude⁽¹⁶⁾. On the other hand, even though there is no consensus on routinely using externalized

n		Group 1 (n=168)		Group 2 (n=38)		P
		n	%	n	%	
Minimal leakage	Absent	144	85.7	33	86.8	0.857
	Present	24	14.3	5	13.2	
Major leakage	Absent	154	91.7	37	97.4	0.314
	Present	14	8.3	1	2.6	
Bile leakage	Absent	162	96.4	37	97.4	1.000
	Present	6	3.6	1	2.6	
Mortality	Absent	157	93.5	37	97.4	0.700
	Present	11	6.5	1	2.6	
Causes of Mortality	Absent	157	93.5	37	97.4	0.224
	Bleeding	2	1.2	0	.0	
	Sepsis	6	3.6	0	.0	
	Cardiac	1	.6	0	.0	
	Pulmonary embolism	2	1.2	0	.0	
	COVID-19 Pneumonia	0	.0	1	2.6	

Table 2: Inter-group comparison of the postoperative complications.

stents, it was reported that it would be effective in patients with a high leakage risk⁽¹⁷⁾. To reduce the POPF rate, not only the anastomosis technique, material, and additional measures such as tissue adhesives were investigated, but also techniques modifying the anastomosis loops and pathways such as the double-loop and modified single-loop have been employed. In a double-loop technique described by Machado et al. in 1976, it was suggested that the pancreatic fluid and bile entering the enteric system through different pathways would have lessened the two fluids' synergistic effect and prevented their destructive effects on the PJ⁽¹⁸⁾. Even though there are studies investigating this technique and reporting reductions in the POPF rate, some other studies have not reached such results⁽¹⁹⁻²¹⁾.

A meta-analysis study involving a total of 802 patients in three randomized controlled trials (RCT) and four controlled clinical trials (CCT) compared the standard single-loop reconstruction with the dual-loop reconstruction⁽²²⁾. No significant superiority of performing the PJ to a separate loop was determined regarding POPF compared to the standard procedure. Besides, this method was determined to cause no difference in overall mortality and morbidity rates, duration of hospitalization, and requirement for additional interventions. In another recently published study, the PJ and HJ were constructed using a single loop, but an additional anastomosis was performed between the HJ and the PJ loop, aiming to drain the pancreatic fluid to the enteric system without passing the HJ⁽²³⁾. In that study, no significant decrease was determined in the POPF rate; however, significant decreases were found in major complication and mortality rates.

Similarly, we modified the Whipple procedure by performing an additional anastomosis. With this newly added anastomosis, we aimed for the pancreatic fluid to enter the enteric system more quickly due to the gravity's effect, avoid the pancreatic fluid from accumulating within the jejunal loop, and reduce the loop's pressure distal to the anastomosis. Since the distance between the 2 entero-enterostomy anastomosis is short, we assert that the gravity effect would be superior to the peristaltic move of the fluid in the intestine which results in the down flow of the fluid. As a result, we hypothesized that the leakage rate of the pancreaticojejunostomy anastomosis would decrease. This additional anastomosis was performed with a circular stapler introduced through the enterotomy made for the Braun anastomosis. Since the anastomosis was made with the stapler, the

operative time was not prolonged. Moreover, since the rate of complications did not increase when the Whipple technique was modified, we suggest that the additional anastomosis caused no increased burden for the patients, neither for operative time nor the postoperative complication rate.

Limitations and strength of the study

One limitation of the study was the discrepancy between the number of patients in the two groups (168 vs. 38). Since we started using the modified technique in 2021, our patient number who underwent the modified technique is relatively low. This fact might have caused a reduction in the study's comparison strength. On the other hand, we believe that as the number of patients in the modified technique group increases, the differences that we have already determined in the present study will become statistically significant.

In our study, all procedures were performed by a single surgeon using the same technique from 2016 until today. One of the crucial factors affecting the POPF rate is the surgical team's experience in the Whipple procedure. In our study, the fact that the same surgeon performed all procedures is very significant because one of the essential variables was eliminated, which constituted the study's strength.

Conclusions

In the light of our study's results, Group 2 was superior to Group 1 regarding both the early-period POPF and mortality rates, even though statistically not significant. Therefore, it can be surmised that performing this additional anastomosis in patients with a soft pancreas, a canal less than 3 mm in diameter, and those with a high leakage risk might reduce the rate of POPF following PJ and the associated mortality and morbidity rates.

High morbidity rates, even in the presence of technological developments, have provoked surgeons to seek new methods. We concluded that the described new anastomosis would contribute to reducing PJ pressure and the rates of POPF development and its complications.

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