Evaluation of eversion technique for bilioenteric anastomosis in bile duct reconstruction

Original Article

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ABSTRACT

Background: The bilioenteric anastomosis plays a role in the surgical management of biliary tract disease. A wide variety of techniques for suturing a portion of the biliary tract to the digestive tract have been described with many advances in surgical techniques. Preoperative and postoperative care have contributed to the low morbidity of current reconstructive biliary surgery. The eversion technique has been gaining attention as an alternative to traditional anastomosis methods. This involves inverting the enteric mucosa and suturing it to the duct wall, thereby creating a stable anastomosis with reduced tension. While studies suggest that the eversion technique provide advantages such as an improved patency rates and a lower incidence of biliary leaks, evidence comparing its outcomes with other techniques remains limited.

Aim: This study aims to evaluate the eversion technique in bilioenteric anastomosis, focusing on its outcomes, advantages, and complications. By conducting a comprehensive review and presenting new data, this research aims to contribute to current discussions regarding the optimal surgical approach for biliary-enteric anastomosis.

Patients and Methods: A prospective cohort study was conducted at Ain Shams University Hospitals and Nasr Institute Hospitals. Fifty patients underwent bilioenteric anastomosis using the eversion technique in a Roux-en-Y configuration. Three patients were excluded due to incomplete follow-up. All patients were monitored for complications, including bile leakage, cholangitis, and strictures.

Results: Out of the 47 patients who completed follow-up, four (8.6%) patients experienced bile leakage. However, all cases were managed conservatively without requiring reoperation. Three patients developed cholangitis, which was also managed conservatively. One patient experienced a late stricture and was successfully treated with computed tomography-guided transhepatic balloon dilatation. No incidence of early strictures was observed.

Conclusion: The eversion technique offers significant advantages and promising outcomes in bilioenteric anastomosis, with a lower incidence of complications.

Key Words: Bilioenteric anastomosis, Biliary surgery, Bile duct, Eversion technique.

Received: 23 December 2024, **Accepted:** 23 January 2025, **Published:** 1 July 2025

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ISSN: 1110-1121, July 2025, Vol. 44, No. 3: 933-938, © The Egyptian Journal of Surgery

INTRODUCTION

Hepatobiliary and pancreatic surgery for benign or malignant diseases often requires biliary-enteric anastomosis (BEA) and biliary reconstruction. Despite advances in surgical techniques and oncological therapy with declining mortality rates, postoperative morbidity following Hepatobiliary and pancreatic surgery remains still high[1].

BEA is a common surgical procedure performed for a variety of indications. This includes bypass or reconstruction following resection of malignant or benign biliary obstruction, primary biliary stones, iatrogenic bile duct injury, liver transplantation; and a number of biliary tract problems that are benign but have malignant potential such as primary sclerosing cholangitis, choledochal cyst, and hepatolithiasis. Surgical options for these diverse conditions include hepaticojejunostomy, choledochoenterostomies and cholecystoenterostomies. Biliary-enteric surgery is an essential surgical procedure even for a benign disease etiology[2].

Also, due to refinements of preoperative imaging and perioperative management, indications for surgery with BEA and biliary reconstruction were extended to low

DOI: 10.21608/EJSUR.2025.347107.1323

grade malignancy or premalignancy such as intraductal papillary neoplasms with increasing long-term survival of patients. By definition, BEA results in a loss of the barrier function of the Sphincter of Oddi with a higher risk of ascending infections to the Hepatobiliary system. One of the infectious complications associated with BEA is cholangitis, which can lead to emergent hospitalizations and life-threatening conditions such as portal hypertension and biliary cirrhosis[3].

Postoperative complications following BEA including anastomotic leak, hemorrhage, wound infection, cholangitis, intra-abdominal abscess/biloma and stricture formation have been reported. These complications are sometimes serious enough to warrant a repeat surgery and at times result in serious long-term morbidity. A few studies have looked at factors associated with the development of these complications. Patient's age, co-morbid conditions, nutritional status, preoperative serum bilirubin, associated chronic liver disease, nature and extent of the primary disease and type of anastomosis performed have been proposed to influence the outcome of BEA. Intraoperative, the surgical technique is the most important factor affecting the postoperative outcome. The eversion technique is a reasonable technique for biliary reconstruction in BEA[2].

Aim

To evaluate the role and outcome of the eversion Technique for bilioenteric Anastomosis in biliary reconstruction and assessment of postoperative complications including biliary leakage, cholangitis, and stricture.

PATIENTS AND METHODS:

BThis prospective cohort study aims to assess the efficacy of the eversion technique. Additionally, it seeks to investigate the impact of surgery on the overall morbidity rates associated with this condition. The study was conducted at Ain Shams University Hospitals and Nasr Institute Hospital from September 2023 to December 2024. Ethics Committee approval and written informed consent were obtained from all participants.

The study population consisted of 50 patients who met the inclusion criteria; however, three patients were excluded due to incomplete follow-up, as one patient unfortunately passed away and two patients missed follow-up. The inclusion criteria were Roux-en-Y bilioenteric anastomosis. Exclusion criteria included duct-to-duct anastomosis, redo bile duct surgery, CHILD B and CHILD C hepatic patients, previous vascular injury of the right hepatic artery, and omega loop bilioenteric anastomosis.

Postoperative follow-up includes routine postoperative labs including complete liver profile through the whole hospital stay and a routine pelviabdominal ultrasound done regular before discharge and if suspecting complications MRCP and computed tomography pelviabodmen as required.

Follow-up for patients was conducted at intervals after hospital discharge at 1, 3, and 6 months up to 1 year postoperatively.

Surgical technique

Regarding the eversion technique it reduces the risk of mucosal inversion, leading to wider diameter of the anastomosis. Therefore, it facilitates biliary drainage without obstruction.

Similar to classic bilioenteric anastomosis the eversion technique passes through three steps which are preparation, suturing and completion of the anastomosis.

i. Preparation of bile duct and bowel segment.

a. The bile duct is transected with preparing of the edges carefully.

b. Trimming of the bile duct to ensure a healthy egdes with a good vascularity.

c. Two hanging sutures are placed at 3 and 9 o'clock of the trimmed duct opening for gentle traction, exposure and proper handling of the duct.

d. Then bowel segment preparation which include creating a Roux-en-Y jejunal limb to be opened with scalpel at appropriate site to match duct diameter.

e. Jejunal mucosa is everted using 5/0 or 6/0 PDS sutures by four sutures at 3, 6, 9, and 12 O'clock as shown in Figure (1).

f. Then start suturing the anastomosis which include, simple interrupted sutures placed 2 mm apart using 4/0 or 5/0 PDS without stent to create anastomosis. As shown in Figure (2).

g. Sutures are placed through the outermost layer of the bile duct and the jujunal everted mucosa which allows good mucosal adherence to duct wall.

h. Begin by constructing the posterior wall of the anastomosis. Sequentially, place simple interrupted sutures without direct tying or smudging the knot until all sutures are positioned.

i. After completion of posterior wall interrupted sutures, every simple suture is tied individually with appropriate approximation.

j. After completing the posterior wall, continue to construct the anterior wall using the same

technique, leaving a tension free approximation with bowel mucosa everted, thereby preserving patency as shown in Figure (3).

k. Completion of the anastomosis which include rechecking that circumferentially placed sutures with no gaps.

l. Then the enteroenteric anastomosis is created ~50–70 cm from the bilioenteric anastomosis, using a linear stapler with a second line of sutures (4/0 PDS or Prolene).

m. Finally, after achievement adequate hemostasis, a surgical drain is placed near the anastomosis for postoperative monitoring.

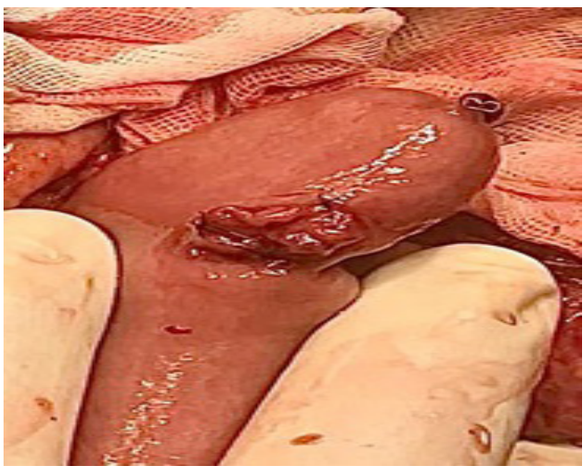

Figure 1: Eversion of Small bowel mucosa with PDS 4/0 at 3, 6, 9and 12 O'clock.

Figure 2: Start suturing the posterior wall of the anastomosis with sutures 2mm apart with (4/0) PDS.

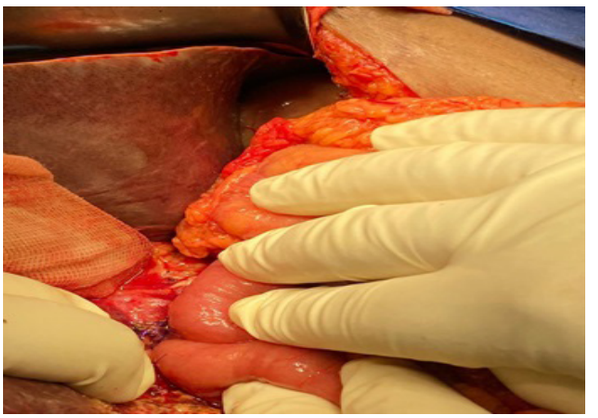

Figure 3: Completion of the anterior wall leaving a patent and tension free anastomosis.

Data gathering

In this study, 50 patients underwent bilioenteric anastomosis using the eversion technique. Preoperative data were collected in Ain shams university hospital and Nasser Institute as regard demographic data, medical and surgical condition. Proper selection of patients to be enrolled in this study was done according to inclusion and exclusion criteria. Operative data were registered and recorded by the attending surgeons as regard the operative technique and intraoperative events if any. Postoperative data were daily recorded by ward registrars as regard the vital data, wound condition, drains labs and radiology.

RESULTS:

Our study included 50 patients who underwent the eversion technique in BEA, one patient was excluded due to death and two patients missed follow-up leaving 47 patients who completed the study follow-up. Among the study population, 40(85.1%) patients underwent hepaticojujnostomy and seven (14.9%) patients underwent Choledochojejunostomy. Eight (17%) patients were diagnosed preoperative with CBD stones, 14(29.8%) patients were diagnosed with benign CBD stricture and 25(53.2%) patients were malignant bile duct pathology as shown in Table (1).

Regarding Epidemeologic data, the mean of age of study population was 49±15.13 with female predominance (61.7%) to male (38.3%) with hypertension and diabetes mellitus are the two most prevalent comorbidity between study population. Two patients were hepatic classified as CHILD A.

Out of 47 patients, four (8.5%) patients developed bile leak, two (50%) patients of total bile leak were diagnosed with malignant cause while one (25%) patient

was diagnosed with CBD stones and one (25%) patient was diagnosed with a benign stricture. One of them had biliary stricture and complicated with recurrent cholangitis as shown in Table (2).

Out of total study population, three (6.4%) patients developed cholangitis and one (2.1%) patient had late bile duct stricture. No incidence of early stricture was recorded.

Operative time ranged from 2 to 3h with median intraoperative blood loss about 150ml.

There was no statistically significance between Occurrence of bile leakage and preoperative diagnosis either cellular, benign or malignant as shown in Table (3). While those four patients with bile leak. Leak onset was between day 2 and 3 and the median of whole leak duration was 12 days ranging from 3 to 15 days. While, the median of the drain output per day is about 100 ml, as shown in Table (4). The median of hospital stay was 7 days ranging from 5 days in patients with uneventful early postoperative period to 15 days with complicated cases.

Table 1: Preoperative diagnosis of the studied patients:

	Total *N*= 47
Preoperative diagnosis	
Calcular (stones)	8 (17.0)
Benign stricture	14 (29.8)
Malignant stricture	25 (53.2)

Table 2: Postoperative complication data among study population:

	Total *N*= 47
Bile leak	
No	43(91.5)
Yes	4(8.5)
Early stricture	
No	47(100.0)
Yes	0
Late stricture	
No	46(97.9)
Yes	1(2.1)
Cholangitis	
No	44(93.6)
Yes	3(6.4)

Table 3: Incidence of diagnosis and occurrence of bile leak:

	Bile leak				
	No *N*= 43	**Yes *N*= 4**	**Test value**	***P* value**	**Significance**
Preoperative diagnosis					
Calcular	7(16.3)	1(25.0)	1.857*	0.395	NS
Benign stricture	14(32.6)	0			
Malignant stricture	22(51.2)	3(75.0)			

Table 4: The Course of patients with bile leak:

Leak duration	Median (IQR)	12(6.5–14.5)
	Range	3–15
Day of leak onset	Mean±SD	2.5±0.58
	Range	2–3
Drain amount	Median (IQR)	100(100–200)
	Range	50–500

DISCUSSION

Bilioenteric anastomosis is a surgical procedure to restore bile flow between the liver and intestines[4]. It involves the reconnection of the biliary system, which can be performed using different techniques. This study aims to evaluate a novel technique in biliary anastomosis and its outcomes.

Regarding bile leakage, we agree that it is typically defined as the abnormal escape of bile from the biliary system into surrounding tissues or cavities, and it can lead to serious complications, including infection, abscesses, or peritonitis (with peritoneal fluid bilirubin levels exceeding serum levels by a factor of 10 or more). In our study, four (8.6%) patients of the study population had bile leakage, which may suggest a higher rate than the 3.7% incidence of bile leakage reported by Kadaba *et al.*[5]. After Roux-en-Y hepaticojejunostomy or choledochojejunostomy, and comparing with Hirano *et al*.,[6], who reported a bile leakage rate of 5.6% using a mucosa-to-mucosa anastomosis with a Roux-en-Y jejunal limb, we observed lower rates than Hamdy *et al*.,[7], who reported a postoperative bile leakage rate of 16.7% in 30 patients who underwent the interrupted suture technique for hepaticojejunostomy. Our rates are also lower than Seifer *et al*.,[8], who reported an incidence of 10.3% for bile leakage after using the interrupted suture technique in 39 patients, and lower than Braunwarth *et al*.,[9], who observed a bile leakage rate of 10.4% in 48 out of 458 patients after hepatectomy and bilioenteric reconstruction.

Biliary leakage was diagnosed clinically, through laboratory testing, and radiologically. All four patients in our study had overt bile leakage in the drain, with drain bilirubin levels more than 10 times the serum level.

All of these four patients were febrile early in the postoperative period ($T > 38^{\circ}C$), and their surgical drains contained overt bilious fluid. Other common postoperative fever causes, such as chest infection, UTI, and DVT were excluded through routine investigations during their hospital stay. Additionally, all of these patients had sustained leucocytosis (TLC> 11.000), with a mean TLC of 16.97 and increase in inflammatory markers.

None of these 4 patients required reoperation or operative management. This is consistent with the findings of Hirano *et al*.,[6], who stated that most cases of postoperative bile leakage after bilioenteric anastomosis can be treated conservatively by maintaining a prophylactically placed drain and a transanastomotic stent.

All four patients with leak underwent conservative treatment and close postoperative follow-up monitoring. The onset of leakage varied among the patients, occurring between the second and third postoperative days. The duration of the leakage lasted from 3 to 15 days. The leakage was controlled, and the patients were monitored clinically and through surgical drains. One patient had a drain output of 200ml/day from the onset of the leak on day 2 postoperative, continuing until one week postoperative. Another patient's drain output was 800ml of bile per day, starting on day 3 postoperative and lasting for 10 days, after which it stopped suddenly.

Regarding Hamdy *et al*.,[7], the mean surgical drain output for postoperative patients who had a biliary leak was ~280ml/day, with the leak duration ranging from 3 to 14 days, with a mean duration of about 10 days.

One patient required percutaneous ultrasound-guided drainage of an intraperitoneal mild to moderate collection (infected biloma). The average amount was less than 100ml/day, after 1 week, follow-up ultrasound showed no collection.

Regarding hospital stay, the median length of hospital stay was 7 days (range: 5–15 days). The longest hospital stay was in patients with complications. This is consistent with the findings of Aboulfotoh *et al.,*[10], where the median hospital stay for patients was 7 days, and shorter than the mean ward stay of 11 days reported by Hamdy *et al.,*[7].

In our study, three (6.4%) patients had cholangitis, which was classified as Grade I and Grade II (mild to moderate) types according to the Tokyo guidelines (2018). This is lower than a systematic review by Birgin *et al*.,[3], which reported a cholangitis rate of up to 10% following BEA. In comparison, cholangitis incidence in Seifert *et al*.,[8] was 2.4%. All of these patients were managed conservatively and need not reoperation.

One of the most important long-term complications is stricture. BEA strictures can occur early in the postoperative period due to ischemia, excessive dissection, bacterial infection, or technical error. Regarding strictures, patients were classified into two types: early stricture, which occurs in the first month postoperatively, and late stricture, which occurs after the first month. One (2%) patient had late stricture, which is lower than what was reported by Brunner et al.,[11], who stated that the development of anastomotic stenosis is seen in 3.7–8.0% of cases. This wide variation is primarily due to the different

techniques used in bilioenteric reconstruction. According to Kadaba *et al.*,[5], 17(3.7%) patients developed anastomotic strictures at a median duration of 12 months. These patients were managed with either primary or repeated dilation and/or stenting, while only seven patients underwent revision hepaticojejunostomy.

Diagnosis was made based on history, as the patient reported during a follow-up visit 3 months postoperatively that he had frequent itching and slight jaundice. Regarding the patient's data, the early postoperative laboratory bilirubin level was 1.8, and the postoperative period was diagnosed as early bile leak started at day 3 postoperative and managed conservative with no reoperation. During the patient's regular 3-month assessment, lab results revealed high levels of ALP and GGT, and bilirubin was 2.5mg/dl. MRCP showed smooth, localized narrowing at the anastomosis, indicating a bilioenteric stricture.

It was diagnosed as a late stricture, which occurred after the first 30 days postoperatively, and was managed by transhepatic balloon dilation using minimally invasive procedures. This is consistent with the findings of Hirano *et al*.,[6], who stated that once such a stricture is definitively demonstrated, its dilation can be performed by percutaneous transhepatic cholangioscopic drainage.

LIMITATION

Our study aimed to assess the eversion technique in bilioenteric anastomosis, specifically for postoperative complications. While the study shows promising results, there are certain limitations to consider. Time constraints and the short duration of the study may not fully capture long-term complications. Future studies could increase the sample size and extend the study period. Nevertheless, our study highlights a technique that could contribute to a decline in bilioenteric complications.

CONCLUSION

BEA is a critical surgical intervention for patients with biliary obstruction, bile duct injuries, or other conditions impairing bile flow. Eversion technique has shown good outcomes regarding postoperative follow-up data and a reasonable rate of complications. Postoperative care is crucial for managing potential complications, and long-term follow-up is essential to ensure the continued success of the anastomosis. As always, a multidisciplinary approach, including surgeons, radiologists and dietitians, is required to provide optimal care for these patients.

CONFLICT OF INTEREST

There are no conflicts of interest.

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