Original Article

Prediction of Adverse Outcome after Bilioenteric Anastomosis for Postcholecystectomy Bile Duct Injury: Insights from A Tertiary Care Center

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ABSTRACT

Background: Bile duct injury (BDI) is one of the most severe complications of cholecystectomy which requires surgical management. The purpose of this study is to analyze and predict the adverse outcome after bilioenteric anastomosis for the treatment of BDI after cholecystectomy.

Patients and Methods: This retrospective study was conducted at Minia University Liver and GIT Hospital with a total number of 43 patients who underwent Roux-en-Y hepaticojejunostomy (HJ) for management of postcholecystectomy BDI in the period from March 2018 till January 2022.

Results: Sepsis and higher-grade of BDI were strongly associated with increased risks of adverse events. Late surgical reconstruction appears protective. Longer operative time is linked to a slight but significant increase in risk.

Conclusion: Our analysis demonstrates that multiple factors can significantly influence the outcome of the surgical reconstruction after postcholecystectomy BDI, including the clinical presentation after injury (especially biliary leakage and sepsis), grade of injury according to Strasberg classification, timing of surgical reconstruction, use of trans-anastomotic stent, and the operative time.

Key Words: Adverse outcome, bile duct injury, bilioenteric anastomosis, postcholecystectomy, strasberg classification.

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INTRODUCTION

Bile duct injury (BDI) is one of the most severe complications of cholecystectomy which requires surgical management[1].

Research conducted in the last three decades indicated that BDI frequency after laparoscopic cholecystectomy (LC) was higher than that after open cholecystectomy (OC) (0.4–0.6% and 0.1–0.2%, respectively). This emerges when laparoscopic techniques were being more adopted in practice[2,3]. However, later research noted a reduced incidence of BDIs after LC to 0.2% or less, possibly due to improvement of techniques and experience in laparoscopy[4].

Even in experienced hands, detection and management of BDI presents a great difficulty. Because of the nature of these complex injuries, it is recommended to transfer these patients to a specialized center for better management[5].

Roux-en-Y hepaticojejunostomy is still the standard treatment for these injuries[6]. However, there is a scarcity of literature regarding the short and long-term results after surgical repair of complex BDIs and the factors that influence these results have not been deeply investigated[7].

The purpose of this study is to analyze and predict the adverse outcome after bilioenteric anastomosis for the treatment of BDI after cholecystectomy.

PATIENTS AND METHODS:

This is a retrospective study conducted at a tertiary care center, Minia University Liver and GIT Hospital, Egypt with a total number of 43 patients who underwent Roux-en-Y hepaticojejunostomy (HJ) for management of postcholecystectomy BDI in the period from March 2018 till January 2022. Strasberg classification was used to determine the location of BDI (Figure 1).

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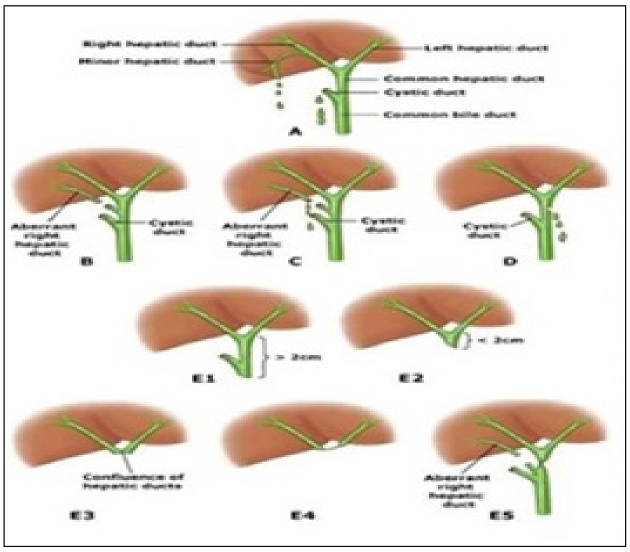

Fig. 1: Strasberg classification of bile duct injuries.

Patients unfit for general anesthesia (GA) and/or surgery (e.g., those with severe cardiopulmonary disease or Child-Pugh C liver cirrhosis) and Patients with minor BDI (Strasberg type A–D) were excluded from our study.

Preoperative assessment:

All patients were subjected to full medical history, especially about the details of cholecystectomy, time interval between diagnosis and referral to our center for patients who underwent cholecystectomy outside our hospital. Results of clinical examination were obtained, with special notice about the clinical presentation (Biliary leakage, jaundice, acute cholangitis, biliary peritonitis, or sepsis).

Diagnostic workup included laboratory tests (CBC, bleeding profile, renal function tests, and liver function tests, electrolytes, and blood sugar), abdominal ultrasound (US) to assess the presence or absence of intraperitoneal collection and intra- or extrahepatic biliary system dilatation. MRCP was used to evaluate the level and extent of BDI (Figure 2). ERCP was not routinely performed for our cases, as endoscopic management of BDI is preferred when there is partial continuity of the injured duct documented by MRCP, and cases with such finding were excluded from our study. Routine computed tomography (CT) arteriography was done if an early repair is planned to detect associated vascular injuries. Patients with bilious collection were treated with drainage, either through percutaneous drainage under US guidance or via surgical drainage without reconstruction. Those presenting with sepsis were initially managed with intravenous (IV) fluids, IV antibiotics, aggressive nutritional support. Definitive bilioenteric anastomosis was postponed in these patients until sepsis was fully controlled.

Timing of surgical reconstruction:

Patients were categorized into 3 groups. The first group, "early reconstruction group", included patients who had surgical reconstruction within the first 72 hours following cholecystectomy. The second group, the "intermediate reconstruction group", comprised patients who underwent surgical reconstruction 72 hours - 6 weeks after cholecystectomy. In the third group, "late reconstruction group", patients underwent surgical reconstruction after 6 weeks following cholecystectomy.

Fig 2: MRCP of two studied patients showing; (A): Strasberg type E1 and (B): type E3 injuries.

The surgical technique:

Anesthesia and Incision: Under GA, a wide right subcostal incision was used with upward extension to the xiphoid process if needed. Any biliary collection or blood clots were removed. Dissection of the hepatoduodenal ligament and adhesiolysis help to expose the common bile duct (CBD) before preparing biliary stump(s) that exhibit brisk bleeding cut edges. If there was insufficient arterial bleeding from the stumps, dissection was carried out further until brisk bleeding was encountered, regardless of the level of reconstruction. This is crucial for the success of HJ, ensuring favorable early and long-term outcomes[8]. For Strasberg E3 injuries, Hepp–Couinaud technique was used to facilitate a wide anastomosis. A Roux jejunal loop was then fashioned and taken up in a retrocolic route to the porta hepatis.

Hepaticojejunostomy: Both end-to-side and Hepp-Couinaud techniques were utilized for HJ in our study. However, end-to-side was the predominant method, with HJ anastomosis constructed using interrupted 3-0 PDS sutures (Figure 3). In cases with bile duct stump diameter less than 5mm, a trans-anastomotic stent (8–10 French Nelaton catheter, Shanghai, China) was used. The tip of the external stent was carefully advanced into the bile duct, predominantly targeting the left duct, traversing the anastomosis, and subsequently brought out through the jejunum. Arterial reconstruction for associated hepatic artery injury was not required because the injured hepatic arteries were already thrombosed.

Fig. 3: Surgical reconstruction by Roux-en-Y herpaticojejunostomy.

Enteroenterostomy: two-layer side-to-side jejunojejunostomy, with 3-0 polyglactin sutures was constructed at a distance of 60–90cm from the HJ.

Follow-up:

The first outpatient visit was scheduled 5 days after discharge. Subsequent visits were planned at 2 weeks, 1 month, 3 months, 6 months, 12 months, and then annually for two years. Each visit included a clinical examination, liver function tests, and an abdominal US.

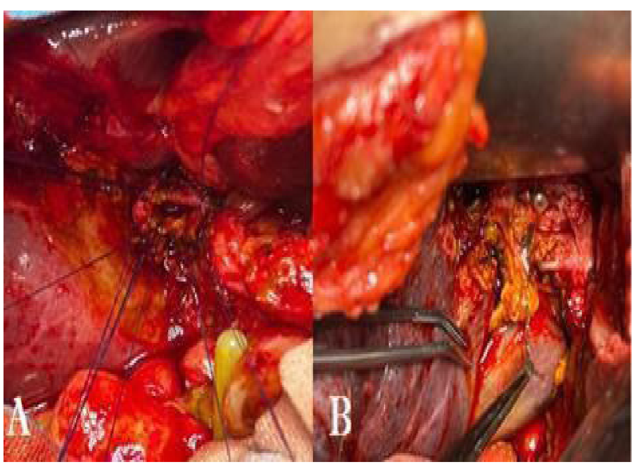

Fig. 4: Strasberg E1 injury with (A): Complete cut of the bile duct; (B): Ligation and complete cut.

Data collection:

The database included the demographic data, injury according to Strasberg classification, time of diagnosis of BDI, time of referral, clinical presentation, comorbidity, laboratory finding, time of surgical reconstruction, operative time, use of trans-anastomotic stent, mortality, and morbidity. The overall postoperative complications were classified based on the Clavien-Dindo classification system[9].

Statistical analysis:

All data were compiled and cross tabulated and then analyzed by SPSS 26 for windows (SPSS Inc. Chicago, IL, USA). Kolmogorov Smirnov test and Shapiro-Wilk test was used to check data for normality. Qualitative data were presented in the form of frequencies and corresponding relative percentages. Chi square and Fisher exact tests were used to calculate difference between qualitative variables as indicated. Mann Whitney *U* test was used to calculate difference between 2 groups for non-parametric data respectively. Univariate and Multivariate Binary logistic regressions were used. All statistical comparisons were conducted using a two-tailed approach. A *p*-value of ≤ 0.05 was considered statistically significant, while a *p*-value of <0.001 indicated a highly significant difference. Conversely, a *p*-value of >0.05 was interpreted as showing no significant difference.

RESULTS:

From total 43 patients with postcholecystectomy BDI who underwent surgical reconstruction by Roux-en-Y HJ, twelve patients (27.9%) were males and thirty-one (72.1%) were females. Most of these patients (88.4%) underwent cholecystectomy in other hospitals and were transferred to our center after injury. Medical comorbidities were positive in 32.6% of the studied patients Majority of the studied cases (55.8%) had BDI during open cholecystectomy as shown in Table (1).

The clinical presentation after BDI was variable, ranging from, biliary leakage, jaundice sepsis, and bleeding (Table 1). Biliary leakage – either in the drain or as localized biloma – was the most common presentation, seen in 58.1% of our patients and manifested by intense upper abdominal pain. Of these, five patients required percutaneous drainage of localized biloma under US guidance prior to preparation for definitive reconstruction.

The second most common presentation was jaundice encountered in 46.5% of patients. Ten patients (23.3%) presented with sepsis due to biliary peritonitis. Of these, three patients presented to us with aggressive peritonitis and urgent surgical intervention was planned, involving initial resuscitation followed by laparoscopic lavage of the abdominal cavity and placement of drains. Only three cases (7%) presented with bleeding manifested by bloody discharge in the abdominal drain.

The majority of cases (25 out of 43) showed Strasberg E1 injury (58.1%) according to MRCP (Figure 4). Strasberg E2 injury was diagnosed in 16 cases (37.2%), while E3 injuries were the least frequent, occurring in 2 cases only (4.7%). Most cases (37 out of 43, 86%) do not involve concomitant vascular injury (Table 1). Right hepatic artery (RHA) injury was encountered in 6 cases (14%) (Figure 5).

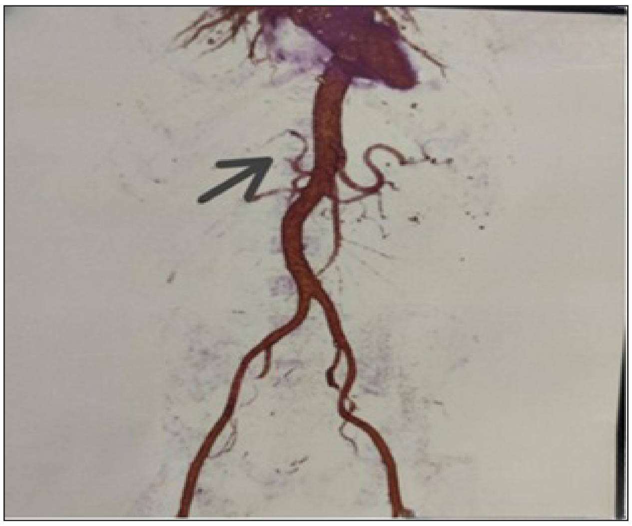

Fig. 5: CT arteriography showing right hepatic artery injury with ligation.

The early, intermediate, and late reconstruction groups included 11(25.6%), 18(41.9%) and 14(32.6%) patients respectively, with all patients who presented with bleeding (3 patients) operated in the early reconstruction group to explore for the cause of bleeding. A trans-anastomotic stent was used 12 patients (27.9%), while HJ was done without a stent in 31 patients (72.1%) (Table 1).

Table 1: Demographic and clinical characteristics of the studied patients:

	Number (%)
Sex	
Male	12(27.9)
Female	31(72.1)
Age (years)	
Mean±SD	41.3±14.8
Range	(20–66)
Medical Comorbidities	
No	29(67.4)
Yes	14(32.6)
Hypertension	4(9.3)
Diabetes mellitus	6(14)
Liver disease	5(11.6)
Heart disease	4(9.3)
Cholecystectomy	
In our center	5(11.6)
In other hospitals	38(88.4)
Open	24(55.8)
Laparoscopic	19(44.2)
Time of BDI diagnosis	
Intraoperative	6(14)
Postoperative (POD3 or later)	37(86)
Injury–referral interval (days)	
Mean±SD	5.07±1-44
Range	(3–7)
Clinical presentation after BDI	
Biliary leakage	25(58.1)
Jaundice	20(46.5)
Biliary peritonitis and Sepsis	10(23.3)
Bleeding	3(7)
Grade of BDI	
Strasberg E1	25(58.1)
Strasberg E2	16(37.2)
Strasberg E3	2(4.7)
Concomitant vascular injury	
No injury	37(86)
RHA injury	6(14)
Intervention prior to definitive reconstruction	
Percutaneous drainage of biloma	5(11.6)
Laparoscopic lavage (peritonitis)	3(7)
Selected perioperative data about surgical reconstruction	
Time of definitive reconstruction	
Early	11(25.6)
Intermediate	18(41.9)
Late	14(32.6)
Trans-anastomotic stent	
No stent used	31(72.1)
Stent used	12(27.9)
Operative time (min)	
Mean±SD	127.91±26.5
Range	(80–200)

BDI: Bile duct injury; POD3: Third postoperative day; RHA: Right hepatic artery.

In the short-term (90-day morbidity), wound infection was observed in 11 patients (25.6%). Chest infections and deep venous thrombosis (DVT) each occurred in 3 patients (7%). Additionally, 5 patients (11.6%) experienced postoperative biliary leakage. Of these, 4 were managed conservatively, while 1 patient (2.3%) developed fever and rigors on postoperative day 5 (POD 5). Further investigation of that patient via abdominal US confirmed the presence of a localized subhepatic intra-abdominal abscess that was effectively treated with percutaneous drainage, as outlined in Table (2).

During follow-up (long-term morbidity), 10 patients (23.3%) demonstrated evidence of anastomotic stricture by gradual mild elevation in serum bilirubin and alkaline phosphatase levels. Three of these patients developed recurrent cholangitis and anastomotic stricture was confirmed by MRCP (Figure 6). These underwent redo hepaticojejunostomy, while the remaining seven cases were treated with transhepatic balloon dilation.

A comparison between patients with adverse outcome (who developed POM, n= 23) and those without (no POM, n= 20) is outlined in Table (3). Among patients with adverse outcome, 17 out of 23(73.9%) presented with biliary leakage after BDI, compared to 40% who had leakage and developed no POM. This difference is statistically significant (*p*= 0.025).

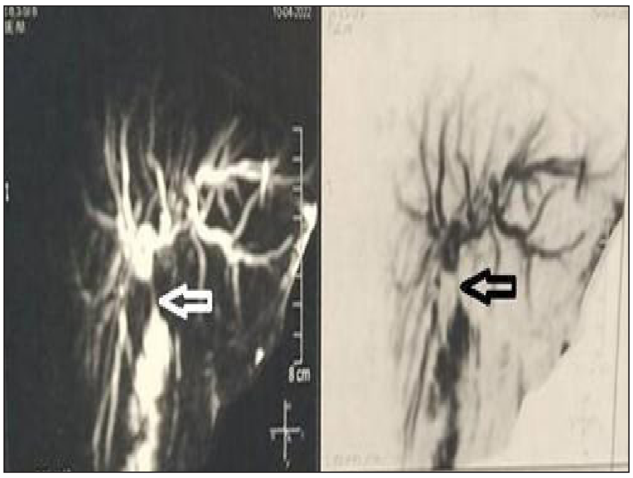

Fig. 6: MRCP showing anastomotic stricture.

Furthermore, 9 out of 23 patients with adverse outcome (39.1%) presented with biliary peritonitis and sepsis before reconstruction, whereas only 1 patient (5%) with good outcome experienced sepsis. This is again a statistically significant difference (*p*= 0.011). No statistically significant differences were observed regarding other clinical presentations (*p*>0.05).

Table 2 : Morbidity in the studied cases including short-term and long-term complications (DVT, deep venous thrombosis):

Postoperative complications	**Number (%)**	**Clavien system classification**
Short-term complications		
Wound infection	11(25.6)	I
Chest infection	3(7%)	II
DVT	3(7%)	II
Biliary leakage	5(11.6)	II
Intra-abdominal abscess	1(2.3)	IIIA
External biliary fistula	1(2.3)	II
Long-term complications		
Anastomotic stricture	10(23.3)	IIIB

Twelve out of 23(52.2%) patients who had adverse outcome had Strasberg E2 injury, compared to 9(39.1%) and 2(8.7%) patients who had Strasberg E1 and E3 injuries respectively. This difference is statistically significant (*p*= 0.016). Additionally, there is another significant difference (*p*= 0.023) between patients with adverse and good outcome regarding concomitant vascular injury. Specifically, among the twenty patients with good outcome, no concomitant vascular injury was observed. In contrast, six out of twenty-three patients who had adverse outcome experienced RHA injury, this was statistically significant (*p*= 0.023) (Table 3).

Ten out of the 20 patients with good outcome were in the late definitive reconstruction group, while 43.5% of those with adverse outcome underwent intermediate reconstruction. The use of trans-anastomotic stents was linked to fewer POM (13%) compared to 87% in those where no stent was used in the anastomosis Table 4. presents a univariate binary logistic regression analysis exploring the relationship between various factors and postoperative outcome. No significant association was identified between age or presentation with jaundice and adverse postoperative events. Female sex showed higher odds (OR= 5.45) of experiencing postoperative issues compared to males, though this finding was not statistically significant (*P*= 0.127) (Table 3).

Biliary leakage at presentation was significantly linked to adverse outcome (*P*= 0.028*), with an OR of 4.25 indicating increased risk. Biliary peritonitis and sepsis demonstrated a strong association with adverse outcome (*P*= 0.024*), showing an OR of 12.21. Site of BDI was also a significant predictor (*P*= 0.009*). Late surgical reconstruction significantly reduced the likelihood of adverse outcomes (*P*= 0.028*; OR= 0.12). Additionally, HJ with trans-anastomotic stenting showed a protective effect, reducing the risk of negative postoperative events (*P*= 0.027*; OR= 0.18).

However, operative time showed a marginally significant relationship (*P*= 0.014*, OR= 1.047), suggesting a slight increase in risk with longer procedures.

Table (4) shows a multivariate binary logistic regression analysis of factors associated with adverse postoperative outcome. Sepsis and higher-grade of BDI (E2/E3) are strongly associated with increased risks of adverse postoperative events. Late surgical reconstruction appears protective, reducing the risk of poor outcomes. Longer operative time is linked to a slight but significant increase in risk. All *P*-values are <0.05, suggesting that these findings are statistically significant, though borderline values (e.g., 0.050 for Site of BDI) warrant cautious interpretation.

Table 3: Comparison between patients with adverse and good outcome after surgical reconstruction regarding the clinical picture at presentation, grade of BDI, and concomitant vascular injury:

		Patients with no POM (good outcome) (*n*= 20) Number(%)	Patients with POM (adverse outcome) (*n*= 23) Number(%)	*P*-value
Clinical picture at presentation				
Biliary leakage				
	No	12 (60)	6 (26.1)	0.025*
	Yes	8 (40)	17 (73.9)	
Jaundice				
	No	11(55)	12(52.2)	0.853
	Yes	9(45)	11(47.8)	
Biliary peritonitis and Sepsis				
	No	19(95)	14(60.9)	0.011**
	Yes	1(5)	9(39.1)	
Bleeding				
	No	19(95)	21(91.3)	0.554
	Yes	1(5)	2(8.7)	
Grade of BDI				
Grade of bile duct injury				
	Strasberg E1	16(80)	9(39.1)	
	Strasberg E2	4(20)	12(52.2)	0.016**
	Strasberg E3	0	2(8.7)	
Concomitant vascular injury				
Concomitant vascular injury				
	No	20(100)	17(73.9)	0.023**
	RHA injury	0	6(26.1)	
Comparison between patients with adverse and good outcome after surgical reconstruction regarding time of reconstruction, use of stent, and the operative time				
Time of definitive reconstruction				
	Early	2(10)	9(39.1)	
	Intermediate	8(40)	10(43.5)	0.029*
	Late	10(50)	4(17.4)	
Trans-anastomotic stent				
	No stent used	11(55)	20(87)	0.020*
	Stent used	9(45)	3(13)	
Operative time (min)				
	Mean±SD	120±17.5	145±25	0.007*#
	Range	(80–150)	(100–200)	

POM: Postoperative morbidity; BDI: Bile duct injury; RHA: Right hepatic artery; *: *p* value is considered statistically significant at <0.05; *: Chi square; **: Fisher test; #: Mann-Whitney test.

Table 4: Univariate binary logistic regression analysis of different factors affecting the postoperative complications:

		Odds ratio	*P* value	Beta	(95% CI) Upper	Lower
Age (years)		1.01	0.478	0.015	0.97	1.05
Sex						
	Male	1Ref.				
	Female	5.45	0.127	1.69	1.21	24.43
Jaundice						
	No	1Ref.				
	Yes	1.12	0.853	0.114	0.33	3.72
Biliary leakage						
	No	1Ref.				
	Yes	4.25	0.028*	1.44	1.16	15.45

	Odds ratio	P value	Beta	(95% CI)	
				Upper	Lower
Bleeding					
No	1Ref.				
Yes	1.81	0.639	0.59	0.15	21.59
Sepsis					
No	1Ref.				
Yes	12.21	0.024*	2.5	1.38	107.86
Grade of BDI					
E1	1Ref.				
E2/E3	6.22	0.009*	1.82	1.56	24.7
Concomitant vascular injury					
No	1Ref.				
Yes	0.00	0.999	-21.36	0.00	-
Time of definitive procedure					
Early / Intermediate	1Ref.				
Late	0.211	0.028*	-1.55	0.052	0.845
Roux-en-Y HJ					
without stent	1Ref.				
with stent	0.183	0.027*	-1.69	0.041	0.82
Preoperative Albumin level	1.06	0.925	0.05	0.3	3.63
Operative time (min)	1.047	0.014*	0.04	1	1.08
Multivariate binary logistic regression analysis of different factors affecting the postoperative complications					
Presentation with sepsis	20.205	0.037*	3.006	1.202	339.622
Grade of BDI (E2/E3)	7.867	0.050*	2.063	1.003	61.723
Late surgical reconstruction (late)	0.091	0.046*	-2.392	0.009	0.959
Operative time (min)	1.086	0.011*	0.083	1.019	1.158

BDI: Bile duct injury; *: *p* value is considered statistically significant at <0.05; CI: Confidence interval.

DISCUSSION

BDI remains one of the most dreaded complications for surgeons performing this procedure[10]. Being linked to significant morbidity and – in some cases – mortality, BDI often necessitates invasive treatment[11].

The primary goals of surgical repair for BDI are to address biliary leakage and peritonitis, alleviate jaundice, and prevent long-term complications such as secondary biliary cirrhosis[12]. However, the procedure carries significant risks, with complication rates reported to be approximately 30%[13].

Given the complexity of these injuries, patients should always be referred to a tertiary care center for specialized management[14].

Patients' data:

Our study demonstrated a higher incidence of BDI among females (72.1%), which is consistent with the findings of Klos and co-authors and those of Vincenzi and co-authors, in which the female sex represented 66.2% and 62.9% of the studied population, respectively[15,16].

A higher incidence of BDI was reported following open cholecystectomy[17,18], and this is consistent with our results (55.8% of our cases were after open cholecystectomy). Conversely, numerous studies have associated LC with increased incidence and complexity of BDI[19-21].

Detection of biloma in both early and late presentation of BDI showed a statistically significant association with severity (p= 0.02), corresponding to a 41.7-fold increased risk of highly complex CBD injuries[22]. The commonest presenting picture in our study was biliary leakage (58.1%), this differs from the results of AbdelRafee and colleagues in which jaundice was the main presentation[23].

Out of 43 cases included in our study, BDI was identified during cholecystectomy in only six cases (13.95%). Of these, four cases were detected at our center with the aid of intraoperative cholangiography, while two cases occurred at other hospitals, where the injuries were visually identified by further dissection following intraoperative bile leakage. The reported frequency of intraoperative detection of BDI ranges from 7–90%[1,20].

Surgical approach:

In our study, most cases were in the intermediate and late surgical reconstruction groups (41.9% and 32.6% of cases respectively). This aligns with the findings of El Nakeeb and co-authors[24] who studied 412 patients with HJ for BDI and found that favorable results were more frequently seen in the immediate and delayed reconstruction. Conversely, a recent systematic review and meta-analysis reported early, and delayed reconstruction to be associated with lower postoperative morbidity and anastomotic stricture rates than intermediate reconstruction[25].

All patients who presented with sepsis before reconstruction (10 patients) was deferred to late reconstruction to guarantee full sepsis control. Three patients of those who presented with sepsis required laparoscopic lavage and drain placement, this "drain now, fix later" algorithm appears to be the most effective approach. Once clinical stabilization is achieved, several weeks are needed by the acute inflammatory phase to resolve. This time allows for reduction of local inflammation, which in turn minimizes the risks associated with extensive surgical reconstruction[26,27].

The ideal timing for surgical reconstruction following BDI remains a topic of unfinished debate. While immediate repair might appear advantageous for prompt resolution of bile leaks and peritonitis12, presence of inflammation and tissue fragility in the early postoperative period can hinder proper healing[28]. Conversely, delayed reconstruction provides time for control of sepsis, percutaneous drainage of collection, and improvement of nutritional status[29,30]. Nevertheless, some researchers recommend that excessive delay may lead to increased fibrosis around the bile duct stump, potentially affecting the surgical outcome[31]. Other authors reported no notable differences in patients' outcome between early and late reconstruction[12,32-35].

While both end-to-side and Hepp-Couinaud techniques were used for Roux-en-Y HJ in our study, end-to-side HJ was the technique of choice for most cases, whereas the Hepp-Couinaud technique was favored patients with Strasberg E3 injury (2 patients, 4.7%) to facilitate a wide anastomosis. Although the Hepp-Couinaud technique provides optimal left hepatic duct exposure, it offers limited visualization of the right hepatic duct[36].

The use of trans-anastomotic stenting in HJ is controversial[37,38], some authors reported a better outcome with stenting[39-41]. On the contrary, other research reported stent-free anastomosis as a safe and effective approach[1,42,43]. We used a trans-anastomotic stent in 12 patients (27.9%) only. In our clinical practice, the decision to utilize this stent is particularly indicated in the following scenarios. First, narrow biliary stump (diameter <5mm) .Second, presence of inflammatory edema or local tissue swelling. Third, patients with a prior history of biliary peritonitis are at a heightened risk for complications due to the potential for adhesions, scarring, or compromised tissue. The placement of a trans-anastomotic stent in these patients mitigates the risk of recurrent bile leakage or anastomotic failure. Our protocol ensures a tailored approach to stent placement, addressing anatomical and pathological challenges while promoting optimal surgical outcomes.

Short- and long-term outcomes after HJ:

The rates of POM after BDI reconstruction have been reported to range from 15% to 65%[12,25,44]. Our study indicates an overall morbidity rate of 53.5% compared to the short-term rate reported by Ahmad and co-authors[43] (51.7%) but lower than their long-term rate (13.7%). Otto and co-authors[45] observed 5% mortality rate with minor surgical complications (including wound infection, peri-stent biliary leakage and stent prolapse) in 11.44%.

Dominguez-Rosado and co-authors1 reported wound infection as the most frequent complication (16%), followed by pneumonia (5%). In our study, the commonest general complication was wound infection occurring in 25.6% of cases.

After HJ, biliary leakage was observed in 5 of our patients (11.6%), and 1 patient (2.3%) developed an intra-abdominal abscess. Díaz-Martínez and co-authors17 reported bile leaks and abscess with the rates of 10% and 3.8% respectively.

Regarding long-term outcomes, the development of bilioenteric anastomotic strictures is a crucial determinant of the success of the procedure. Our results align with those of previous studies[13,18,44,46], which reported anastomotic stricture rates ranging from 5 to 70%. The rate of anastomotic stricture observed in our study diverges from that reported by Ahmad and co-authors, where the long-term stricture rate was less than 6%[43].

Consistent with a recent meta-analysis[25] that reported a mortality rate range of 0 to 18%, our study observed no mortality among the studied patients.

Predictors of adverse outcome:

We found a significant association between biliary leakage at clinical presentation and adverse outcomes (P= 0.028*), with an OR of 4.25 indicating increased risk. This finding is in line with the results of Huang and co-authors[47] who reported the presence of bile leakage as a predictor for long term complications. However, Dominguez-Rosado and co-authors[1] didn't report bile leakage as a significant predictor of adverse outcome.

In this study, development of sepsis after BDI was one of the independent predictors of POM and adverse outcome (OR=20.205 ,95% CI: 1.202-339.622, p= 0.037*). This agrees with the findings of previous studies[38,47,48] which highlighted the association between uncontrolled biliary leakage or sepsis and the difficult accomplishment and/or healing of HJ, regardless the experience of the surgeon.

In the time we suggest early recognition and management of sepsis to reduce adverse outcomes, some authors advocated that scarring and late anastomotic stricture may still develop even with proactive management of sepsis[38,47]. In contrast, several studies[1,30,49] have shown that full control of sepsis protects against reconstruction failure, regardless of timing of surgical reconstruction. Our study aligns with previous research[1,30,34,46,47] concluding that sepsis due to biliary peritonitis is a significant determinant of outcome after reconstruction.

In agreement with many previous studies[19,24,28,30,50], our study revealed a strong correlation between proximal BDI and adverse outcomes after surgical reconstruction, as evidenced by the significantly higher proportion of Strasberg E2 (52.2%) and E3 (8.7%) in patients with adverse outcome compared to those with good outcome. Strasberg (E2/E3) injuries were independent predictor of adverse postoperative events in our study (OR=7.867,95% CI: 1.003-61.723, p= 0.050*). However, this contrasts with the findings of Omar and co-authors[41] that revealed no correlation between the level of BDI and the success of reconstruction.

While none of the twenty patients with good outcome in our study experienced vasculo-biliary injury, six out of the twenty-three patients with adverse outcome suffered from concomitant RHA injury (p= 0.023). Our results concur with Sarno and co-authors[51] who found that combined vascular and biliary injuries were associated with the worst outcomes, but contrast with Sulpice and co-authors[46] and Sultan and co-authors[52] who reported no significant influence of associated vascular injury on the outcome of surgical reconstruction. Sultan and co-authors attributed their result to the lack of routine assessment for vascular injury in their study[52].

According to Booij and co-authors, the timing of surgical reconstruction has no significant impact on short-term and long-term outcomes after HJ[49]. A recent meta-analysis and systematic review[48] found that patients undergoing early biliary reconstruction had a significantly elevated frequency of bile leaks compared to those with delayed reconstruction. El Nakeeb and co-authors[24] found a significantly higher rate of anastomotic leakage in intermediate BDI reconstruction. Conversely, several studies[33,48,53] reported no significant difference in leakage rates between early, intermediate, and delayed repairs.

Our analysis identified late definitive reconstruction as an independent predictor of reduced POM (OR= 0.091, 95% CI: 0.009-0.959, p= 0.046), with 50% of patients undergoing late repair experiencing favorable outcomes. Our finding aligns with Walsh and co-authors[44] who reported lower complication rates in delayed repairs, and de Reuver and co-authors[28] who suggested an association between early repair and worse prognosis. The use of trans-anastomotic stents in biliary reconstruction remains a subject of debate. While some studies[38,39,54,55] advocate for their routine use, citing benefits such as improved biliary drainage, reduced pressure, enhanced integrity of anastomosis, and facilitated access for future interventions, other research has shown comparable outcomes without stenting[1,42,56]. In our study, 87% of patients with adverse outcome performed HJ without stenting. This result agrees with the findings of Ali and co-authors in a study involving[26]. patients who underwent Roux-en-Y HJ for postcholecystectomy BDI, a 12.5% rate of poor postoperative outcome was observed. Importantly, all patients with poor outcomes had no trans-anastomotic stents during surgery[6].

Our study identified operative time of surgical repair after BDI as an independent risk factor for adverse outcomes (OR= 1.086, 95% CI: 1.019-1.158, p= 0.011*). This finding corroborates previous research by AbdelRafee and co-authors who reported operative time as an independent risk factor for postoperative poor outcome (P= 0.007)[23].

Strengths and limitations of the study:

This study possesses several strengths. By exclusively focusing on HJ reconstruction and excluding other surgical approaches, we ensure a homogenous patient population, enhancing the internal validity of our findings. Moreover, our comprehensive assessment of a wide spectrum of complications, both early and late, further strengthens the validity of our results.

However, the following limitations of the study should be acknowledged. Firstly, the retrospective nature of the study. Secondly, the relatively short follow-up period of two years may have limited our ability to capture the full spectrum of long-term complications, such as intrahepatic stones, biliary cirrhosis, and liver cell failure, which may manifest over a more extended timeframe (up to 10 years). Finally, our relatively small sample size.

CONCLUSION

Our analysis demonstrates that multiple factors can significantly influence the outcome of the surgical reconstruction after postcholecystectomy BDI, including the clinical presentation after injury (especially biliary leakage and sepsis), grade of injury according to Strasberg classification, timing of surgical reconstruction, use of trans-anastomotic stent, and the operative time.

INSIGHTS AND RECOMMENDATIONS

The observed stark increase in risk due to sepsis underscores the need for aggressive management protocols to improve postoperative outcome. Given the high incidence of wound infection and anastomotic strictures, targeted preventive and therapeutic strategies are essential. Delayed surgical reconstruction beyond 6 weeks – though counterintuitive – may improve the outcome by allowing for patient stabilization and resolution of inflammation, but exceptions may apply in cases requiring immediate intervention. Use of trans-anastomotic stents in patients with high risk for adverse outcome might protect them from complications like bile leaks or strictures. Minimizing the operative time, while ensuring patient safety and surgical quality, is crucial for optimizing the outcome. Surgical repair should be better performed in a specialized center with expertise in hepatobiliary surgery. To further elucidate the factors associated with adverse outcomes following hepaticojejunostomy for BDI, a prospective, multicenter study with a larger sample size is warranted. Finally, the increasing volume of cholecystectomies and concomitant rise in BDI rates highlight the importance of a deeper dive into appropriate clinical decision-making in these challenging scenarios.

CONFLICT OF INTEREST

There are no conflicts of interest.

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