Research Article

Outcomes of Reconstructive Hepaticojejunostomy for Post-Cholecystectomy Bile Duct Injuries

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Abstract
Objectives: Bile duct injury (BDI) remains a potentially devastating complication of cholecystectomy. BDI is associated with significant morbidity, high costs, impaired quality of life, and decreased survival. After major BDI, reconstructive surgery by Hepaticojejunostomy (HJ) is usually indicated **The study aimed to** analyze and evaluate the presentation, characteristics, related investigation, and outcomes of reconstructive Hepaticojejunostomy in patients with post-cholecystectomy bile duct injuries. **Patients and methods**; This study was done in El-Minia university hospital (minia Hepatobiliary unit), including 26 patients who underwent Hepaticojejunostomy Roux-en-Y for post-cholecystectomy bile duct injury (BDI) between May 2017and May 2020, retrospectively and prospectively. **Results:** The study included 26 patients suffered from iatrogenic BDIs; 19 patients (73%) underwent OC, and 7patients (27%) underwent LC. Regarding injury type; the Leaking, Obstructing, collection, peritonitis, and vascular injuries were 26.9%, 46.1%, 19.3%, 7.7%, and 4.4% respectively. However, the Strasberg classification of injury was as follow E1 = 15.4%, E2 = 46.1%, E3 = 30.8%, and E4 = 7.7%. In this retrospective study, between may 2017and December 2020, 26 patients with major bile duct injuries sustained during cholecystectomy and requiring surgical treatment in the form of HJ Roux-en-Y were referred to minia hepatobiliary center Preoperatively, US was done for all patients, CT in 3(11.5%), PTC in 3(11.5%), ERCP in 17(65%) and MRCP was done for 16 (61.5%) patients. **Conclusion:** Early detection of BDI and early referral to specialized hepatobiliary referral centers are essential for early management of BDI and prevention of its complications and any attempt of repair by non-specialized general surgeon should be avoided. Surgical reconstruction using Roux-en-Y Hepaticojejunostomy mucosa to mucosa repair remains the golden standard procedure of choice for treating these injuries with successful outcome and better long-term result. We recommend long-term follow up of the patients after surgical repair for at least 10 years as anastomotic stricture was diagnosed after long peroid. Further studies should be performed for the best management of recurrent anastomotic stricture. Associated vascular injuries should be emphasized and accurately evaluated.
Keywords: Bile duct injury, cholecystectomy, Hepaticojejunostomy

Introduction
Cholecystectomy is one of the most common general surgical operations performed world-wide. The risk of bile duct injury (BDI) during laparoscopic cholecystectomy is two to three times higher than during open cholecystectomy. The worldwide incidence of bile duct injury is 0.5% or 1 in 200 cases. BDI and its consequences result in significant morbidity and may even cause mortality; it also increases the cost of treatment and can be a common reason for medico-legal suits against the surgeons (Kapoor, 2020a, 2020b) Injuries to the bile ducts are unfortunately not rare and often turn out to be tragedies. A bile duct injury will probably occur, at least once in the lifetime, in the hands of every surgeon who performs laparoscopic cholecystectomy.(Sipos, 2007)

Incidence of post-cholecystectomy bile duct injuries: Cholecystectomy is responsible for 80%-85% of BDI. The incidence of BDI following laparoscopic cholecystectomy has increased over the past decade (0.4%- 0.6%), despite the expertise gained worldwide in performing this procedure while its incidence after open cholecystectomy was (0.1%-0.2%).

(Iannelli et al., 2013; Lillemoe & Jarnagin, 2020)

Mechanisms of bile duct injuries: BDI during cholecystectomy (in order of their frequency and importance) are ignored or mis-identified (and sometimes aberrant) anatomy, inexperience and/or overconfidence on the part of the surgeon, difficult pathology, bleeding, and thermal injury. Misinterpretation of biliary ductal anatomy, i.e., misidentification of the CBD as the cystic duct is the commonest etiological factor for BDI during laparoscopic cholecystectomy; aberrant anatomy(The most common mechanism of BDI is misidentification of anatomy)and difficult pathology are less commonly responsible for the BDI. Aberrant biliary ductal anatomy is frequently blamed but is not usually responsible for majority of the bile duct injuries (Suhocki & Meyers, 1999)

Classifications of bile duct injuries (BDI): Multiple classification schemes have been developed to describe CBD injuries. This has been very useful in standardizing discussions and research regarding the incidence of injuries and the outcomes of repair. (Mesleh & Asbun, 2020; Moy & Birk, 2019)

1- Corlett Bismuth classification:

Type I: Low common hepatic duct injuries (common hepatic duct>2 cm).

Type II: Mid common hepatic duct injuries (common hepatic duct< 2 cm).

Type III: High injuries (hilar) (no hepatic duct and confluence is intact).

Type IV: Destruction of the hilar confluence right and left hepatic duct are separated.

Type V: Involvement of sectorial right branch above or associated with the common hepatic duct injury.

2- Strasberg's classification: (Strasberg, Hertl & Soper, 1995)

a) Cystic duct leaks or leaks from small ducts in the liver bed.

b) Occlusion of a part of the biliary tree, almost invariably the aberrant right hepatic ducts. Transection without ligation of the aberrant right hepatic ducts.

c) Lateral injuries to major bile ducts.

d) Subdivided as per Bismuth's classification into E1 to E5.

The diagnosis of BDI mandates immediate referral to a hepatobiliary surgeon. Whether the injury is identified during surgery, or at any time in the post-operative period, the operating surgeon should not attempt repair since attempted repair by the injuring surgeon is associated with an increased risk of morbidity and mortality. (Perera et al., 2011) Each failed repair is associated with some loss of bile duct length and greatly exacerbate an already difficult situation. (Tocchi et al., 1996)

The management of bile duct injuries depends on the type, extent, and level of injury, and the time of its diagnosis. Initial proper treatment of bile duct injury diagnosed during the cholecystectomy can avoid the development of a bile duct stricture. If a major injury is discovered and an experienced biliary surgeon is not available, an external drain and, if necessary, Tans hepaticbiliary catheters are placed, and the patient is transferred to a referral center (Mercado & Domínguez, 2011)
There is consensus that BDI are best handled in specialized hepatobiliary units However, the optimal time of operative repair remains controversial. (Pekolj et al., 2013)

Aim of the work; The aim of this study is to evaluate the presentation, characteristics, related investigation, and outcomes of reconstructive Hepaticojejunostomy in patients with post-cholecystectomy bile duct injuries.

Patient and Methods

This study was done in El-Minia university hospital (minia Hepatobiliary unit), including 26 patients who underwent hepaticojejunostomy Roux-en-Y for postcholecystectomy bile duct injury (BDI) between May 2017 and May 2020, retrospectively and prospectively. This study includes all patients who were subjected to surgical repair of post cholecystectomy bile duct injuries. In all patients, the only type of surgical repair done in the form of biliary-enteric anastomosis was Hepaticojejunostomy Roux-en-Y .

Patients:

***Inclusion criteria:**

This study included patients with iatrogenic major bile duct injury post cholecystectomy included all transactions or partial lacerations of

the common hepatic duct, common bile duct, or major segmental ducts at porta hepatis and who underwent Hepaticojejunostomy Roux-en-Y as a definite treatment

Exclusion criteria:

This study excluded patients with: Patients with non-cholecystectomy-related BDI. Patients with cholecystectomy related BDI that had been managed by other lines of treatment (endoscopically or radiologically) eg ERCP or other types of surgical repair

Data collection:

Data for this study was obtained from the patients and from the medical records of the patients included in the medical archive of heatobiliary unite of El-Minia general surgery department and All patients gave informed written consent for surgery, possible consequences, and the use of data for scientific purposes.

Preoperative recorded data for patients: Patient demographics which include patint's age and sex, The type of offending cholecyst-ectomy**,** Time of recognition of injury, Presentation of patients after injury or at the time of referral includes**,** Presence of drain, Preoperative laboratory data, MRCP, ERCP or PTC and Level of injury.

Intra-operative data include:

Findings in exploration eg :evidence of vascular injury right or main hepatic artery or portal vein injury, presence of collection. and detection of the level of injury according to Strasberg classification.

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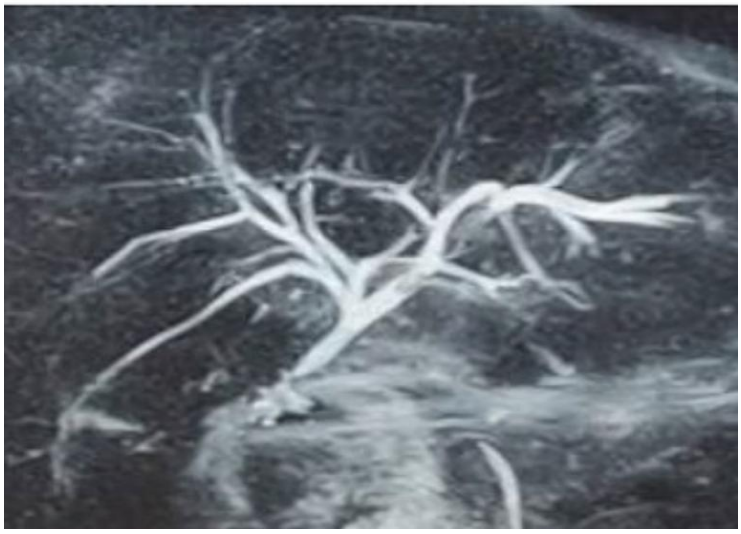

Fig. (1): showing MRCP of a patient with a major BDI, post cholecystectomy
(E1-Proximal CHD stricture-hepatic duct stump > 2 cm.)

Fig.(2): showing Roux-en-Y hepaticojejunostomy

Fig.(3): showing End to side jejunojejunostomy

Postoperative data: Follow up

A- Short-term postoperative complications: were defined as those occurring within 30 days of the repair surgery or during the same hospitalization.

B- Long-term postoperative complications: were those occurring after 30 days post-repair and the most important complication was anastomotic strictures. Clinically significant biliary stricture was defined as a stricture that resulted in signs and symptoms requiring surgical, endoscopic or percutaneous intervention.

Results

The study included 26 patients suffered from iatrogenic BDIs; 19 patients (73%) underwent OC, and 7patients (27%) underwent LC. Regarding injury type; the Leaking, Obstructing, collection, peritonitis, and vascular injuries were 26.9%, 46.1%, 19.3%, 7.7%, and 4.4% respectively. However, the Strasberg classification of injury was as follow E1 = 15.4%, E2 = 46.1%, E3 = 30.8%, and E4 = 7.7%.

In this retrospective study, between may2017and December 2020, 26 patients with major bile duct injuries sustained during cholecystectomy and requiring surgical treatment in the form of HJ Roux-en-Y were referred to minia hepatobiliary center Preoperatively, US was done for all patients, CT in 3(11.5%), PTC in 3(11.5%), ERCP in 17(65%) and MRCP was done for 16 (61.5%) patients.

24 patients underwent long-term follow up with The median follow-up was 13 (1–35) months.

Long-term complications were detected in 5(20.8%) out of 24 patients with long-term follow up; in the form of recurrent cholangitis 2(8.3%); where the initial attacks developedat 6 months, 10 months, 17 months, 30 months from definitive surgery, stricture 2(8.3%), that occurred at 9 months,21 months, 22 months, 25 months, from surgery, and both stricture and recurrent cholangitis 1(4.2%), that happened at 18 months and 25 months from surgery

The long-term outcome according to Terblanche clinical grading system was excellent (grade I) in 16 (66.7%) patients, good (grade II) in 5 (20.8%) patients, fair (grade III) in 2 (8.3%) patients and poor (grade IV) in 1 (4.2%) patients. As regard McDonald's grading, grades A, B, C, and D were 16/24(67%),5/24(21%),2/24(8%), and 1/24(4%) respectively.

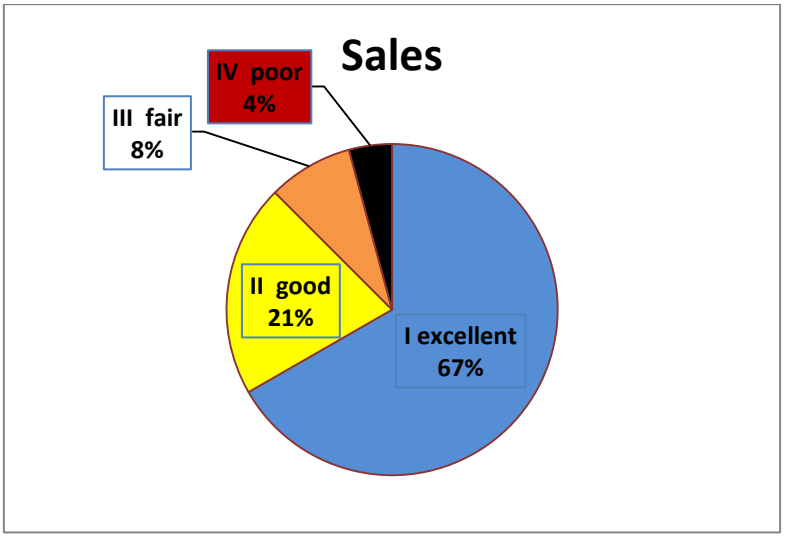

chart (3): Long-term outcome after HJ repair of postcholecystectomy BDI in 24 patients

Table (1): Factors affecting the long-term outcome after surgical repair as regard patients' characteristics & preoperative data (P value <0.05is significant).

	G1: excellent outcome [n=21(87.5%)]	G2: poor outcome [n=3(12.5%)]	Total [n=24(100%)]	P value
Age (mean ±SD)	41.41 ± 12	40.29 ± 13.09	45.42 ± 11.5	0.713
Sex:				
Male	6 (25%)	2 (8.3%)	8 (33.3%)	0.779
Female	15 (62.5%)	1 (4.2%)	16 (66.7%)	
Type of chole:				
Lap	4 (16.7%)	2 (8.3%)	6(25%)	
Open	17 (70.8%)	1 (4.2%)	18(75%)	0.284
Recognition of injury:				
Intra-operative	3 (12.5%)	0 (0 %)	3(12.5%)	
Early (<2w)	13 (54.2%)	2 (8.3%)	15 (62.5%)	
Intermediate (2 – 6w)	4 (16.7%)	0 (0%)	4 (16.7%)	0.072
Late (> 6w)	1 (4.2%)	1 (4.2%)	2 (8.3%)	
Interval for referral (m):	6.23 ± 14.29	14.58 ± 33.07	7.13±17	**0.021**
<10 days	2 (8.3%)	0 (0%)	2(8.3%)	
10 d – 3m	18 (75%)	1 (4.2%)	19 (79.2%)	
> 3 months	1 (4.2%)	2 (8.3%)	3 (12.5%)	**0.035**
Interval for repair(m):				
< 3 days	0 (0%)	0 (0%)	0 (0 %)	
3d – 6w	5 (20.8%)	2 (8.3%)	7(36.7%)	0.088
> 6 weeks	16 (66.7%)	1 (4.2%)	17(62.5%)	
Jaundice:				
Yes	9(64.3%)	2 (8.3%)	11 (45.8%)	0.930
No	12 (50 %)	1 (4.2%)	13(54.2%)	
Cholangitis+EBF				
Yes	9(64.3%)	1 (4.2%)	10 (41.7%)	0.590
No	12 (50 %)	2 (8.3%)	14(58.3%)	
WBC (×103)	8.56 ± 4.5	7.34 ± 2.78		0.384
Albumin (gm/dL)	3.84 ± 0.51	3.82 ± 0.51		0.899
Bilirubin (mg/dL)	3.51± 1.28	5.61± 2.98		0.293
ALP(K.A.U)	32.43 ± 27.01	49.08 ± 34.19		**0.045**
SGOT (u/mol)	100.45 ± 70.37	86.57 ± 38.69		0.472
SGPT (u/mol)	103.17 ± 81.88	80.86 ± 55.48		0.326
Level of injury:				
low (E1, E2)	14(54.2%) 7(29.2%)	2 (8.3%)	16 (66.7%)	**0.044**
high (E3, E4)		1 (4.2%)	8(33.3%)	
RHA injury:				0.075
Yes	0(0%) 21(87.5%)	1 (4.2%)	1(4.2%) 23(95.8%)	
No		2 (8.3%)		
Intraabdominal Biloma:				0.067
Yes	3 (12.5%)	2 (8.3%)	5(20.8%)	
No	18(75%)	1 (4.2%)	19 (79.2%)	
No. of anastomosis:				**0.048**
Single duct	19 (79.1%)	2(0 %)	21 (87.5%)	
Ductoplasty	1(4.2%)	0(0%)	1(4.2%)	
Double ducts	1(4.2%)	1(62.5%	2(8.3%)	
Stent use:				
Yes	6(25%)	0 (0%)	6(25%)	**0.028**
No	15 (62.5%)	3 (12.5%)	18(75%)	
Operative time (min)	158.48 ± 48.03	229.09 ± 79.68		**0.016**
Early complications				
Yes	7(29.2%)	3 (12.5%)	10(41.2%)	
No	14(58.3%)	0 (0%)	14(58.3%)	**0.018**

Discussion

In this cohort, we analyzed the factors affecting early morbidity as well as late biliary morbidity. **In this study,** referral time to our center after injury diagnosis had significant impact on early complications or late biliary morbidity (P value0.021) was independent predictor of worse outcome in DeReuver et al., 2007 (de Reuver et al., 2007)and Martinez-Lopez et al., 2017 (Martinez-Lopez et al., 2017) studies, also, longer delay of referral (> 3 months) from index surgery was associated with poor outcome in AbdelRafee et al., 2015 (AbdelRafee, El-Shobari, Askar, Sultan, & El Nakeeb, 2015) study.

Intra-abdominal sepsis and abscesses(Intra-abdominal Biloma) even if drained effectively may remain active in the period after surgery, predisposing patients to fibrosis, resulting in late anastomotic stricture. Furthermore, inflammatory changes in the surgical bed produce tissue friability, resulting in increased technical difficulty at repair time(Campana & Santibañes, 2015; Huang et al., 2014). In similar, In this study, sepsis at referral due to biliary peritonitis or severe cholangitis was significant predictor of early and late morbidities (P value 0.057), despite our aggressive management of it before doing the definitive repair, similarly, it was independent predictor of complications and anastomotic failure after primary repair in Dominguez-Rosado et al., 2016 (Dominguez-Rosado, Sanford, Liu, Hawkins, & Mercado, 2016) study and was predictor of severe complications in Patrono et al., 2015 (Patrono et al., 2015)study and it was the only independent predictor of major morbidity and a significant predictor of late biliary stricture in Sulpice et al., 2014 (Sulpice, Garnier, Rayar, Meunier, & Boudjema, 2014) study, in the same line, it was independent predictor of long-term complica-tions in Huang et al., 2014 (Huang et al., 2014) study.

In the same way, Schmidt et al., 2005 (Schmidt, Langrehr, Hintze, & Neuhaus, 2005) found that the presence of active peritonitis was independently associated with long-term complications, such as anastomotic stricture, or secondary biliary cirrhosis. Similarly, repair at a stage with active biliary or peritoneal inflammation was a significant predictor of long-term failure in Huang et al., 2003 (Huang et al., 2014) study.

Repair in patients with higher strictures (Strasberg- Bismuth types III, IV was a predictor of failure in some series (Chapman, Halevy, Blumgart, & Benjamin, 1995; Schmidt et al., 2005), In this study, it had effect on late biliary outcome despite its effect on early complications. (P value 0.044) it was independently associated with an overall poor short- and long-term outcomes in Bansal et al., 2015 (Bansal et al., 2015) study, and was a significant predictor of postoperative stricture in Walsh et al.,2007 (Walsh, Henderson, Vogt, & Brown, 2007) study.

The occurrence of major postoperative complications were associated with an increased risk of biliary stricture after surgery in Sulpice et al., 2014 (Sulpice et al., 2014) and Booij et al., 2018 (Booij et al., 2018) studies, in the same line, In this study early morbidity was significant predictor of late biliary morbidity, and it was independent predictor of late stricture (P value 0.018) also in AbdelRafee et al., 2015 (AbdelRafee et al., 2015) study.

Conclusion

Early detection of BDI and early referral to specialized hepatobiliary referral centers are essential for early management of BDI and prevention of its complications and any attempt of repair by non-specialized general surgeon should be avoided. Surgical reconstruction using Roux-en-Y Hepaticojejunostomy mucosa to mucosa repair remains the golden standard procedure of choice for treating these injuries with successful outcome and better long-term result. We recommend long-term follow up of the patients after surgical repair for at least 10 years as anastomotic stricture was diagnosed after long peroid. Further studies should be performed for the best management of recurrent anastomotic stricture. Associated vascular injuries should be emphasized and accurately evaluated.

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