Timing Of Surgical Repair Of IatrogenicMajor Bile Duct Injury During Cholecystectomy

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ABSTRACT

ObjectivesComparison between early and delayed surgical repair of an iatrogenic biliary duct injury during cholecystectomy referred to a hepatobiliary surgeon in terms of mortality and early and long-term morbidity.

Methods and Materials Between January 2004 and June 2018, a retrospective analysis was done on 63 patients with bile duct injuries who were referred to KHMC (King Hussein medical centre/ Hepatobiliary Unit). All patients with an attempt at repair by the primary surgeon (11 cases) managed non-surgically were also excluded (13 cases) from the study. The remaining 39 patients were analysed in this study, 13 males and 26 females with biliary injury. Of these, 11 patients were diagnosed intraoperatively, and 28 patients were diagnosed postoperatively. In all, 8 patients developed biliary injury during open cholecystectomy and 31 patients during laparoscopic cholecystectomy.

ResultsThe bile duct injuries were classified using the Bismuth-Strasberg classification of bile duct injury, ranging from type A to type E. Complete preoperative cholangiography was achieved in almost all cases. Preoperative percutaneous drainage required in ten patients for bile collections, and one for a subhepatic abscess. Twenty patients underwent biliary reconstruction within 6 weeks of the injury (median time = 2 weeks) and 19 patients after 6 weeks (median time= 13 weeks). All patients were managed by Roux-en-Y hepaticojejunostomy, except one patient who was managed by laparoscopic suture closure of the cystic duct. Three patients required surgical revision of the hepaticojejunostomy, one in the late and two in the early group. Successful surgical reconstruction was possible in early surgical repairs. There was no mortality among both groups in the early perioperative period.

ConclusionEarly surgical repair of biliary injury is successful in most of the cases when undertaken by a hepatobiliary surgeon, with early referral to a tertiary care centre, and the outcome is similar to that of delayed repair.

Keywords: bile duct injury, early bile duct injury repair, Delayed bile duct injury repair, Bismuth-Strasberg classification, laparoscopic cholecystectomy.

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INTRODUCTION

With the introduction of laparoscopic cholecystectomy, the number of bile duct injuries has increased markedly [1].

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Initially the incidence of iatrogenic laparoscopic bile duct injury was around 10-fold that of open cholecystectomy, but with the increased experience in this technique, the incidence has decreased drastically but remains higher than that of open cholecystectomy (0.3–0.7% vs. 0.1–0.3%) [2]. However, the number of cholecystectomies has increased worldwide with the introduction of the laparoscopic approach, and even with improved surgeon experience with this approach, the rate of biliary injury remains constant. Hence, bile duct injury following cholecystectomy (both open and laparoscopic) continues to be a problem [3].

The presentation, diagnosis and management of these injuries may be challenging in most of these cases. A multidisciplinary approach, including a gastroenterologist, hepatobiliary surgeon, interventional radiologist and psychiatrist, is required during the management of such a complex disease [4].

Many factors influence the outcome of bile duct injury repair, including general health status of the patient, duration of illness, level of injury, eradication of any associated intra-abdominal infection, achievement of complete preoperative cholangiography, surgeon experience performing the repair and correct surgical repair. In fact, bile duct injury results in a serious complication and long-term morbidity and impaired quality of life [4–7]. The optimal timing of surgical repair of bile duct injury still matter of debate and controversies. The current study examines the early and delayed surgical repair of an iatrogenic biliary duct injury during cholecystectomy referred to a hepatobiliary surgeon in terms of mortality and early and long-term morbidity.

PATIENTS AND METHODS

Between January 2004 and June 2018, a retrospective study that included 63 patients with bile duct injuries who were referred to KHMC (Hepatobiliary Unit). All patients with an attempt at repair by the primary surgeon were excluded 17.5% (11 cases), and all patients managed non-surgically were also excluded 20.6% (13 cases) from the study. The remaining 39 (62%) patients were analysed in this study, 13 (33.3%) males and 26 (66.6%) females with biliary injury. In all, 11 (28.2%) patients were diagnosed with biliary injury intraoperatively and 28 (71.8%) patients were diagnosed postoperatively. In all, 8 (20.5%) patients developed biliary injury during open cholecystectomy and 31(79.5%) patients during laparoscopic cholecystectomy (Table I). The bile duct injuries were classified using the Bismuth-Strasberg classification of bile duct injury (Type A: injury with a leak in the duct of Luschka or the cystic duct. Type B: injury to a sectoral duct resulting in obstruction of the sectorial duct. Type C: injury to a sectoral duct with bile leak. Type D: lateral injury to the extrahepatic biliary ducts. Type E1: stricture more than 2 cm from the bile duct confluence. Type E2: stricture within 2 cm of the bile duct confluence. Type E3: stricture at the confluence with continuity. Type E4: stricture involving the right and left bile ducts, without continuity. Type E5: complete occlusion of all bile ducts, including sectoral ducts).

Table I. Demographics and initial operation.

Demographics	Number	%
Age (years)		
Mean	42	
Median	43 (18–67)	
Gender		

Male	13	33.3%
Female	26	66.7%
Type of operation		
Open cholecystectomy	8	20.5%
Laparoscopic cholecystectomy	31	79.5%
Onset of recognition of the injury		
Intraoperatively	11	28.2%
Postoperatively	28	71.8%

Most of the patients were referred from a community hospital, except for seven (17.5%) cases from an academic hospital. The time from injury to referral varied according to the time of diagnosis and range from immediate transfer after intraoperative diagnosis of bile duct injury to 19 weeks postinjury, with mean time of referral of 11 ± 5 weeks (Table II).

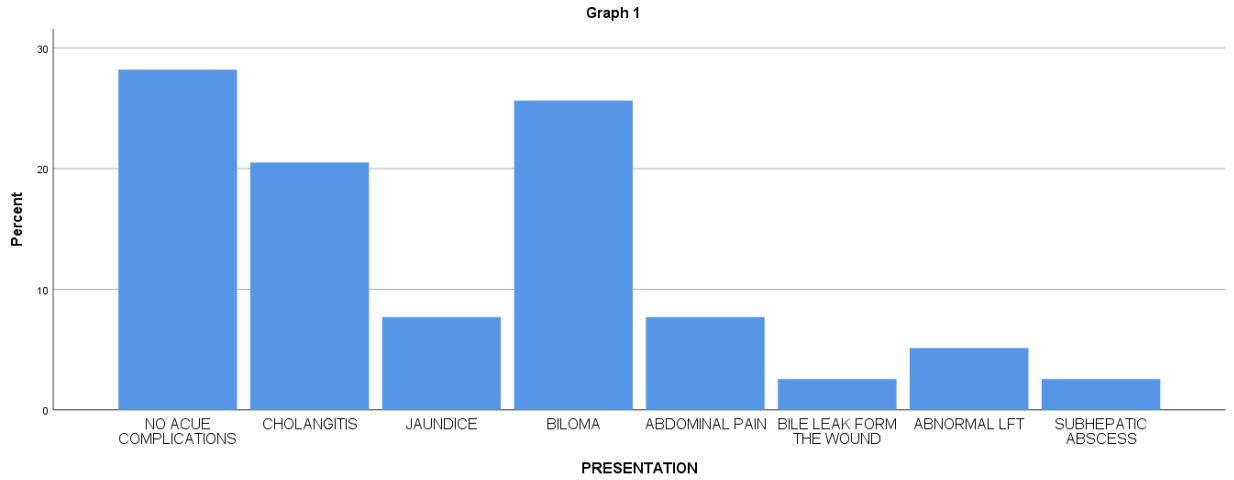
Table II Time from injury to referral (in weeks) and presentation.

Time from injury to referral	n = 39	
Range	0–19 weeks	
Mean	11 ± 5 weeks	
Median	3 weeks	
Referral hospital	n = 39	%
Community hospital	32	82.0
Academic hospital	7	18.0

The most common presenting signs and symptoms were biloma (25.6%), cholangitis (20.5%), jaundice (7.7 %) and no acute complications (28.2%), which was the case in patients diagnosed with bile duct injury intraoperatively (Table-III and graph-1).

TableIII. Presentation.

Presentation	Frequency	Percent	Valid Percent	Cumulative Percent
NO ACUTE COMPLICATIONS	11	28.2	28.2	28.2
CHOLANGITIS	8	20.5	20.5	48.7
JAUNDICE	3	7.7	7.7	56.4
BILOMA	10	25.6	25.6	82.1
ABDOMINAL PAIN	3	7.7	7.7	89.7
BILE LEAK FROM THE WOUND	1	2.6	2.6	92.3
ABNORMAL LFTs	2	5.1	5.1	97.4
SUBHEPATIC ABSCESS	1	2.6	2.6	100.0
Total	39	100.0	100.0	100.0



All patients with a bile duct injury underwent abdominal ultrasonography, abdominal CT scan and MRCP. Nine patients underwent ERCP, and seven patients required PTC to achieve complete preoperative cholangiography or preoperative biliary drainage. Ten patients required preoperative percutaneous drainage of a biloma, and one patient required preoperative percutaneous drainage of a subhepatic abscess (Table IV).

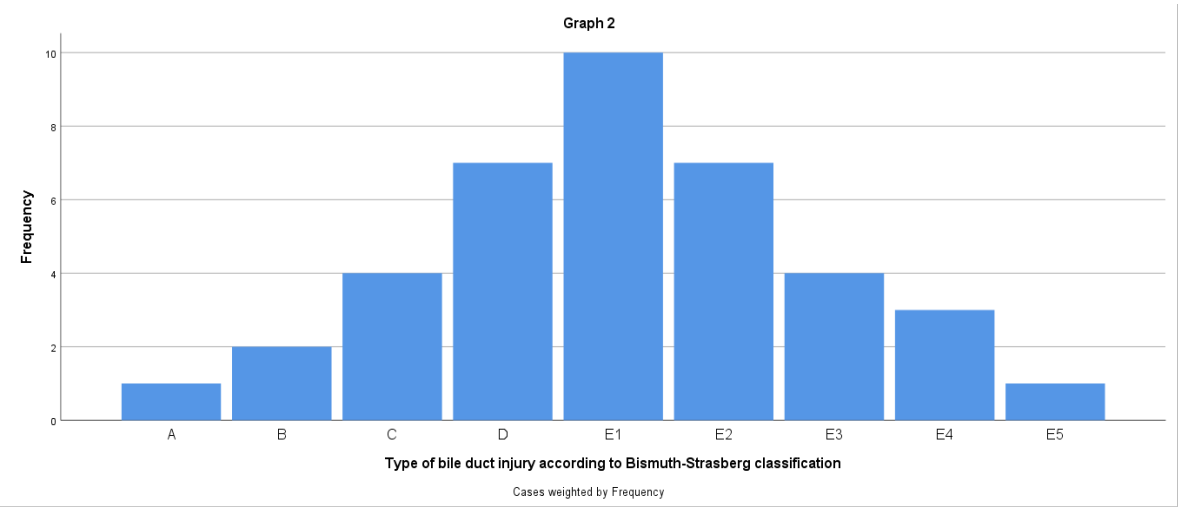
The bile duct injuries were classified using the Bismuth-Strasberg classification of bile duct injury, ranging from type A to type E. Most of the injuries were type E (64.1%), and the most common type of injury was type E1 (25.6%) (Table-V and graph-2).

Table IV Preoperative imaging and percutaneous drainage

	Frequency	%
Abdominal US	All	100
Abdominal CT scan	All	100
MRCP	All	100
ERCP	9	23.1
PTC	7	18.0
Percutaneous drainage of biloma	10	25.6
Percutaneous drainage of abscess	1	2.6

Table V. Type of bile duct injury according to Bismuth-Strasberg classification.

Bismuth-Strasberg type	Frequency	Percent	Valid Percent	Cumulative Percent
Type A	1	2.6	2.6	2.6
Type B	2	5.1	5.1	7.7
Type C	4	10.3	10.3	17.9
Type D	7	17.9	17.9	35.9
Type E1	10	25.6	25.6	61.5
Type E2	7	17.9	17.9	79.5
Type E3	4	10.3	10.3	89.7
Type E4	3	7.7	7.7	97.4
Type E5	1	2.6	2.6	100.0
Total	39	100.0	100.0	



Study variables and statistical analysis

Study variables included patient's demographic characteristics, type of primary operation, onset of recognition of the injury, time from injury to referral, referral hospital, presentation, diagnostic procedures, type of bile duct injury according to Bismuth-Strasberg classification and postoperative complications defined by Clavien-Dindo classification. The primary endpoint of the study was the comparison of mortality as well as the early and long-term outcomes between patients who underwent early or delayed reconstruction of the bile duct injury.

Patients were divided into two groups based on the timing of definitive biliary repair or reconstruction: early (≤ 6 weeks after index procedure) and delayed (> 6 weeks after index procedure). Data analyses were performed with IBM SPSS Statistics version 25. Continuous and categorical variables were presented as means, medians,ranges,counts, and percentages, respectively. Categorical variables were analyzed using Fisher's exact test. A $P < 0.05$ was considered statistically significant.

RESULTS

The study cases included 39 patients with major bile duct injuries, and complete preoperative cholangiography was achieved in almost all cases by MRCP, PTC or ERCP. All patients (10 cases) with intra-abdominal collections underwent preoperative percutaneous drainage of bile collections, and one patient required preoperative percutaneous drainage of a subhepatic abscess. Twenty patients underwent early biliary reconstruction within 6 weeks of the injury (median time from injury to repair 2 weeks), and 19 patients underwent late biliary reconstruction after 6 weeks, ranging from 6 to 27 weeks (median time from injury to repair 13 weeks). A total of 38 patients were managed by end-to-side Roux-en-Y hepaticojejunostomy using interrupted single layer absorbable 4-0 to 6-0 sutures, and one patient with a type A injury was managed by laparoscopic suture closure of the cystic duct after failure of endoscopic management of the bile leak using endobiliary stent and percutaneous drainage of a biloma for 9 weeks. The mean follow-up period of patients was 32 months (18– 67 months).

Wound infection occurred in two cases and was managed by wound drainage and intravenous antibiotics (one in the early repair group and one in the late repair group), and the difference was statically insignificant (95% CI, $P = 1.0000$). Five patients developed cholangitis postoperatively (three in the early repair group and two in the late repair group), and the difference was also statically insignificant (95%

CI, *P* = 1.0000). Seven patients developed anastomotic strictures. Five of these patients were managed successfully by percutaneous dilatation and endobiliary stenting, while two patients required revision of the anastomosis due to failure of stricture dilatation by PTC (one in the early repair group and one in the late repair group), which was statically insignificant (95% CI, *P* = 0.6948). One patient in the early repair group required surgical revision of the hepaticojejunostomy due to a bile leak from a disrupted repair, which was statically insignificant (95% CI, *P* = 1.0000). The overall postoperative complication rate was 42.6% (18/39 patients), with 10 patients in the early repair group and eight patients in the late repair group (95% CI, *P* = 0.7512). Successful surgical reconstruction was possible in 18 of 20 early surgical repairs compared with 18 of 19 delayed surgical repairs (95% CI, *P* = 1.0000). There was no mortality among both groups in the early perioperative period (Table VI).
The mean follow-up of patients was 32 months (18– 67 months).

Table VI Postoperative complications and surgical outcomes

	n = 39	Early repair group (n = 20)	Late repair group (n = 19)	*P*
Wound infection	2 (5.1%)	1	1	1.0000
Cholangitis	5 (12.8%)	3	2	1.0000
Stricture	7 (17.9%)	3	4	0.6948
Major bile leak	1 (2.6%)	1	0	1.0000
Revision of the hepaticojejunostomy	3 (7.7%)	2 (1 stricture and 1 bile leak)	1 (stricture)	1.0000
Overall postoperative complication rate	18/39 (46.2%)	10/10 (50%)	8/19(42.1%)	0.7512
Successful surgical repair	36 (92.3%)	18/20 (90)	18/19 (94.7%)	1.0000

DISCUSSION

There is a great frequency of cholecystectomy worldwide. Gallstones are extremely common in Western society, approximately 15% of the American population is found to have gallstones, and over 700,000 cholecystectomies are performed every year in the United States [8]. This operation remains the most common cause of bile duct injury [9], and with the introduction of the laparoscopic approach, the incidence of bile duct injury has increased substantially [9].
The incidence of bile duct injury following open cholecystectomy is between 0.1% and 0.2%. In comparison, laparoscopic cholecystectomy has a reported incidence of bile duct injury between 0.3% and 0.7%. Suspicion bile duct injuries and appropriate early referral can reduce the chances of litigation [10,11]. It has been suggested that at least half of all general surgeons may encounter bile duct injuries during their surgical career [12]. Other causes of biliary injury include biliary surgery (such as choledochotomy) or surgeries involving organs in the upper abdomen (such as gastric, pancreatic, hepatic surgeries), liver transplantation and hepatoduodenal ligament lymphadenectomy [13,14].

Bile duct injury is associated with several factors, and the most frequent cause is the classical Davidoff injury, which is the misidentification of the bile duct as the cystic duct at its insertion into the common hepatic duct (visual perception illusion) resulting in clipping, ligating and dividing of these structures [15]. Damage to the pericholedochal arterial plexus from excessive dissection along the common bile duct is another potential cause of bile duct injury [16], and obliteration of Calot's triangle by dense fibrosis and inflammation secondary to acute and chronic inflammatory processes increases the risk of bile duct injury [17]. Based on the location of bile duct injury , width of bile duct injury, mechanism of injury and associated vascular injury, as well as the complexity of bile duct injury, several classification systems have been devised, such as the Corlette-Bismuth classification, Strasberg classification, McMahon classification, Stewart-Way classification and Hannover classification [18–21]. However, none of these proposed classifications are ideal or address all of the issues previously mentioned (figures 1-4).

Figure 1: Intraoperative image of bile duct injury (Strasberg type E4) in a patient presented with obstructive jaundice.

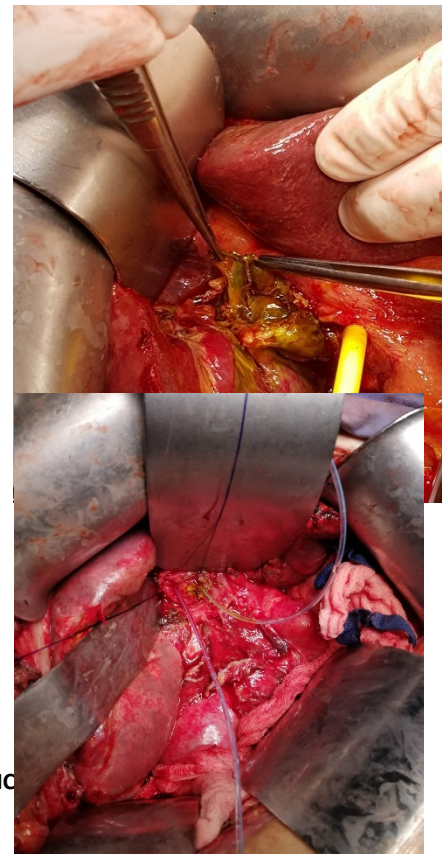


Figure 2: Intraoperative image of bile duct injury with a clip at the right hepatic artery (Hannover type C4dbileduct injury) in a patient presented with obstructive jaundice and mildly elevated liver transaminases.

Figure 3: Intraoperative image of bile duct injury (Strasberg type E4) in a patient presented with obstructive jaundice.

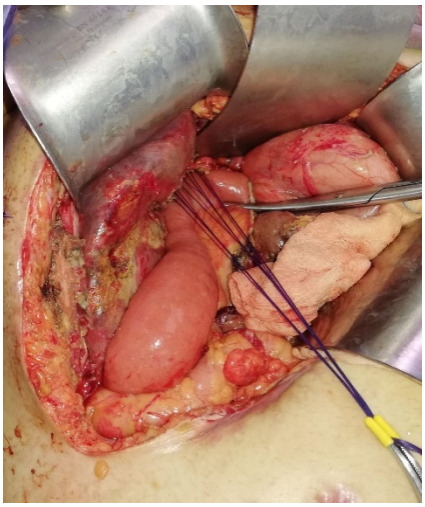


Figure 4: Intraoperative image of bile duct injury (Strasberg type E4)managed by hepaticojejunostomy.

The timing of bile duct repair after a bile duct injury sustained during a cholecystectomy is still a matter of debate, and several studies have investigated the timing of biliary reconstruction in terms of outcomes. Several series have reported negative outcomes for early biliary reconstruction performed within 6 weeks of the injury [22–25]. Others have reported the best outcomes for repair in the immediate period (< 72 hours after the injury) or after 6 weeks due to significant associations with biliary stricture during early repair (> 72 hours and<6 weeks after the injury) [26]. Some series have also reported worse outcomes during early repair [27], whereas others have shown no differences in outcomes related to the timing of the repair [28–30]. A recent systemic review and meta-analysis by Wang et al. found early referral and delayed repair were associated with the most favourable outcomes [31].

Biliary reconstruction in most of the cases was challenging because of the high level of injury and presence of concomitant inflammation and intra-abdominal infections. We think that successful repair in these cases requires a multidisciplinary team [32,33], experienced biliary surgeon and complete preoperative management, including control of intra-abdominal collections and complete preoperative images.

In our study, successful biliodigestive flow was established in 36/39 patients (91%) with no statistical differences in the early or late repair groups. We did not find any correlation between the timing of biliary repair, postoperative complications and successful surgical repair. If the patient's condition is optimized

prior to the operation and complete preoperative cholangiography is achieved to guide the plane of surgery, the success of surgical biliary repair has no significant differences regarding early vs. late repair.

CONCLUSSION

Early surgical repair of biliary injury is successful in most of the cases when undertaken by a hepatobiliary surgeon, with early referral to a tertiary care centre, and the outcome is similar to that of delayed repair when the patient's condition is optimized and complete preoperative cholangiography is achieved.

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