

Research Article

Injuries of Bile Duct in Laparoscopic Cholecystectomy: Incidence, Risk Factors and Management Strategies

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ABSTRACT

Background: Laparoscopic cholecystectomy is the gold standard for the treatment of gallstone disease; however, bile duct injury remains a serious complication associated with significant morbidity.

Objective: To determine the incidence, risk factors, and management strategies of bile duct injuries following laparoscopic cholecystectomy.

Methods: This was a retrospective observational study conducted at Department of Surgery, Sughra Shafi Medical Complex/Sahara Medical College, Narowal Pakistan from 1st March 2025 to 31st August 2025 including 210 patients who underwent laparoscopic cholecystectomy.

Results: The incidence of bile duct injury was 12 (5.7%). The most common injury was minor bile leak (2.4%), followed by partial transection (1.4%), complete transection (1%), and stricture formation (1%). Most injuries were detected postoperatively (3.8%). Significant risk factors included body mass index >30 kg/m² (50% vs 26.3%, p=0.048), emergency surgery (58.3% vs 20.7%, p=0.006), presence of inflammation (75.0% vs 31.3%, p=0.002), and surgeon experience <5 years (66.7% vs 27.3%, p=0.004). Management included endoscopic retrograde cholangiopancreatography with stenting (41.7%), surgical repair (33.3%), and conservative treatment (25.0%).

Conclusion: Bile duct injury is an uncommon but significant complication of laparoscopic cholecystectomy, with higher risk in difficult and emergency cases. Early recognition and appropriate management, particularly endoscopic and surgical interventions, are essential for favorable outcomes.

Keywords: Laparoscopic cholecystectomy, Bile duct injury, Incidence, Risk factors, Endoscopic retrograde cholangiopancreatography (ERCP), Surgical management

INTRODUCTION

Laparoscopic cholecystectomy is currently the procedure of choice for symptomatic gallbladder stones as it is associated with less postoperative pain, shorter length of hospital stay and quicker return to work compared to the open procedure.¹ Since its introduction, it has gained worldwide acceptance and is one of the most common abdominal procedures.² Despite the benefits of laparoscopic cholecystectomy, it is associated with some complications, one of which is bile duct injury which is one of the most serious and feared complications.³ Bile duct injuries associated with laparoscopic cholecystectomy may be severe, lead to complications and even death.⁴ The reported rate of the bile duct injury is between 0.3% and

0.8, which is slightly more common than open cholecystectomy.⁵ The injuries may cause bile leakage, strictures, recurrent cholangitis, secondary biliary cirrhosis and may require complex surgical procedures.⁶ The etiology of bile duct injuries is complex and is associated with poor recognition of the anatomical structures of the hepatobiliary triangle.⁷ Variations in biliary anatomy, inflammation (acute or chronic cholecystitis) and technical factors during surgery are also part of the risk factors.⁸ In particular, failure to achieve the so-called critical view of safety has been one of the main risk factors for ductal injuries.⁹

There are several known risk factors for bile duct injury. Male sex, obesity, previous upper abdominal surgeries and excessive

inflammation or fibrosis around gallbladder are patient risk factors.¹⁰ Surgeon inexperience, mis-use of technique and lack of visualisation of Calot triangle are other factors.¹¹ Surgery and challenging gallbladders also increase the complications.¹² Early detection of bile duct injuries is important for the best outcome. However, many injuries remain undiscovered during the surgery and may be diagnosed later, presenting with abdominal pain, jaundice, bile leak or sepsis.¹³ This delay in diagnosis is associated with a poor outcome and the need for complex surgery.¹⁴ So, a high index of suspicion and good post-operative care is important. Bile duct injuries are treated according to the nature, extent and timing of the injury. Minor injuries can be managed conservatively or by endoscopic means using endoscopic retrograde cholangiopancreatography and stenting.¹⁵ On the other hand, large injuries would typically require surgery for reconstruction but hepaticojejunostomy is most frequent and can be considered as the definitive treatment.¹⁶

MATERIALS AND METHODS

This was a retrospective observational study conducted at Department of Surgery, Department of Surgery, Sughra Shafi Medical Complex/Sahara Medical College, Narowal Pakistan from 1st March 2025 to 31st August 2025. A total of 210 patients who underwent laparoscopic cholecystectomy were enrolled. All patients of either gender who underwent laparoscopic cholecystectomy, aged ≥ 18 years, complete medical records including operative details and postoperative follow-up and diagnosed with gallstone disease undergoing elective or emergency surgery were included. Patients who had primary open cholecystectomy, known bile duct cancer, were lost to follow-up, had inadequate documentation or had a bile duct injury prior to cholecystectomy were excluded. The data collection was done from medical records. Demographic data age, sex, indication for surgery, elective or emergency surgery, intraoperative findings, presence of inflammation or adhesions and experience of surgeon were also collected. Information about bile duct injury, including the nature or type of the injury, the time of diagnosis (intraoperative/late), and presenting symptoms were noted. Treatment approaches, including conservative management, endoscopic

procedures (e.g., ERCP and stent placement), and surgical interventions (e.g., bile duct repair) were recorded. Information on complications, length of stay and recovery was also recorded. Data were entered into and analysed using SPSS version 26.0. Chi-square or Fisher's exact test was used to test the association between risk factors and bile duct injury. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS

The mean age was 45.8 ± 13.2 years. Most patients were aged 41–60 years (44.8%), followed by ≤ 40 years (37.1%) and > 60 years (18.1%). Females predominated (65.7%) compared to males (34.3%). The mean BMI was 27.6 ± 4.8 kg/m², with 72.4% having BMI ≤ 30 kg/m². The majority of procedures were elective (77.1%), while 22.9% were emergency. The most common indication was symptomatic cholelithiasis (60.0%), followed by acute (24.8%) and chronic cholecystitis (15.2%) [Table 1].

Bile duct injury was occurred in 12 patients, giving an incidence of 5.7%, while 94.3% had no injury. Among injuries, minor bile leak was most common (2.4%), followed by partial transection (1.4%), complete transection (1.0%), and stricture formation (1.0%). Most injuries were detected postoperatively (3.8%) compared to intraoperatively (1.9%), indicating delayed recognition in the majority of cases (Table 2).

Risk factor analysis showed that bile duct injury was more frequent in patients with BMI > 30 kg/m² (50.0% vs 26.3%, $p=0.048$), emergency surgeries (58.3% vs 20.7%, $p=0.006$), and presence of inflammation (75.0% vs 31.3%, $p=0.002$). Injuries were also significantly higher when performed by less experienced surgeons (< 5 years) (66.7% vs 27.3%, $p=0.004$). Age and gender did not show statistically significant association with injury occurrence ($p>0.05$) [Table 3].

Among the 12 patients with bile duct injury, the most common management approach was ERCP with stenting (41.7%), followed by surgical repair (33.3%) and conservative treatment (25.0%). Postoperative complications included bile leak (33.3%), wound infection (16.7%), and stricture (16.7%), while 33.3% had no complications (Table 4)

Table 1: Baseline Demographic and Clinical Characteristics (n = 210)

Variable	No.	%
Age Group		
≤40 years	78	37.1
41–60 years	94	44.8
>60 years	38	18.1
Gender		
Male	72	34.3
Female	138	65.7
Body mass index Category		
≤30 kg/m ²	152	72.4
>30 kg/m ²	58	27.6
Type of Surgery		
Elective	162	77.1
Emergency	48	22.9
Indication		
Symptomatic cholelithiasis	126	60.0)
Acute Cholecystitis	52	24.8
Chronic Cholecystitis	32	15.2

Table 2: Incidence and type of bile duct injury (n = 210)

Variable	No.	%
Bile Duct Injury		
Present	12	5.7
Absent	198	94.3
Type of Injury		
Minor Leak	5	2.4
Partial Transection	3	1.4
Complete Transection	2	1.0
Stricture Formation	2	1.0
Timing of Detection		
Intraoperative	4	1.9
Postoperative	8	3.8

Table 3: Risk factors associated with bile duct injury

Variable	Category	Injury		P value
		Present (n=12)	Absent (n=198)	
Age Group	≤40 years	3 (25%)	75 (37.9%)	0.412
	41–60 years	6 (50%)	88 (44.4%)	0.701
	>60 years	3 (25%)	35 (17.7%)	0.456
Gender	Male	5 (41.7%)	67 (33.8%)	0.581
	Female	7 (58.3%)	131 (66.2%)	0.581
Body mass index	>30 kg/m ²	6 (50%)	52 (26.3%)	0.048
Surgery Type	Emergency	7 (58.3%)	41 (20.7%)	0.006
	Elective	5 (41.7%)	157 (79.3%)	0.006
Inflammation	Present	9 (75%)	62 (31.3%)	0.002
Surgeon Experience	<5 years	8 (66.7%)	54 (27.3%)	0.004
	≥5 years	4 (33.3%)	144 (72.7%)	0.004

Table 4: Management strategies and outcomes of bile duct injury (n = 12)

Variable	No.	%
Management approach		
Conservative	3	25.0
ERCP + Stenting	5	41.7
Surgical repair (Hepaticojejunostomy)	4	33.3
Postoperative complications		
Bile Leak	4	33.3
Wound Infection	2	16.7
Stricture	2	16.7
No Complications	4	33.3
Outcome		
Recovered	10	83.3
Morbidity (Persistent Issues)	2	16.7
Mortality	-	-
Hospital stay (days)	9.8±4.2	

DISCUSSION

The incidence of bile duct injury in the present study was 12 (5.7%) and this is higher than the reported incidence of 0.3-0.8% in literature. This can be attributed to the fact that the cases were different, there were more complex cases and also that the experience of surgeons is different. The current studies have also been backed up by other studies that show that the rates are higher in settings where there are more emergency surgeries and when the gallbladder pathology is complicated.¹⁷ In this study, minor bile leak (2.4) was the most common type of injury followed by partial transection (1.4), complete transection (1.0), and stricture formation (1.0). The dominance of minor injuries suggests that there were large numbers of injuries that were not major and could be managed non-operatively. Previous research also indicates that bile leak is one of the common presentation of bile duct injuries, especially in the early postoperative period.¹⁸ A significant finding from this study was the fact that most of the injuries were detected in the postoperative (3.8%) rather than intraoperative (1.9). This highlights the concern of early recognition of injury and need for postoperative awareness. Previous studies have also shown that many bile duct injuries are not identified and are shown later with complications like leak of bile, pain or jaundice which cause a delayed diagnosis and morbidity.¹⁹ We have also studied the risk factors and found that obesity (BMI >30 kg/m²), emergency surgery, inflammation during surgery and the

experience of surgeons were the significant factors for predicting bile duct injuries. 50.0% of injured patients were obese (BMI >30 kg/m²) compared to 26.3% of the patients who had no injuries (p=0.048) and 58.3% of injuries were due to emergency surgery when compared to 20.7% of uninjured patients (p=0.006). In 75.0% of the injuries versus 31.3% of the non-injuries, there was inflammation and 66.7% of the injuries were incurred in surgeries performed by less experienced surgeons (less than 5 years of experience) (p=0.004). Our results are in line with other studies that have shown difficult anatomy, inflammation and surgeon experience as important risk factors for bile duct injuries.²⁰

The approaches used in the present study were determined by injury severity. The most common management strategies were ERCP and stenting (41.7%), surgical repair (33.3%) and conservative management (25.0%). This is a reflection of less invasive treatment for less severe injuries. Previous studies have also shown that endoscopic management is successful for the treatment of bile leak and minor injuries but major injuries may require surgical reconstruction such as hepaticojejunostomy.²¹ Bile leak, wound infection and stricture were 33.3, 16.7 and 16.7 per cent, respectively, in patients, and 33.3 per cent had no complications. The average relative hospital stay was 9.8±4.2 days, which is the additional cost of bile duct injury. Other reports also demonstrated the high hospital stay and complications in patients with bile duct injuries, particularly

when the injury is diagnosed late.²² Despite these complications, the overall recovery in this study was good (83.3%) and there was no mortality. There was a 16.7% rate of ongoing morbidity. These outcomes can be attributed to the early intervention and management. Other studies also indicate that early diagnosis and interdisciplinary treatment have a significant positive impact on patient outcomes and reduce complications. In summary, the findings of this study suggest that bile duct injury is a serious complication of laparoscopic cholecystectomy, particularly in high-risk conditions such as emergency procedure, obesity and inflamed gallbladder. The results are consistent with other research, and it is important for the surgeon to have good skills and perform the surgery carefully and identify the injury early to minimise complications and improve the outcomes.

CONCLUSION

Bile duct injury remains an important complication of laparoscopic cholecystectomy, with an incidence of 5.7% observed in this study. The risk of injury was significantly higher in patients with obesity (BMI >30 kg/m²), those undergoing emergency procedures, cases with marked inflammation, and surgeries performed by less experienced surgeons. Most injuries were detected postoperatively, highlighting the need for careful intraoperative assessment and vigilant postoperative monitoring. Endoscopic retrograde cholangiopancreatography with stenting was the most commonly employed management strategy, while major injuries required surgical repair.

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