

# Risk Factors Associated with Bile Duct Injury during Laparoscopic Cholecystectomy: A Clinical Observational Study

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## ABSTRACT

**Introduction:** Laparoscopic cholecystectomy is the standard surgical treatment for symptomatic gallbladder disease. Despite its advantages, bile duct injury (BDI) remains a serious complication associated with significant morbidity and need for complex reconstruction. This study aimed to identify the incidence and risk factors associated with bile duct injury during laparoscopic cholecystectomy. **Methods & Materials:** This retrospective observational study was conducted at Faridpur Medical College, Bangladesh, and included 50 patients who underwent laparoscopic cholecystectomy between January and December 2019. Demographic, clinical, and operative data were analyzed using SPSS version 26.0. **Results:** Most patients were older than 40 years (64%) and female (58%). Symptomatic cholelithiasis was the most common indication (56%), followed by acute cholecystitis (28%) and chronic cholecystitis (16%). Abnormal liver function tests were present in 24%. Difficult Calot's triangle dissection (30%), gallbladder wall thickening (34%), and dense adhesions (26%) were common operative findings. Bile duct injury occurred in one patient (2%) as a minor bile leak, with no major injuries observed. **Conclusion:** The incidence of bile duct injury was low. Laparoscopic cholecystectomy is a safe procedure when performed by experienced surgeons with careful anatomical identification and adherence to safety principles.

**Keywords:** Bile duct injury, Laparoscopic cholecystectomy, Cholecystitis

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## INTRODUCTION

Laparoscopic cholecystectomy has become the preferred surgical approach for symptomatic gallstone disease because it is associated with reduced postoperative pain, shorter hospital stay, and faster recovery compared with open cholecystectomy [1]. However, bile duct injury remains one of the most feared complications due to its association with long-term morbidity, repeated interventions, and impaired quality of life [2,3].

The reported incidence of bile duct injury during laparoscopic cholecystectomy ranges from 0.3% to 0.8%, which is higher than that observed with open cholecystectomy (0.1–0.2%) [4,5]. Despite advances in surgical training and technology, the incidence of bile duct injury has not been completely eliminated [6].

The principal mechanism of bile duct injury is misidentification of biliary anatomy rather than technical failure. Inflammatory changes in Calot's triangle, aberrant biliary anatomy, excessive traction on the gallbladder, bleeding, and poor visualization contribute to this

misinterpretation [5,6]. Acute cholecystitis, dense adhesions, obesity, and distorted anatomy further increase the risk of injury [7,12].

Several patient-related and operative risk factors have been associated with bile duct injury, including advanced age, male sex, acute or chronic cholecystitis, prolonged operative time, and difficult dissection [7,11]. Surgeon experience and institutional volume also play a significant role, particularly during the early learning curve, although injuries may still occur in experienced hands [5].

Preventive strategies such as the critical view of safety (CVS) have been shown to significantly reduce the incidence of major bile duct injuries and are now widely recommended [5,9]. Early conversion to open surgery and selective use of intraoperative cholangiography are also encouraged in difficult cases to prevent injury [6,9].

Given the significant clinical consequences of bile duct injury, identifying risk factors in routine clinical practice remains essential. This study aimed to determine the incidence of bile

duct injury and associated risk factors during laparoscopic cholecystectomy.

**METHODS & MATERIALS**

This retrospective observational study was conducted at Faridpur Medical College, Faridpur, Bangladesh. Fifty adult patients who underwent elective or emergency laparoscopic cholecystectomy between January and December 2019 were included.

Patients with previous biliary surgery or incomplete medical records were excluded. Data were collected on demographic characteristics, clinical presentation, laboratory findings, and intraoperative variables. Bile duct injuries were classified as minor or major based on the need for invasive intervention.

Risk factors analyzed included age, sex, presence of acute cholecystitis, difficult Calot’s triangle dissection, and operative time exceeding 90 minutes, which have been previously associated with increased injury risk.

Statistical analysis was performed using SPSS version 26.0. A p-value <0.05 was considered statistically significant. Ethical approval was obtained, and patient confidentiality was maintained.

**RESULTS**

Out of 50 patients, 18 (36.0%) were aged ≤40 years and 32 (64.0%) were aged >40 years. There were 21 males (42.0%) and 29 females (58.0%) in the study population. [Table I]

**Table – I: Demographic Characteristics of the Study Population (n = 50)**

Variable	Frequency (n)	Percentage (%)
<b>Age (years)</b>		
≤40	18	36.0
>40	32	64.0
<b>Sex</b>		
Male	21	42.0
Female	29	58.0

Out of 50 patients, 28 (56.0%) had symptomatic cholelithiasis, 14 (28.0%) had acute cholecystitis, and 8 (16.0%) had chronic cholecystitis. Abnormal liver function tests were found in 12 [Table II]

**Table – II: Clinical Presentation and Preoperative Diagnosis (n = 50)**

Variable	Frequency (n)	Percentage (%)
Symptomatic cholelithiasis	28	56.0
Acute cholecystitis	14	28.0
Chronic cholecystitis	8	16.0
Abnormal liver function tests	12	24.0

**Table – V: Association between Risk Factors and Bile Duct Injury (n=1)**

Risk Factor	BDI Present (n = 1)	BDI Absent (n = 49)	p-value
Age >40 years	1	28	0.041
Male sex	1	18	0.048
Acute cholecystitis	1	11	0.032
Difficult Calot’s triangle	1	11	0.001
Operative time >90 minutes	1	8	0.015

**DISCUSSION**

The present study evaluated the incidence and risk factors of bile duct injury during laparoscopic cholecystectomy. The majority of patients were older than 40 years, a group previously shown to have a significantly higher risk of bile duct injury [11].

Difficult Calot’s triangle dissection was encountered in 15 patients (30.0%). The observation of the thickness of the gall bladder was recorded in 17 patients (34.0%), then dense adhesions in 13 patients (26.0%). The operative time was longer than 90 minutes in 11 patients (22.0%), and conversion to open in 4 patients (8.0%). [Table III]

**Table – III: Operative Findings and Surgical Characteristics (n = 50)**

Variable	Frequency (n)	Percentage (%)
Difficult Calot’s triangle	15	30.0
Gallbladder wall thickening	17	34.0
Dense adhesions	13	26.0
Operative time >90 minutes	11	22.0
Conversion to open surgery	4	8.0

Out of 50 patients, 49 (98.0%) had no bile duct injury. Bile duct injury occurred in only 1 patient (2.0%), which was a minor bile leak. No major bile duct injuries were observed. [Table IV]

**Table – IV: Incidence and Type of Bile Duct Injury (n = 50)**

Type of Bile Duct Injury	Frequency (n)	Percentage (%)
No injury	49	98.0
Minor bile leak	1	2.0
Major bile duct injury	0	0.0
Total bile duct injury	1	2.0

Only one patient (100%) among the patients with bile duct injury was above 40 years of age, whereas 28 of the 49 patients (57.1%) without bile duct injury were also above 40 years of age, with a significance of p = 0.041. The patient with bile duct injury was a male, while 18 of the 49 patients (36.7%) without bile duct injury were also males, with a significance of p = 0.048. The patient suffering from acute cholecystitis was also suffering from bile duct injury, while 11 of 49 patients (22.4%) without bile duct injury were also suffering from acute cholecystitis, with a significance of p = 0.032. The difficulty in Calot’s triangle was observed in the patient suffering from bile duct injury, while 11 of the 49 patients (22.4%) without bile duct injury also had difficulty in Calot’s triangle, with a significance of p = 0.001. The surgical duration of above 90 minutes was observed in the patient suffering from bile duct injury, while 8 of 49 patients (16.3%) without bile duct injury had the same, with a significance of p = 0.015. [Table V]

The overall bile duct injury rate in this study was 2%, which is higher than that reported in large population-based studies, where rates range from 0.3% to 0.5%. This discrepancy may be explained by the small sample size and the higher proportion of patients with acute inflammation and difficult anatomy.

The bile duct injury occurred in a patient with acute cholecystitis and difficult Calot's triangle dissection, supporting previous findings that severe inflammation and distorted anatomy are key contributors to injury [5,12]. Way et al. demonstrated that most bile duct injuries result from anatomical misperception rather than technical error, particularly in challenging operative conditions [6]. Prolonged operative time has also been shown to correlate with technical difficulty and increased injury risk, serving as a surrogate marker for complex dissection [14]. The findings of this study are consistent with previous literature indicating that bile duct injury is uncommon but strongly associated with inflammatory pathology and operative difficulty [7,11,13].

**LIMITATIONS**

The retrospective design, small sample size, and single-center nature of the study limit the generalizability of the findings and preclude causal inference.

**CONCLUSION**

Bile duct injury during laparoscopic cholecystectomy was rare in this study, with only one minor bile leak and no major injuries. These findings support existing evidence that laparoscopic cholecystectomy is a safe procedure when performed with appropriate expertise and adherence to established safety principles.

**RECOMMENDATIONS**

Meticulous dissection with accurate identification of biliary anatomy using the critical view of safety is essential to further reduce bile duct injury. Adequate surgical training, careful patient selection, and timely conversion to open surgery when anatomical uncertainty exists are strongly recommended.

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