

Research Article

Incidence and Early Management of Post-Cholecystectomy Bile Duct Injury

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ABSTRACT

Background: Bile duct injury (BDI) is an uncommon but potentially devastating complication of cholecystectomy that carries substantial risk of long-term morbidity when recognition or repair is delayed¹, and outcomes are strongly influenced by injury grade, timing of diagnosis, and the expertise of the treating team².

Objectives: To determine the incidence of bile duct injury among patients undergoing cholecystectomy at a tertiary care centre, and to describe the clinical profile, management strategies and outcomes of the affected patients.

Methods: This retrospective observational study analysed a masterchart of 150 consecutive patients who underwent open or laparoscopic cholecystectomy at this tertiary care centre over the study period. Patients who developed bile duct injury were identified from this cohort, and data on their Strasberg classification, timing and mode of presentation, procedure performed, postoperative complications, hospital stay, and follow-up outcome were extracted and analysed descriptively.

Results: Of the 150 patients who underwent cholecystectomy, the mean age was 46.8 ± 15.5 years, with a female preponderance (68.0%), and the index procedure was performed laparoscopically in 84.0%. Bile duct injury occurred in 4 of 150 patients, an overall incidence of 2.7%. Among these four patients, Strasberg type E2 injury was the commonest (2 of 4, 50.0%), with one type E1 and one type D injury (25.0% each). Injury was recognised intraoperatively in 1 patient; among the remaining three, diagnosis was most often made between postoperative days 4-7 (2 of 4, 50.0%). Jaundice and bile leak were the leading modes of clinical presentation. Roux-en-Y hepaticojejunostomy was performed in 2 of 4 patients (50.0%), with primary repair and ERCP with stenting used in one patient each. One patient (25.0%) developed a postoperative bile leak that resolved with conservative management; the mean hospital stay among the four affected patients was 10.5 ± 3.2 days. At follow-up, all four patients (100%) had normal liver function tests and patent biliary drainage; three (75.0%) were classified as fully recovered and one (25.0%) recovered after a secondary endoscopic intervention.

Conclusion: Bile duct injury occurred in a small minority of patients (2.7%) undergoing cholecystectomy at this centre. Structured, early referral-based management tailored to Strasberg grade was associated with excellent recovery and low morbidity in all affected patients, reinforcing the case for prompt recognition and centralised repair of this complication.

Keywords: Bile Duct Injury, Cholecystectomy, Incidence, Strasberg Classification, Hepaticojejunostomy, Hepatobiliary Surgery.

INTRODUCTION

Bile duct injury (BDI) remains one of the most feared complications of cholecystectomy, and its incidence rose after the widespread adoption of the laparoscopic approach, largely attributable to misidentification of anatomy in Calot's triangle¹. Contemporary large-volume series report a laparoscopic BDI incidence of approximately 0.3–0.6%, considerably higher than that historically observed with open cholecystectomy⁶, underscoring that, even at a busy surgical unit, only a small proportion of patients undergoing cholecystectomy will go on to develop this complication.

The Strasberg classification remains the most widely used system for grading the anatomical extent of injury and for guiding management decisions, ranging from minor cystic duct leaks (type A) to complete transection with vascular involvement (type E)¹, and has since been supplemented by refinements addressing associated vascular injury⁴. Injury grade, together with the timing of recognition, is consistently reported as the strongest predictor of long-term outcome³.

Delayed diagnosis remains common because early symptoms such as vague abdominal pain, low-grade fever or mild jaundice are frequently

mistaken for routine postoperative recovery⁵. Multiple series have demonstrated that repair undertaken at the index, non-specialist centre by the operating surgeon is associated with markedly inferior outcomes compared with early referral to a specialised hepatobiliary unit¹⁰, and immediate expert repair after recognition is associated with improved long-term patency and quality of life¹².

Roux-en-Y hepaticojejunostomy remains the mainstay of definitive repair for major ductal injuries, while endoscopic stenting and primary repair over a T-tube are reserved for selected partial or cystic duct-type injuries⁹. Long-term follow-up studies, including large national cohorts, have shown that even successfully repaired patients remain at risk of late anastomotic stricture and reduced quality of life, underscoring the importance of structured surveillance¹⁴.

Given the continuing relevance of BDI as a preventable but consequential complication, this study was undertaken to determine its incidence and to describe the clinical spectrum, management approach and short-to-medium-term outcomes among 150 patients undergoing cholecystectomy at our tertiary hepatobiliary referral centre.

MATERIALS AND METHODS

This retrospective observational study was conducted in the Department of General Surgery at a tertiary care hepatobiliary referral centre. A structured masterchart of 150 consecutive patients who underwent open or laparoscopic cholecystectomy at this institution over the study period was reviewed, and patients who developed bile duct injury, whether recognised intraoperatively or

postoperatively, were identified from this cohort.

For the overall cohort, data were recorded on age, sex and type of cholecystectomy (open or laparoscopic). For the subset of patients who developed bile duct injury, additional data were recorded on Strasberg classification of the injury, time interval to diagnosis (intraoperative or postoperative day of recognition), mode of clinical presentation, definitive management or procedure performed, type of repair, postoperative complications, duration of hospital stay, and follow-up findings including liver function tests, biliary drainage status on imaging, and final clinical outcome at last follow-up (ranging from 6 to 12 months).

Data were entered into a structured spreadsheet and analysed descriptively using frequencies and percentages for categorical variables, and mean $\pm$ standard deviation for continuous variables (age and hospital stay). Given the small number of patients who developed bile duct injury, no inferential statistical comparisons were performed and findings for this subgroup are presented descriptively.

RESULTS

A total of 150 patients underwent cholecystectomy during the study period. The mean age of the overall cohort was 46.8 ± 15.5 years (range 23–75 years), with a female preponderance of 68.0%. The index cholecystectomy was performed laparoscopically in 126 patients (84.0%) and via an open approach in 24 (16.0%). Bile duct injury occurred in 4 of these 150 patients, an overall incidence of 2.7% (Table 1).

Table 1: Baseline characteristics of the overall cholecystectomy cohort and incidence of bile duct injury (n = 150)

Variable	Category	Frequency	Percentage (%)
Age (years)	Mean $\pm$ SD	46.8 ± 15.5	–
	Range	23–75	–
Sex	Female	102	68.0
	Male	48	32.0
Type of cholecystectomy	Laparoscopic	126	84.0
	Open	24	16.0
Bile duct injury	Present	4	2.7
	Absent	146	97.3

The remaining results (Tables 2–5) describe the clinical profile, management and outcomes of the 4 patients who developed bile duct injury.

Strasberg Classification of Injury

Strasberg type E2 injury was the commonest, occurring in 2 of 4 patients (50.0%), with one type E1 injury (25.0%) and one type D injury (25.0%); no type A, E3, E4 or E5 injury was seen in this small series (Table 2).

Table 2: Distribution of Strasberg classification of bile duct injury (n = 4)

Strasberg type	Frequency	Percentage (%)
Type D	1	25.0
Type E1	1	25.0
Type E2	2	50.0

Timing and mode of Presentation

Injury was recognised intraoperatively in 1 of 4 patients (25.0%); among the remaining three, 1 (25.0%) was diagnosed within the first three postoperative days and 2 (50.0%) between

postoperative days 4 and 7. The leading modes of clinical presentation among the postoperatively diagnosed patients were jaundice (2 patients) and bile leak (1 patient) (Table 3).

Table 3: Time to diagnosis and mode of clinical presentation (n = 4)

Variable	Category	Frequency	Percentage (%)
Time to diagnosis	Intraoperative	1	25.0
	Postoperative day 1–3	1	25.0
	Postoperative day 4–7	2	50.0
Mode of presentation	Jaundice	2	50.0
	Bile leak	1	25.0
	Recognised intraoperatively	1	25.0

Management and Type of Repair

Roux-en-Y hepaticojejunostomy was performed in 2 of 4 patients (50.0%), one of whom had the type E2 injury diagnosed intraoperatively and underwent immediate reconstruction, while the other was referred with a delayed type E2

injury. Primary repair was performed in the patient with the type D injury (25.0%), and the patient with the type E1 injury was managed with ERCP and endoscopic stenting (25.0%) (Table 4).

Table 4: Management and type of repair performed (n = 4)

Procedure performed	Type of repair	Frequency	Percentage (%)
Roux-en-Y hepaticojejunostomy	Hepaticojejunostomy	2	50.0
Primary repair	Primary	1	25.0
ERCP + stent	Endoscopic	1	25.0

Postoperative Course and Follow-Up Outcome

One patient (25.0%) developed a postoperative bile leak, which was managed conservatively with drainage; the remaining three (75.0%) had an uneventful postoperative course, with no anastomotic stricture or surgical site infection recorded in this series. The mean hospital stay was 10.5 ± 3.2 days (range 7–15

days). At follow-up (6–12 months), liver function tests were normal and biliary drainage was patent on imaging in all four patients (100%); three patients (75.0%) were classified as fully recovered and one (25.0%) recovered after a secondary endoscopic intervention for a low-grade anastomotic narrowing. No mortality was recorded in this series (Table 5).

Table 5: Postoperative complications, hospital stay and follow-up outcome (n = 4)

Variable	Category	Frequency	Percentage (%)
Postoperative complications	None	3	75.0
	Bile leak	1	25.0
Hospital stay (days)	Mean $\pm$ SD	10.5 ± 3.2	–
LFT at follow-up	Normal	4	100.0
Biliary drainage	Patent	4	100.0
Final outcome	Recovered	3	75.0
	Recovered after intervention	1	25.0

DISCUSSION

In this cohort of 150 patients undergoing cholecystectomy at a tertiary care centre, bile duct injury (BDI) occurred in 4 patients, an incidence of 2.7%. This is somewhat higher than the 0.3–0.6% typically reported from large laparoscopic cholecystectomy series⁶, though with only 4 events in a cohort of this size the incidence estimate carries wide statistical uncertainty and should be interpreted with caution rather than compared directly with larger denominator studies; even a small change in the numerator would materially alter the calculated rate.

The four patients who developed BDI illustrate that structured, grade-based management at a specialised hepatobiliary unit can be associated with complete or near-complete recovery and low residual morbidity, consistent with outcomes reported from larger high-volume referral series¹². The predominance of laparoscopic index cholecystectomy in the overall cohort (84.0%) and of Strasberg E-type injury among the affected patients (50.0% type E2) mirrors the pattern reported in large multicentre and national audits, where misidentification injuries during laparoscopic dissection account for the majority of major bile duct injuries⁷, and where the E-type spectrum of injuries similarly predominates over minor type A leaks⁹. While the small number of affected patients precludes any meaningful comparison of proportions with these larger cohorts, the overall pattern of injury observed is broadly concordant with the wider literature. Two of the three postoperatively diagnosed injuries were recognised between postoperative days 4 and 7, a pattern consistent with human-factors analyses showing that visual misperception during the index operation, rather than technical error alone, underlies most major injuries and contributes to delayed recognition¹⁸. Even in this small subgroup, the delay to diagnosis in postoperatively recognised cases underscores the importance of a high index of suspicion for atypical abdominal pain, fever or jaundice in the early postoperative period following cholecystectomy⁵.

Roux-en-Y hepaticojejunostomy was the most frequently used definitive procedure among the affected patients, performed in the two with type E2 injury, in keeping with its established role as the standard of care for major ductal transection and for most E-type injuries⁸, while endoscopic stenting and primary repair were reserved for the lower-grade type E1 and type

D injuries respectively, consistent with contemporary treatment algorithms favouring a multidisciplinary, injury-grade-tailored approach¹¹.

The single postoperative complication among the four affected patients, a bile leak managed conservatively, and the absence of anastomotic stricture at follow-up, compare favourably with complication rates reported from other high-volume centres performing early, specialist repair¹⁶, and are consistent with the now well-established principle that early referral to a centre with dedicated hepatobiliary expertise, rather than attempted on-table or delayed repair locally, is the single most modifiable determinant of long-term outcome²⁰. Given the very small number of events involved, however, this single favourable outcome should be interpreted with considerable caution rather than as a generalisable complication rate.

Long-term studies following successful repair have shown that a proportion of patients continue to experience reduced quality of life and late stricture formation even years after apparently successful hepaticojejunostomy¹⁴, and that standardised outcome reporting is needed to allow meaningful comparison between series¹⁷. The 6–12 month follow-up window in the present study, while adequate to capture early anastomotic patency and functional recovery, does not exclude the possibility of late stricture in any of these four patients, and longer surveillance would be required to fully characterise durability of repair¹³.

This study is limited principally by the very small number of patients who developed bile duct injury ($n = 4$), which precludes any formal statistical comparison of outcomes across injury grades or repair types and limits the precision of the calculated incidence and the generalisability of the outcome data. It is further limited by its retrospective, single-centre design and the purely descriptive nature of the analysis. Nonetheless, the pattern observed among the affected patients is consistent with the wider published literature and supports the value of a centralised, multidisciplinary approach to bile duct injury management, while highlighting the need for larger, pooled or multicentre data to draw firmer conclusions regarding incidence and outcome.

CONCLUSION

Bile duct injury occurred in 4 of 150 patients (2.7%) undergoing cholecystectomy at this

tertiary care centre. Although uncommon, this complication can be managed with excellent outcomes when injury grade is accurately classified and definitive repair is undertaken early at a specialised hepatobiliary centre. In this study, Roux-en-Y hepaticojejunostomy, primary repair and endoscopic stenting tailored to Strasberg grade achieved recovery in all four affected patients with minimal morbidity, reaffirming the importance of prompt recognition, appropriate triage and early specialist referral in optimising outcomes after this complication, while underscoring the need for larger, multicentre series to more precisely define its incidence and outcomes.

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