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Original Research

Surgical Management of Bile Duct Injuries During Laparoscopic Cholecystectomy: A Retrospective Analysis of 20 Cases

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Abstract

Objectives: This study aimed to retrospectively evaluate the clinical outcomes of surgical repair techniques applied in bile duct injuries occurring during laparoscopic cholecystectomy (LC).

Methods: A total of 20 patients who developed bile duct injury during laparoscopic cholecystectomy and subsequently underwent surgical reconstruction were retrospectively analyzed. Demographic characteristics, timing of injury recognition, type of injury according to the Strasberg classification, surgical techniques employed, postoperative complications, and length of hospital stay were evaluated.

Results: Thirteen patients were female (65%) and seven were male (35%), with a mean age of 57.6 years (range: 19–90). According to the Strasberg classification, the most common injury type was Type E2 (70%), followed by Type E1 (25%) and Type E3 (5%). Roux-en-Y hepaticojejunostomy was performed in 85% of cases. Concomitant vascular injury was present in two patients. The mean length of hospital stay was 7.2 days. Postoperative bile leakage developed in two patients and was successfully managed using interventional or conservative approaches.

Conclusion: Early diagnosis and appropriate surgical reconstruction are crucial in the management of bile duct injuries. Even in cases of delayed diagnosis, successful clinical outcomes can be achieved in experienced centers through a multidisciplinary approach.

Keywords: Bile duct injury, laparoscopic cholecystectomy, Strasberg classification, hepaticojejunostomy

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Laparoscopic cholecystectomy is the gold standard surgical treatment for benign biliary diseases. However, compared with open surgery, it is associated with a higher risk of bile duct injury.[1] The incidence of bile duct injuries following laparoscopic cholecystectomy has been reported to range between 0.4% and 0.6%.[2] Bile duct injuries develop due to multiple factors, including surgeon experience, anatomical variations, inflammation, and misidentification of biliary anatomy.

Bile duct injuries may lead to significant morbidity, prolonged hospital stay, and a marked deterioration in quality of life. In cases that are not recognized early or managed appropriately, serious clinical consequences may occur, including recurrent episodes of cholangitis, secondary biliary cirrhosis, development of portal hypertension, and ultimately the need for liver transplantation.

Bile duct injuries occurring after laparoscopic cholecystectomy should generally be managed using a multidisciplinary approach. Accordingly, the treatment of patients with bile duct injury should be performed in experienced

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centers that include general surgery, gastroenterology, and interventional radiology units.

In this study, we aimed to present the surgical management and clinical outcomes of bile duct injuries occurring during laparoscopic cholecystectomy.

Methods

This retrospective study included patients who were diagnosed with bile duct injury during laparoscopic cholecystectomy or in the early postoperative period and underwent surgical reconstruction at the Department of General Surgery, Harran University, between 2018 and 2025. Demographic characteristics, including age and sex, timing of injury recognition (intraoperative or postoperative), type of injury, referral status, presence of concomitant vascular injury, type of surgical reconstruction performed, postoperative complications, and length of hospital stay were recorded. All bile duct injuries were categorized according to the Strasberg classification (Fig. 1).

To determine the type of bile duct injury, intraoperative assessment was used in patients who underwent early reconstruction, whereas endoscopic retrograde cholangiopancreatography (ERCP) and magnetic resonance cholangiopancreatography (MRCP) were utilized in the remaining patients.

Early reconstruction was performed in patients who were referred to our center in the early period and in those whose injuries occurred at our institution. In the remaining patients, surgical treatment was performed after appropriate diagnostic evaluation and initial management. As part of the surgical treatment, T-tube cholangiography was performed on postoperative day 21 in patients who underwent T-tube repair or in whom an external stent was placed during hepaticojejunostomy. In cases with normal cholangiographic findings (Fig. 2), the T-tube and external catheters were subsequently removed.

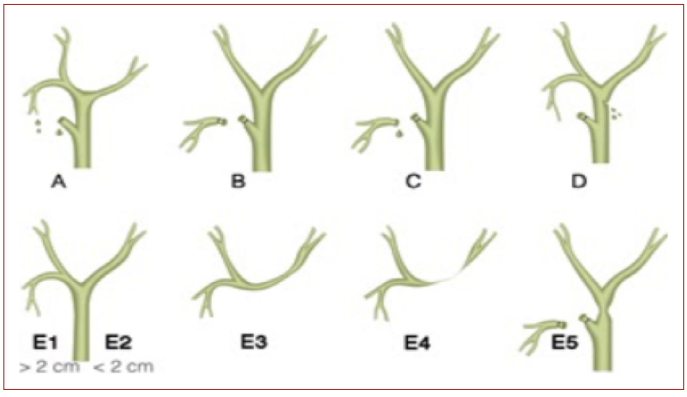

Figure 1. Strasberg Classification of Bile Duct Injuries.

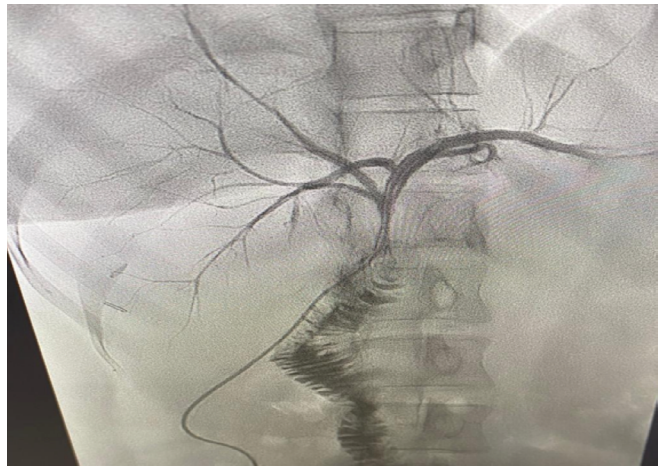

Figure 2. Postoperative MRCP Image of a Patient Who Underwent Surgery for Bile Duct Injury.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 27.0 (Armonk, NY: IBM Corp.). This study was designed as a descriptive analysis, and no comparative or inferential statistical tests were applied. Continuous variables were summarized as mean±standard deviation or median (minimum–maximum), as appropriate, based on data distribution assessed by visual inspection of histograms. Categorical variables were presented as numbers and percentages (%).

Results

Of the 20 patients included in the study, 13 (65%) were female and 7 (35%) were male. The mean age was 57.6 years (range: 19–90). Eighteen patients (90%) were referred from external centers, while bile duct injury occurred at our institution in two patients (10%). Bile duct injuries were identified intraoperatively in 19 patients and in the postoperative period in one patient (Table 1).

According to the Strasberg classification, the most frequently observed injury type was Type E2 (70%), followed by Type E1 (25%) and Type E3 (5%). Roux-en-Y hepaticojejunostomy was performed in 85% of cases, while portoenterostomy was performed in one patient and choledochal repair using a T-tube was performed in two patients (Table 2).

Concomitant vascular injury was present in two patients; injury to the right hepatic artery was identified in one patient, and injury to the proper hepatic artery was detected in the other. Reanastomosis with a graft was performed in the patient with proper hepatic artery injury, whereas no additional surgical intervention was performed in the patient with right hepatic artery injury.

Table 1. Demographic Characteristics of Patients

Characteristic	Value
Sex, n (%)	
Female	13 (65)
Male	7 (35)
Age, years (mean, range)	57.6 (19-90)
Referral status, n (%)	
External center	18 (90)
Same institution	2 (10)
Timing of diagnosis	
Intraoperative	19 (95)
Postoperative	1 (5)
Diagnosis	
Acute cholecystitis	14 (70)
Cholelithiasis	5 (25)
Gallbladder polyps	1 (5)
Hospital stay (mean, range)	7.2 days (5–11)

Table 2. The distribution of injuries according to the Strasberg classification and Surgical Procedure

Characteristic	Value
Type of Injury	
Type E1	5 (25)
Type E2	14 (70)
Type E3	1 (5)
Concomitant vascular injury	2 (10)
Surgical Procedure Performed	
Roux-en-Y hepaticojejunostomy	17 (85)
Choledochal repair with T-tube	2 (10)
Portoenterostomy	1 (5)
Biliary fistula following surgical procedure	2 (10)

The mean length of hospital stay was 7.2 days (range: 5–11). Postoperative bile leakage developed in two patients; one was treated with ERCP and percutaneous drainage, while the other was managed conservatively. No perioperative mortality was observed.

Discussion

Although laparoscopic cholecystectomy (LC) is widely accepted as the gold standard treatment for symptomatic gallstone disease, it is associated with one of its most serious and potentially life-threatening complications, namely major bile duct injuries (BDIs).[3,4] The reported incidence of BDIs following LC ranges from 0.4% to 0.6%.[2] Despite a gradual reduction in these rates attributable to increased surgical experience and the adoption of standardized technical principles, BDIs continue to represent a major clinical challenge due to their association with considerable morbidity, mortality, and increased healthcare costs.[5] Notably, Sağlam et al. have reported cases progressing to liver transplantation after bile duct injury, highlighting the potentially devastating consequences of this complication.[6]

In the early period following the introduction of laparoscopic cholecystectomy, the incidence of bile duct injury was reported to be higher compared with open cholecystectomy. However, with increasing surgical experience and completion of the learning curve, these rates have gradually declined, and laparoscopic cholecystectomy has become the standard surgical approach in current practice. Nevertheless, despite improved surgical expertise, several studies have demonstrated that the incidence of bile duct injury remains higher in cases defined as difficult laparoscopic cholecystectomy. Advanced age, male sex, the presence of anatomical variations, and procedures performed in the setting of acute cholecystitis are considered risk factors associated with difficult laparoscopic cholecystectomy.[7] In our study, 35% of the patients were male, the mean age was 57.6 years, and 70% of the patients underwent surgery for acute cholecystitis. These findings are consistent with the existing literature and suggest that laparoscopic cholecystectomy performed during acute cholecystitis represents a significant risk factor for the development of bile duct injury. Due to the relatively limited sample size of our study, no statistically significant difference was observed with respect to male sex.

From a pathophysiological perspective, most injuries result from misidentification of the common bile duct as the cystic duct, leading to inadvertent transection, clipping, or ligation. This mechanism is closely related to inadequate achievement of the "critical view of safety" during dissection.[8] While previous studies have shown that approximately 20–30% of BDIs are recognized intraoperatively, the majority are diagnosed in the postoperative period based on clinical suspicion.[9] In the present study, bile duct injuries were identified intraoperatively in 19 patients, whereas only one patient was diagnosed postoperatively. In patients with delayed recognition, the most common warning signs include bile output from surgical drains, persistent abdominal pain, abdominal distension, clinical findings of biliary peritonitis, and unexplained elevations in cholestatic liver enzymes—particularly alkaline phosphatase and gamma-glutamyl transferase—as well as serum bilirubin levels.[10]

Appropriate imaging modalities are essential for confirming the diagnosis of major bile duct injuries (BDIs) and for accurately defining the type and anatomical level of injury, which are critical determinants of the subsequent treatment strategy. Among available imaging techniques, magnetic resonance cholangiopancreatography (MRCP) is currently

regarded as the preferred first-line modality owing to its non-invasive nature and high diagnostic accuracy.[10] MRCP enables detailed three-dimensional visualization of the biliary tree and allows precise identification of the presence, location, and extent of bile leakage. Consequently, it facilitates reliable classification according to the Strasberg system and supports appropriate therapeutic decision-making.[11] In the present study, MRCP, complemented by endoscopic retrograde cholangiopancreatography (ERCP) when indicated, was used to characterize the type of bile duct injury.

The Strasberg classification remains the most widely accepted framework for guiding management algorithms in patients with major BDIs. While minor injuries, classified as Types A–D, are generally amenable to minimally invasive interventions such as ERCP with biliary stenting or percutaneous drainage, Type E injuries—defined by complete transection of the main bile duct or extensive defects—typically necessitate surgical reconstruction, particularly in Types E1–E4.[12] In our cohort, approximately 70% of patients were diagnosed with Type E2 injuries. For these high-grade injuries, Roux-en-Y hepaticojejunostomy (HJ) is widely considered the gold standard reconstructive approach, as it provides a tension-free biliary-enteric anastomosis and is associated with favorable long-term patency and low stricture rates.[13] Consistent with these recommendations, HJ was performed as the primary reconstructive procedure in 17 patients in our series.

The management of major bile duct injuries (BDIs) requires a multidisciplinary approach and should ideally be undertaken in experienced hepatobiliary centers with the collaboration of specialists in gastroenterology and interventional radiology.[13] Such an integrated strategy is crucial for accurate diagnosis, prompt patient stabilization in the setting of acute biliary peritonitis or sepsis, and determination of the optimal timing for definitive surgical repair. Importantly, concomitant vascular injuries involving the hepatic arterial system—most frequently the right hepatic artery—or, less commonly, the portal vein, have been reported in approximately 10–25% of patients with BDIs.[14] In the present study, vascular injury was detected in two patients, involving the proper hepatic artery in one case and the right hepatic artery in the other. Given that associated vascular injuries substantially increase the risk of hepatic parenchymal ischemia and subsequent biliary strictures, their early recognition and repair, when technically feasible, are of paramount importance. Moreover, high-level bile duct injuries affecting the biliary confluence or proximal hepatic ducts (Strasberg Types E3, E4, and E5) represent the most technically demanding scenarios and, in rare instances, may ultimately necessitate liver transplantation following unsuccessful reconstructive attempts.[6,15]

The timing of intervention is another critical determinant of prognosis in patients with major BDIs. When the injury is recognized intraoperatively and the patient remains hemodynamically stable, immediate or early reconstruction—performed during the index operation or within the first 72–96 hours by an experienced surgical team—offers the highest likelihood of favorable outcomes.[9] In our series, bile duct injuries were diagnosed early in 19 patients, allowing for timely reconstruction. Conversely, in cases with delayed diagnosis accompanied by sepsis, intra-abdominal infection, or pronounced inflammatory changes, initial management should prioritize biliary decompression through interventional radiological techniques, effective infection control, and metabolic stabilization. Definitive reconstructive surgery in these patients is generally postponed for 4–6 weeks to permit resolution of inflammation and to facilitate repair under elective and more favorable conditions.[16]

This study has certain limitations, including its retrospective design and the relatively small sample size. Nonetheless, our results are in agreement with existing literature and further underscore the importance of multidisciplinary management, accurate injury classification, and appropriate timing of intervention in the treatment of major BDIs. In our clinical experience, early reconstruction in patients diagnosed intraoperatively was technically less challenging and associated with lower complication rates. Additionally, favorable outcomes were achieved in patients referred from external centers with delayed diagnosis through initial stabilization followed by carefully planned elective surgical reconstruction.

Conclusion

Early recognition and appropriately timed surgical reconstruction are fundamental to achieving favorable outcomes in the management of bile duct injuries. Importantly, even in patients with delayed diagnosis, successful clinical and surgical results can be attained when management is conducted within experienced hepatobiliary centers using a multidisciplinary approach.

Disclosures

Ethics Committee Approval: Ethical committee approval was not obtained because this study was retrospective in design.

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Conflict of Interest: None declared.

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