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Journal of Clinical Surgery and Research
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Research Article

Bile Duct Injury in Laparoscopic Cholecystectomy; A Multi Centre Experience

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Received Date: March 18, 2024 | **Accepted Date:** March 25, 2024 | **Published Date:** April 08, 2024

Citation: Vinod K Singhal., Diddi G., Faris D Alaswad., Moussa H., Suleman A., et al. (2024), Bile Duct Injury in Laparoscopic Cholecystectomy; A Multi Centre Experience, *Journal of Clinical Surgery and Research*, 5(3); **DOI:10.31579/2768-2757/120**

Abstract:

Background: Laparoscopic cholecystectomy (LC), a minimally invasive gallbladder removal surgery, has revolutionized the field with benefits like quicker recovery. However, it is not without risks, and bile duct injury (BDI) is a severe but rare complication. BDI incidence during LC varies (0.4%-0.9%), with potentially life-threatening consequences. Surgeon experience, intraoperative cholangiography, and careful handling are crucial in preventing and managing BDIs.

Aim of the study: This study aims to present and analyze a Multi centre experience regarding the management of these bile duct injuries in LC.

Methods: This retrospective study, conducted at UAE medical institutions from 2014 to 2024, analyzed 2400 Laparoscopic Cholecystectomy surgeries over ten years. Out of 18 patients, thirteen patients were treated with ERCP, while five required additional surgery. Inclusion criteria involved patients aged 30 to 70+, of both genders, with BDIs. Exclusion criteria included minor BDIs and comorbidities. Two diagnostic techniques, including intraoperative cholangiography and postoperative assessments, identified BDIs. Treatment varied based on Strasberg classification, involving suturing, ERCP, stent placement, and Roux-en-Y hepaticojejunostomy. Data analysis employed SPSS, presenting results through tables and graphs with statistical parameters.

Result: The study focused on Laparoscopic Cholecystectomy-related Bile Duct Injuries (BDI), with a cohort primarily aged 51-70 (66.67%). This age group showed higher susceptibility to BDI. The average participant age was 55.21±12.54 years, with a male majority (55.56%). Among 18 Endoscopic Retrograde Cholangiopancreatography (ERCP) cases, five had BDI, diagnosed intra/postoperatively. Two patients with clinical symptoms had postoperative diagnosis through Percutaneous Transhepatic Cholangiography (PTC). Strasberg classification revealed 60% Type A injuries; Types E1 and E2 each constituted 20%. Treatment modalities varied, with ERCP for Type A injuries (60%) and Roux-en-Y Hepaticojejunostomy (RYHJ) for Types E1 and E2.

Conclusion: ERCP is a valuable method for diagnosing and managing Bile Duct Injuries (BDIs). The predominant type of BDIs, specifically Type A, is typically diagnosed after surgery. ERCP demonstrates its efficacy in addressing the majority

of Strasberg Type A BDIs. In substantial and intricate BDIs, the Roux-en-Y Hepaticojejunostomy is a secure and efficient approach.

keywords: bile duct injury, laparoscopic cholecystectomy, strasberg classification ecrp, ptc and ryhj

Introduction

Laparoscopic cholecystectomy (LC), a minimally invasive surgical procedure for gallbladder removal, has significantly transformed the surgical landscape due to its associated benefits, such as reduced recovery times and smaller incisions [1]. LC has become the gold standard for treating symptomatic gallstones, presenting advantages over traditional open cholecystectomy, including decreased pain, shorter hospital stays, and faster recovery [2]. Despite its widespread use and generally high success rates, LC is not without potential complications, with bile duct injury (BDI) being one of the most severe [3]. BDI during LC is a rare but potentially devastating complication that can result in substantial morbidity and mortality [4]. The reported incidence of BDI varies widely, ranging from 0.2% to 2.0%, with an overall rate of approximately 0.4%, influenced by differences in surgical technique, patient characteristics, and the definition of BDI [5,6]. Recent studies indicate an incidence of BDIs during cholecystectomy ranging from 0.4% to 0.9% [7,8]. While the rate of BDIs may have been considered low before the LC era (0.1% to 0.2%) [9,10], cholecystectomy's widespread prevalence makes BDIs an essential and potentially life-threatening complication [11]. Consequences of BDI include severe complications like bile leakage, sepsis, cholangitis, liver abscess, and even death [12]. Although most cholecystectomies are now performed laparoscopically, some complex cases still necessitate open cholecystectomy (OC) [13]. LC is the preferred method for uncomplicated gallstone disease and early acute cholecystitis. BDIs are classified based on severity, ranging from minor to primary, and around 20% of BDIs are overlooked during cholecystectomy [14,15]. Neglected BDIs may lead to severe postoperative complications, including fluid collection, biliary peritonitis, sepsis, hepatic or multiple organ failure, and death. Management of BDI depends on its severity and may involve endoscopic or surgical repair to restore bile flow and prevent further complications [16]. The risk of BDI is influenced by factors such as the surgeon's experience, patient anatomy, and the presence of risk factors like inflammation, adhesions, and a small gallbladder [17]. Surgeons with extensive LC experience exhibit lower BDI rates than their less experienced counterparts [18]. Recognizing and preventing BDI during LC is crucial [19]. The use of intraoperative cholangiography, involving contrast agent injection into bile ducts for anatomical visualization, has been shown to reduce BDI risk [20]. Meticulous dissection and careful bile duct handling are essential to minimize injury risk. Despite advances, BDI remains a potential LC complication, emphasizing the importance of surgeon awareness and appropriate measures to prevent and manage BDI, ensuring patient safety and well-being. This study aims to present and analyze a single-centre experience regarding the management of these bile duct injuries in LC.

Methodology & Materials

This retrospective was conducted at the Department of Surgery within Prime Hospital, UAE primarily. Over ten years, from 2014 to 2024, a comprehensive examination was conducted on 2400 Laparoscopic Cholecystectomy surgeries. Throughout the study duration, 18 patients experienced Bile Duct Injuries (BDIs) because of Laparoscopic Cholecystectomy. All 18 patients were diagnosed using ERCP. Out of 18 patients, 13 were treated by ERCP and 5 patients needed further surgery. The relevant data was retrospectively gathered from hospital records, and ethical approval was obtained from the institution's ethics committee.

- Inclusion criteria:
- Patients aged from 30 to more than 70 years.
- Both male and female.
- Patients with BDIs (Bile Duct Injuries).
- Exclusion criteria:
- Patients with minor BDIs.
- Patients with other comorbidities (chronic kidney disease and coronary artery disease).

Diagnostic Approaches:

To identify bile duct injuries (BDI), we employed a comprehensive set of four diagnostic techniques. Intraoperative diagnosis relied on detecting bile leakage from tubular structures, and confirmation was obtained through intraoperative cholangiography. Postoperative diagnosis involved a series of assessments, including complete blood count, C-reactive protein (CRP), bilirubin levels, aspartate transaminase (AST), alanine transaminase (ALT), abdominal ultrasonography, and Multislice Computed Tomography (MSCT) scans. When a definitive BDI diagnosis was not established, Magnetic Resonance Cholangiopancreatography (MRCP) was conducted. If MRCP was unavailable, Percutaneous Transhepatic Cholangiography (PTC) was an alternative for evaluating biliary obstruction. When both MSCT and MRCP results were inconclusive for detecting bile leaks, Endoscopic Retrograde Cholangiopancreatography (ERCP) was employed. The identified types of BDI were then classified according to the Strasberg classification [21].

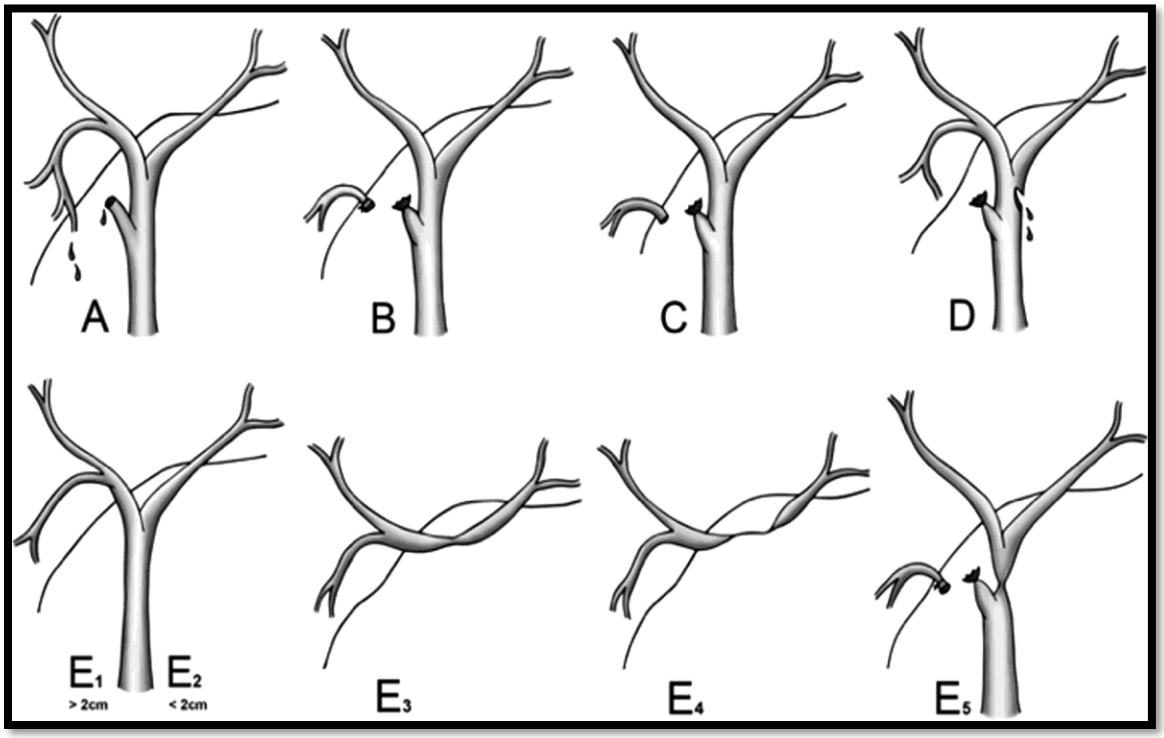

Figure 1: Strasberg classification of bile duct injury [22].

Treatment Approach:

In cases where bile duct injuries (BDIs) are identified during surgery, the approach involves suturing the injury either with or without choledochotomy. Postoperatively diagnosed BDIs are addressed through endoscopic retrograde cholangiopancreatography (ERCP) and stent placement, particularly for minor leaks without peritonitis. If ERCP proves ineffective and the bile leakage is well-drained, conservative treatment is pursued. For Strasberg A injuries, percutaneous drainage is employed. In Strasberg E (E2 and E3), injuries lead to Roux-en-Y hepaticojejunostomy (RYHJ). Incomplete stenosis of the CBD and common hepatic ducts is addressed through ERCP with stent placement or percutaneous transhepatic biliary stenting.

Data analysis:

The data were organized and visually represented in appropriate tables and graphs based on their relationships. Detailed descriptions for clear comprehension accompanied each table and graph. Statistical analysis was conducted utilizing the Statistical Package for the Social Sciences (SPSS) program on a Windows platform. Mean values with standard deviations were used to express continuous parameters, while categorical parameters were presented as frequencies and percentages.

Result

The demographic composition of our study cohort revealed a predominant presence of individuals aged 51-70 years, constituting 66.67% of the population. This age group exhibited a higher susceptibility to Bile Duct Injury during Laparoscopic Cholecystectomy. The average age of the participants was 55.21±12.54 years (Table 1). The majority of the study population was male (55.56%), while females accounted for 44.44% (Figure 2). Among the 18 patients diagnosed with Endoscopic Retrograde Cholangiopancreatography (ERCP), only five instances of Bile Duct Injury (BDI) were identified. Three BDIs were diagnosed intraoperatively, while the remaining two were identified postoperatively. Notably, two patients presented with clinical symptoms such as abdominal pain, jaundice, and fever, but their BDIs were not detected during the initial surgery. These two were diagnosed by Percutaneous Transhepatic Cholangiography (PTC) postoperatively. Applying the Strasberg classification, Type A injuries comprised 60% of the cases, with Types E1 and E2 constituting each 20% (Table 2). Table 3 presents a comprehensive summary of the treatment modalities corresponding to Bile Duct Injuries (BDIs) types. For Type A injuries, Endoscopic Retrograde Cholangiopancreatography (ERCP) served as the exclusive treatment method, accounting for 60% of the cases. Meanwhile, Roux-en-Y Hepaticojejunostomy (RYHJ) was employed to address Type E1 and E2 injuries.

Age range (in years)	Frequency (n)	Percentage (%)
30-50	4	22.22
51-70	12	66.67
>70	2	11.11
Mean±SD	55.21±12.54	

Table 1: Age distribution of the study population (N=18).

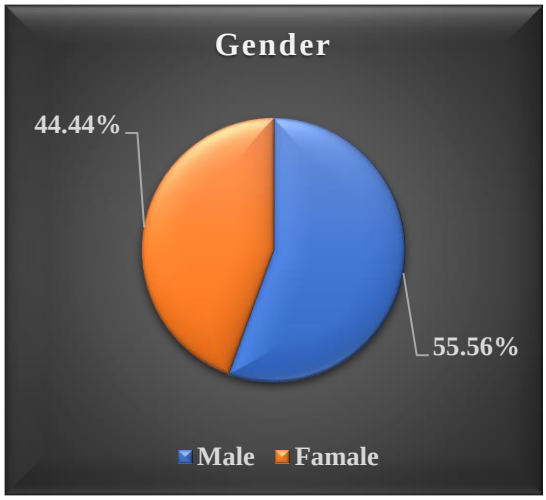

Figure 2: Gender distribution of the study population (N=18).

BDI type	Frequency (n)	Percentage (%)
Type A	3	60.00
Type E1	1	20.00
Type E2	1	20.00
Total	5	100.00

Table 2: BDI type according to the Strasberg classification and diagnostic methods.

Treatment	Type A		Type E1		Type E2		Total	
	n	%	n	%	n	%	n	%
ERCP	3	60.00	0	0.00	0	0.00	3	60.00
RYHJ	0	0.00	1	20.00	1	20.00	2	40.00
Total	3	60.00	1	20.00	1	20.00	5	100.00

Table 3: Treatment methods according to the type of BDI.

Endoscopic Retrograde Cholangiopancreatography (ERCP), Roux-en-Y hepaticojejunostomy (RYHJ).

Bile Duct Injury in Laparoscopic Cholecystectomy; A Multi Centre Experience.

Discussion

Cholecystectomy stands out as one of the most frequently performed abdominal surgical procedures. Laparoscopic Cholecystectomy (LC) is recognized as the preferred method for surgically managing gallstone disease, often referred to as the "gold standard." LC is associated with benefits such as reduced postoperative pain, improved cosmetic outcomes, shorter hospital stays, and less work-related disability than open cholecystectomy [23,24]. In such cases robust training of surgeons in Gastrointestinal and Hepatobiliary procedures, particularly Laparoscopic Cholecystectomy (LC) surgery, involves comprehensive hands-on experience, simulation-based training, and mentorship must be needed. Over the past two decades, LC has gained popularity in the United Arab Emirates (UAE) as a preferred intervention for addressing symptomatic and complex gallstone disease. In cases of symptomatic gallstones, LC is the primary choice. For gallstone-induced cholecystitis, the decision between LC and a two-stage surgical approach (involving percutaneous transhepatic gallbladder drainage in the first stage followed by LC in the second stage) is made based on the patient's condition, following the guidance of the 2018 Tokyo guidelines [25]. Establishing early thresholds for converting laparoscopic to open surgery in complex cases of laparoscopic cholecystectomy is imperative for ensuring optimal patient outcomes. Surgeons must recognize challenging situations and be prepared to make timely decisions, prioritizing safety over the continuation of minimally invasive procedures. Hospitals must prioritize comprehensive readiness for intricate surgeries. Cutting-edge technology, advanced surgical instruments, and highly skilled medical teams are imperative. Bile Duct Injury (BDI) emerges as a severe complication of LC, significantly impacting the patient's quality of life [26,27]. Managing BDI depends on factors such as the timing of diagnosis, locally available devices, and the surgeon's expertise. Recent studies indicate a higher likelihood of biliary tract reconstruction procedures in patients aged 40 to 50 [28–30]. In our study, the mean patient age was 55.21±12.54 years, with the majority falling within the 51-70 age range at 66.67%. These results imply an increased vulnerability to BDI in Laparoscopic Cholecystectomy among individuals aged 51-70. The findings further support the notion that older patients are more prone to requiring post-cholecystectomy biliary reconstruction, aligning with earlier research [27,31,32]. The gender distribution in our study showed 55.56% male and 44.44% female participants, consistent with previous observations indicating a higher incidence of these lesions in men, where gender serves as an independent predictor of BDI [32]. Notably, our study's relatively small sample size may have limited the ability to discern potential sex differences in BDIs. BDI diagnosis typically involves identifying characteristic signs, such as bile leakage through abdominal drainage tubes, biliary peritonitis, or obstructive jaundice post-LC. In our study, all 18 patients diagnosed with BDIs underwent Endoscopic Retrograde Cholangiopancreatography (ERCP), revealing 5 cases of BDI. Three cases were identified intraoperatively, while two were diagnosed postoperatively through Percutaneous Transhepatic Cholangiography (PTC). The latter two patients exhibited clinical symptoms, including abdominal pain, jaundice, and fever. Strasberg classification methods confirmed 60.00% of BDIs as Type A, with E1 and E2 injuries each

constituting 20% of cases. Comparable studies by Viste A. and Arcerito M. reported Strasberg A accounting for 52.2% and 44.2% of all BDIs, respectively [33,34]. ERCP played a crucial role in our study's diagnosis and management of BDI. However, it had limitations in identifying bile leaks from the accessory bile duct and detecting Common Bile Duct (CBD) cutoff lesions. MRCP was preferred for BDIs with biliary obstruction, while PTC served as an alternative when MRCP was unavailable or biliary drainage was necessary due to cholangitis. Most authors concur that simple BDIs can be effectively managed with ERCP and stent placement, whereas complicated BDIs may require surgical intervention [39,40]. Our approach aligned with these recommendations, utilizing ERCP and stent placement for minor bile leaks and incorporating additional measures such as ultrasound-guided percutaneous drainage for localized intraabdominal fluid accumulation. We combined ERCP for stent placement with laparoscopic lavage and drainage for cases of biliary peritonitis or biliary ascites. In instances where ERCP failed or was unavailable, laparoscopic surgery was performed. For Strasberg E1 and E2, Roux-en-Y hepaticojejunostomy (RYHJ) surgery was conducted. Notably, our study reported a zero-morbidity rate, consistent with previous findings, and highlighted the routine application of Roux-en-Y hepaticojejunostomy in managing complicated BDIs. This technique was identified as potentially safeguarding the biliary-enteric anastomosis, increasing the likelihood of successful conservative treatment for anastomotic leakage, and enabling subcutaneous intervention for anastomotic stenosis through a jejunal tunnel.

Limitations of the study: Despite the valuable insights provided by this study on Bile Duct Injuries (BDIs) in Laparoscopic Cholecystectomy (LC), several limitations should be acknowledged:

1. The study's retrospective nature introduces inherent biases and reliance on available medical records, potentially leading to incomplete or inaccurate data.
2. The single-center focus may limit the generalizability of findings to broader populations, given variations in surgical practices and patient demographics across different medical institutions.
3. Variations in the severity and presentation of BDIs may influence treatment outcomes, and the study's categorization may oversimplify the complexities associated with managing different types of injuries.

Conclusion And Recommendations

This study investigates the management of bile duct injuries (BDIs) during laparoscopic cholecystectomy (LC) through a single-center experience. The research reveals a higher susceptibility to BDIs among individuals aged 51-70. Predominantly, the identified BDIs were Strasberg Type A, with effective management demonstrated through endoscopic retrograde cholangiopancreatography (ERCP). For more intricate injuries (Types E1 and E2), the study successfully employed Roux-en-Y hepaticojejunostomy (RYHJ). Accurate diagnostic methods, such as intraoperative cholangiography and postoperative assessments, are emphasized for identifying and classifying BDIs. The study underscores the significance of surgeon experience and skill in preventing and managing BDIs, highlighting the need for continuous training and awareness in LC procedures.

Based on the findings, the study recommends enhancing surgeon training programs, primarily focusing on recognizing and preventing bile duct injuries during laparoscopic cholecystectomy. A well-equipped hospital ensures optimal patient outcomes, instilling confidence in healthcare professionals and the community. Adequate preparation for complex procedures is deemed paramount for delivering quality healthcare services. In instances where expertise is lacking, the study advocates for the referral of patients to specialized centers for complex procedures. Timely transfer is essential to guarantee access to skilled professionals, ultimately enhancing patient outcomes and safety. Furthermore, the study advocates for collaborative efforts between primary and tertiary care facilities to optimize healthcare delivery. This collaborative approach ensures comprehensive and proficient treatment, contributing to an overall improvement in the quality of healthcare services.

Funding: No funding sources

Conflict Of Interest: None declared

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