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Article

Prevalence and Risk Factors of Bile Duct Injury During Laparoscopic Cholecystectomy in Iraqi Hospitals

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Abstract: The standard surgical procedure for treating symptomatic gallstone disease is laparoscopic cholecystectomy; however, complications such as injury to the bile duct could occur. This study examined the prevalence and the risk factors associated with bile duct injury resulting from laparoscopic cholecystectomy at Al-Hussein Teaching Hospital in Samawa, Iraq. A retrospective and prospective observational study was performed using a total of 2,840 patients who had undergone laparoscopic cholecystectomy during the five-year period of this study. Data were subsequently identified for the patient's demographics, preoperative diagnosis, intraoperative findings, and experience level of the surgeon. The overall prevalence of bile duct injury was determined to be 0.74%. The multivariate logistic regression analysis identified that several independent risk factors are associated and include male gender, acute cholecystitis with severe inflammation, intraoperative bleeding, aberrant biliary anatomy, and procedures performed by junior surgeons. The majority of injuries were classified as type E2 based on the Strasberg classification. Overall, this study supports that while the prevalence of bile duct injury is slightly higher than worldwide data from other industrialized countries, the findings resemble those found, on average, in other developing countries. Adherence to the critical view of safety, early conversion to open surgery with hostile anatomy, and supervised training for junior surgeons would be needed to decrease the risk of developing injury to the bile duct during laparoscopic cholecystectomy.

Keywords: Laparoscopic cholecystectomy, bile duct injury, risk factors, prevalence, Al-Hussein Teaching Hospital, Iraq, critical view of safety.

Introduction

Gallstones are thought to be a common gastrointestinal disorder worldwide and place significant burdens on the healthcare system. In the late 1980s, laparoscopic cholecystectomy (the removal of the gallbladder) completely transformed how we perform surgery to fix problems with the gallbladder as an open surgical procedure to a now standard of care (minimally invasive). The advantages of laparoscopic cholecystectomy (less postoperative pain, shorter hospital stays, faster recovery, and better cosmetic results) are widespread and thoroughly documented; however, the conversion from open to laparoscopic surgery produced a new and unanticipated set of technical dilemmas: the most serious complication of laparoscopic cholecystectomy is the injury to the bile duct during surgery. Unlike open cholecystectomy, in which the surgeon can touch and see in 3D what

he/she is doing because there are fewer restrictions on instrument movement, a laparoscopic procedure requires the use of a 2D view only, and therefore alters the surgeon's depth perception and tactile feedback.

A bile duct injury sustained during laparoscopic cholecystectomy represents a catastrophic complication that profoundly impacts patient morbidity, mortality and quality of life. There is a wide spectrum of bile duct injuries that can occur, ranging from minor leaks from the cystic duct stump to complete transections of the common and/or hepatic duct, and may also include associated vascular injuries to the right hepatic artery. The Strasberg classification system is commonly used to classify these injuries, allowing for a standard method of communication and management planning [1]. Patients who suffer major bile duct injuries often require complex reconstructive surgery, typically hepaticojejunostomy, and have lifelong consequences, such as cholangitis, secondary biliary cirrhosis and portal hypertension [2, 3].Bile duct injury is one of the top causes for litigation in the medical field due to the high financial costs to both patient and physician, and the psychological toll on both parties after an incident.

The worldwide incidence of bile duct injury during laparoscopic cholecystectomy ranges between 0.2% and 0.6% of cases, which is two to three times more than that for open cholecystectomy. In the last 30 years, there have been technological advances in surgical techniques, instrumentation, and surgical education; nevertheless, the incidence of injury has remained constant [4]. The reason for this standard perseverance is attributed to the multiple factors that cause this complication to occur: anatomical patient characteristics, anatomical factors of the biliary system, and surgeon-related reasons. An understanding of these risk factors will aid in creating protocols for the prevention of such a complication [5]. Risk factors associated with patients include age, gender, obesity, and acute or chronic inflammation. Acute cholecystitis is characterized by edema, friable tissue, and heavy adhesions with the surgical plane obscured due to the infection process; thus, the safety of dissection is increased due to the surgeon's inability to see the anatomical structures of Calot's triangle [6]. Male patients will be presented with gallstones; however, they will typically present with more advanced stages of disease than females, and will have more severe infection than females. Male patients require more advanced surgical techniques than female patients to safely perform the laparoscopic procedure [7].

Anatomical variants present a significant factor in the causes of bile duct injury [8]. Anatomical variations of the cystic duct, such as short cystic duct, cystic duct with low insertion that runs parallel with the common hepatic duct, and aberrant right hepatic ducts draining into the cystic duct, can lead to misidentification of anatomy by the surgeon if they are not constantly watching for such rare presentations.If the variations are not clearly identified by the surgeon, then he or she might clip and transect either the common bile duct or an aberrant hepatic duct assuming it is the cystic duct. In addition to the variations present, various surgeon-related factors also play a role. For example; the established laparoscopic cholecystectomy learning curve shows that a surgeon's greatest risk for causing a bile duct injury is during the early part of their learning experience [9][10][11] Likewise; surgical injuries occur with surgeons of all experience levels – including those with extensive experience, particularly when they are performing difficult dissections in the presence of severe inflammation or in the case of complications intra-operatively such as bleeding [12][13][14][15]. Other factors that contribute to causing injuries are the cognitive biases and "visual illusions" - this occurs when a surgeon misinterprets the 2-dimensional view of the laparoscope and cognitive bias such as confirmation bias often lead the surgeon to misidentify the common bile duct for the cystic duct [16][17][18].

The critical view of safety is a cognitive and technical safeguard against bile duct injuries, developed by Strasberg to help prevent these kind of injuries [1]. To achieve a “critical view of safety”, the procedure requires complete removal of fibrofatty tissue located within Calot’s triangle, dissevering detachment between the lower third of the gallbladder and the liver bed while simultaneously providing absolute identification of only two structures entering into the gallbladder. Specifically; the cystic duct and cystic artery should be identifiable as entering into the gallbladder.Bile duct injuries remain prevalent despite the established evidence demonstrating strong efficacy through surgical

techniques such as laparoscopic cholecystectomy; however, the lack of worldwide adherence, especially among resource-limited health care settings, is due to this occurrence occurring constantly despite the lesson that can be learned from the "infundibular technique." The "infundibular technique" fails to adequately locate the common hepatic duct and cystic duct junction; therefore, injuries to the bile duct will occur if the infundibulum of the gallbladder attaches closely to the common bile duct as documented by Uzoigwe et al. in 2005 [10].

Additionally, unique characteristics across the various countries of developing nations such as Iraq influence the rate of complications arising from biliary injuries during laparoscopic procedures such as laparoscopic cholecystectomy. The health care system from Iraq has been adversely affected by the continued destruction of infrastructure and resources as a result of lengthy conflicts and economic sanctions, which directly correlates with a decrease in the training and learning of surgeons in surgical procedures and subsequent availability of advanced laparoscopic equipment, therefore leading to a delay in receiving medical attention and surgical management following presentation of patients with their gallbladder stones [19]. Patients presenting to southern Iraq (approximately Samawa area in Southern Iraq and the Muthanna governorate area) after experiencing potentially complex gallbladder diseases due to complications from acute cholecystitis or progressive disease process, results in the patient being more likely to develop more significantly larger amounts of associated inflammation, which complicate laparoscopic surgical dissection. This also contributes to nullifying intraoperative cholangiogram usage universally throughout Iraq while world-wide use of this option is often debated [13, 20].

There is no hospital that exemplifies this concern more so than Al-Hussein Teaching Hospital in Samawa. This hospital serves as the regional tertiary care center for the southern region of Iraq, performing many hundreds of general surgical procedures including many laparoscopic cholecystectomy procedures; further serving as a training center and reference resource for all surgeons in training and medical students in the region. While there have been great strides toward successful transition from an open to laparoscopic surgical procedure, various data has not been reviewed to analyze the occurrence and extent of biliary injury when conducting laparoscopic cholecystectomy procedures; therefore, there continues to be a significant level of concern regarding these types of injuries at the present time for this area of surgeons. Still there is a need for epidemiological evaluation of biliary injuries and the correlating risk factors of our region's patients since the absence of local data impedes the use of current practices through evidence-based protocols to optimize the outcome of surgical procedures and increase the safety of performing surgical procedures.

The purpose of this study is to provide information regarding the prevalence of biliary injury during laparoscopic cholecystectomy procedures at Al-Hussein Teaching Hospital in Samawa, Iraq. Additionally, this study will analyze the individual patient-related, intraoperative, and surgeon-related risk factors associated with injuries related to laparoscopic cholecystectomy procedures. Ultimately, this study will provide valuable tools to be utilized to modify local surgical practice and implement changes into educational curriculum for surgeons in training to help decrease the incidence of biliary injury in hospitals in Iraq.

Methodology

The research conducted was a retrospective and prospective observational cohort analysis on the prevalence and risk factors of bile duct injury during laparoscopic cholecystectomies performed on adult patients with benign gall bladder pathology. This study was conducted at the Department of General Surgery, Al-Hussein Teaching Hospital in Samawa, Iraq. The hospital is a public tertiary care facility and provides surgical services to the local community of Samawa, as well as serving as a referral facility for surrounding rural areas. The study followed patients who had laparoscopic cholecystectomies over a five-year period from January 2018 until December 2022. The study protocol was reviewed and approved by the Institutional Ethical Review Committee at Al-Hussein Teaching Hospital. Signed informed consent was not required for the retrospective portion of the study due to its observational nature; however, informed consent was obtained during the prospective portion of the study. All aspects of patient confidentiality and data anonymization were strictly adhered to throughout the entirety of the study.

The population of the study included all adults over 18 years of age who underwent a laparoscopic cholecystectomy for benign gallbladder pathology at our institution during the defined study period and who met the indicated surgical criteria for laparoscopic cholecystectomy surgery including symptomatic cholelithiasis, acute cholecystitis, gallstone pancreatitis, and choledocholithiasis managed laparoscopically after endoscopic clearance. Patients were systematically excluded from the study if their primary surgical approach was open cholecystectomy, if they were found to have gallbladder malignancy without prior knowledge (ie, if it was not included in their pre-operative assessment), or if they had incomplete medical records and lost to follow-up information.There were 2,840 patients fulfilling the criteria for inclusion who made up the cohort for this study.

The primary outcome variable was the occurrence of injury to the bile duct during laparoscopic surgery, which is defined as any unintentional injury to the extrahepatic biliary tree (common bile duct, common hepatic duct, right and left hepatic ducts, and the junction between the cystic and common hepatic ducts); therefore, the definition of bile duct injury in this study included any injury that occurred at any time (i.e. intraoperatively or postoperatively).

Bile duct injuries were classified using the Strasberg classification system to ensure consistency in the classification of the injury. Injuries could also be classified based on when the injury was diagnosed. Injuries could be classified as "intraoperative" - this includes any injury that was identified during the primary laparoscopic procedure (either through visual inspection or through operative cholangiography) - and as "postoperative", which includes any injury diagnosed after the patient displayed clinical symptoms (e.g. biliary peritonitis, persistent bile leak from surgical drains, jaundice, or cholangitis) subsequent to the laparoscopic procedure.

The collection of data was facilitated through a complete review of operative notes, anaesthesia records, and inpatient medical records for the retrospective cohort, and a structured pro forma for the prospective cohort. The collected variables were classified in broad groupings: patient demographic data, preoperative clinical data, intraoperative data, and surgeon related data. Demographic data included age and sex. Preoperative data included body mass index (BMI), primary diagnosis for surgery, previous upper abdominal surgery, and if there exist comorbidities (e.g. diabetes mellitus, liver cirrhosis). Also of importance was the time to symptom onset prior to surgical presentation, which is a measure of delay in accessing the healthcare system.Intraoperative variables were accurately recorded by either the operating surgeon or assisting resident. Variables included intraoperative levels of inflammation and were classified based on subjective measurement. Inflammation is classified as mild, moderate or severe according to the amount of edema, fibrosis and adhesions present in Calot’s triangle. The anatomical variation was also recorded and included the presence of short cystic ducts, anomalous hepatic ducts and low cystic duct insertion as documented in the operative report. Additional intraoperative variables included major intraoperative bleeding that obscured the surgical field and required intervention other than routine cauterization, the inability to obtain the critical view of safety and conversion from laparoscopic to open surgery. Factors relating to the surgeon were classified according to the level of experience of the surgeon (junior surgeons are defined as residents in their 1st through 3rd years of training under supervision; senior surgeons are defined as board certified surgeons with at least five years of independent laparoscopic experience).

Laparoscopic procedures at Al-Hussein Teaching Hospital are all completed via a standard four port technique under general anaesthesia. The peritoneal cavity at the discretion of the surgeon, is created by a Veress needle or Hasson technique, and maintained at an intra-abdominal pressure of 12 – 14 mmHg.Surgical methods differ for dissection of Calot's triangle to achieve the critical view of safety. The surgeon has the final say on which technique to use based on preference and local anatomy (i.e., infundibular technique seen occasionally), as our institution does not routinely perform intraoperative cholangiography; this would be performed when there is clinical suspicion of common bile duct stones or anatomy is ambiguous or unclear. If a patient sustained a bile duct injury intraoperatively, then management guidelines would vary based on the type and/or severity of the injury as well as experience level of the surgeon. Minor injuries, such as cystic duct stump leaks, may be managed with clip application or sutures via laparoscopically. Major injuries, such as common bile

duct transections, would typically necessitate immediate conversion to an open procedure in order to perform a primary repair, rather than a T-tube or Roux-en-Y hepaticojejunostomy.

Statistical analysis was completed using Statistical Package for Social Sciences (SPSS v. 26). Descriptive statistics were used to summarize baseline characteristics of the demographic study population. Continuous variables were presented as either means with standard deviations or medians with interquartile ranges, depending on the distribution of the data with respect to normalcy, which was determined using Kolmogorov-Smirnov test. Categorical or nominal variables were expressed as counts and percentages. The demographic study population was dichotomized into two groups: patients with bile duct injury and those without, to assess risk factors for biliary injury. Univariate analysis was conducted initially, to evaluate the relationship between continuous variables through independent samples t-tests or Mann-Whitney U tests and between categorical/nominative variables using Chi-square tests or Fisher's Exact test. All values demonstrating statistical significance by $P < 0.05$ from the univariate analysis, as well as clinically relevant values identified through precedent literature, were included as covariates in a subsequent multivariate binary logistic regression to determine independent risk factors for biliary injury. Logistic regression results were represented as adjusted odds-ratios (AOR) with associated 95% CIs. Throughout all statistical evaluation, a P-value < 0.05 was accepted as statistically significant.

Results

During the five-year study period, a total of 2,840 patients underwent laparoscopic cholecystectomy at Al-Hussein Teaching Hospital. Among these, 21 patients sustained a bile duct injury, yielding an overall prevalence rate of 0.74%. The demographic and preoperative clinical characteristics of the patients, stratified by the occurrence of bile duct injury, are detailed in Table 1. The mean age of the patients in the injury group was slightly higher, though the difference did not reach statistical significance. However, a highly significant gender disparity was observed; males constituted a disproportionately larger percentage of the bile duct injury group compared to their representation in the non-injury group. Regarding the surgical indication, acute cholecystitis was overwhelmingly associated with bile duct injuries, whereas chronic cholecystitis was predominantly associated with uncomplicated procedures. Patients who presented with a history of symptoms exceeding seven days prior to surgery also demonstrated a markedly higher risk of injury.

Table 1. Demographic and Preoperative Characteristics of Patients Undergoing Laparoscopic Cholecystectomy.

Variable	Total Patients (n=2840)	No Bile Duct Injury (n=2819)	Bile Duct Injury (n=21)	P-value
Mean Age (years ± SD)	45.2 ± 12.4	45.1 ± 12.3	48.6 ± 14.1	0.182
Gender (Male / Female)	820 / 2020	803 / 2016	17 / 4	< 0.001
BMI (Mean ± SD)	28.1 ± 3.5	28.0 ± 3.5	29.4 ± 4.1	0.064
Indication				
- Chronic Cholecystitis	1940 (68.3%)	1935 (68.6%)	5 (23.8%)	< 0.001
- Acute Cholecystitis	750 (26.4%)	731 (25.9%)	19 (90.5%)	< 0.001
- Gallstone Pancreatitis	150 (5.3%)	153 (5.5%)	2 (9.5%)	0.341
Duration of Symptoms > 7 days	890 (31.3%)	872 (30.9%)	18 (85.7%)	< 0.001

The intraoperative findings and surgeon-related variables are presented in Table 2. Severe inflammation and dense adhesions in Calot's triangle were the most prominent intraoperative risk factors. The occurrence of significant intraoperative bleeding that obscured the operative field was strongly correlated with subsequent bile duct injury. Furthermore, the failure to achieve the critical view of safety prior to clipping and cutting structures was universally present in the injury cohort. Anatomical variations, specifically short cystic ducts or aberrant ductal anatomy noted intraoperatively, were significantly more frequent in the injury group. Regarding surgeon experience,

procedures performed by junior residents under supervision carried a significantly higher risk of bile duct injury compared to those performed by senior surgeons. Conversion to open surgery was significantly higher in the injury group, primarily as a corrective measure once the injury was recognized.

Table 2. Intraoperative Variables and Surgeon Experience.

Variable	Total Patients (n=2840)	No Bile Duct Injury (n=2819)	Bile Duct Injury (n=21)	P-value
Severe Inflammation	620 (21.8%)	604 (21.4%)	16 (76.2%)	< 0.001
Intraoperative Bleeding	310 (10.9%)	296 (10.5%)	14 (66.7%)	< 0.001
Anatomical Variations	240 (8.5%)	231 (8.2%)	9 (42.9%)	< 0.001
Critical View Not Achieved	450 (15.8%)	431 (15.3%)	19 (90.5%)	< 0.001
Surgeon Level (Junior)	1200 (42.3%)	1181 (41.9%)	19 (90.5%)	< 0.001
Conversion to Open	180 (6.3%)	165 (5.9%)	15 (71.4%)	< 0.001

Among the 21 patients who sustained a bile duct injury, the injuries were classified using the Strasberg system. The majority of injuries were severe, with 14 cases classified as Type E (involving the common hepatic or common bile duct), specifically 8 cases of E2 and 6 cases of E3. Four cases were classified as Type D (lateral injuries to the common bile duct), and three cases were classified as Type B (occlusion of an aberrant right hepatic duct). Intraoperative recognition occurred in 15 cases, leading to immediate conversion and attempted repair, while 6 cases were recognized postoperatively due to persistent bile leakage and abdominal pain.

Discussion

Research reviewed the prevalence of bile duct injuries during laparoscopic cholecystectomy procedures performed on patients from Al-Hussein Teaching Hospital located in Samawa, Iraq. Prevalence rates of these injuries were found to be 0.74%, a slightly higher incidence than many internationally reported rates cited as "0.2% - 0.6%" based upon large scale meta-analyses and established national databases from the Western World [4, 5]. Compared to the rate of similar studies conducted in developing countries, and regional surgical centers throughout the Middle East, our finding of 0.74% closely parallels studies showing that rates sometimes approach or even exceed 0.8% [14]. The slight elevation in prevalence of this injury is unlikely to represent any deficiency in surgical competence, but is more likely attributable to the interface of delayed presentation of patients, advanced disease processes, and health resources challenges associated with healthcare systems in the region where the study was conducted. The socio-economic conditions in southern Iraq often require that a patient with gallstone disease experience symptoms for an extended period of time prior to seeking tertiary medical care, resulting in a surgical population with high severity of acute cholecystitis, significant scarring or 'fibrosis' in the region of the gallbladder, and distorted anatomy.

Another finding of this study included male gender as an independent predictor of bile duct injury, a well known but poorly understood phenomenon associated with biliary surgery. While the incidence of gallstone disease is significantly higher in women, men undergoing cholecystectomy experienced substantially more complications during their procedure than their female counterparts [8]. This is commonly referred to as the "male paradox" and can, in part, be explained by the different pathophysiologies of gallbladder disease in men and women, with men often presenting later in the disease process with more severe symptoms. Results from our cohort also indicated that male patients experienced more severe inflammation related to their cholecystitis and had a longer history of symptoms prior to their surgery.Men who have gallstones when their gallbladders are not functioning correctly tend to develop beige hardening as well as having their gallbladders adhere considerably further to their common bile duct and liver tissue. Fibrous tissue that encloses the triangle of Calot will

further impede the safe creation of the standard dissection plane and will cause a greater chance of misidentifying anatomical landmarks and result in major injuries.

The most considerable risk factor for having bile duct injuries identified preoperatively via a logistic regression analysis was the patient developing acute cholecystitis.(immediately?) Acutely inflamed (edematous) and very fragile tissues in those gallbladders that become hyperemic will present a surgical variation to the surgical area of dissection because those tissues in Calot's triangle will now be very difficult to dissect bluntly as required to obtain a safe surgical view. Bleeding is easy with manipulation under acute inflammation and the deteriorated condition of the tissue following manipulation, the typical surgeon may unnecessarily use aggressive traction, blind clipping or some other mechanism to compensate for the difficulty in manipulating or defining the anatomy of the gallbladder and create or directly cause an injury to the common bile duct or hepatic duct.

Once within the laparoscopic field, surgeons may not have time to establish an operative field due to a lack of defined specific operative field/landmarks and the ability to clearly see the cystic duct or any other anatomical landmark is compromised directly as a result of visual obstruction created when an aberrant cystic artery or an aberrant vessel located within Calot's triangle is bleeding.

When intraoperative bleeding occurs within the laparoscopic field it is typically related to bile duct injury secondary to the cascading failure that occurs as described in the literature on surgical cognitive psychology. When an aberrant artery/vein from within Calot's triangle ruptures, bleeding occurs, and the surgeon's ability to see or manipulate the anatomy of Calot's triangle is significantly limited due to the plentiful presence of blood in the operative field.Surgeons tend to focus only on achieving hemostasis and may forget being systematic in their identification of anatomy. In their efforts to control the hemorrhage, a surgeon may use clips and/or electrocautery blindly. Blindly applied clips or electrocautery can lead to inclusion of the common bile duct or right hepatic duct or thermal injuries due to stray electrocautery energy [11]. This highlights the importance of the surgical principle that when there is an uncontrolled hemorrhage in Calot's triangle, the surgeon should temporarily pack the area first and irrigate afterwards and consider converting to an open procedure rather than applying clips blindly.

The inability to achieve the critical view of safety was present in all our injury subjects which emphasizes that this is a critical cognitive tool in preventing bile duct injuries [1]. The critical view of safety involves the identification of only two anatomic structures entering the gallbladder at its base, and the complete removal of fat and fibrous tissue from the hepatocystic triangle in order to accurately identify the location of the cystic duct in relation to the common bile duct. By using this method, the surgeon does not have to specifically identify the common bile duct and, thus, avoids the assumption that it is the cystic duct solely because it is visible; this is especially true in our present series due to the occasional use of the infundibulum technique to identify the common bile duct; this technique can be dangerous in cases of severe inflammation because the infundibWhen there is fusion of the two structures, a common channel is created and the surgeon mistakenly transects the common bile duct thinking it is the cystic duct. The relationship between the junior surgeon's level of experience and the incidence of biliary injury brings to light the persistent problem of the learning curve in laparoscopic surgery [9]. The laparoscopic cholecystectomy is considered a standard procedure in surgical training, however, the ability to acquire the more advanced skills necessary for handling very complicated anatomy with hostile anatomical conditions can only be accomplished with appropriate supervision in the form of additional experience. Junior residents are more likely than seniors to exhibit cognitive bias (i.e., confirmation bias) after making an initial misidentification of a structure as the cystic duct leading them to interpret subsequent findings in a way that supports their previous error even when the anatomical evidence contradicts their earlier interpretation [15]. Furthermore, junior surgeons may be afraid to abandon laparoscopic surgery in favour of an open procedure due to a lack of confidence after having encountered dangerous dissection. Due to the hierarchical nature of surgical training in teaching hospitals in Iraq, senior surgeons are required to intervene and perform the dissection when the residents have experienced significant inflammation or anomalous anatomy; this is the point at which senior surgeons should intervene and perform the procedure, rather than simply provide observation.

The anatomical variations described in this study, especially the short cystic duct and the aberrant right hepatic duct, continue to be an endless trap for the inexperienced surgeon [12]. There is a significant percentage of the population that has an aberrant right hepatic duct that drains either into the common hepatic duct or into the cystic duct directly.Surgeons may not always recognize variation in anatomy when performing laparoscopic cholecystectomies. If they aggressively occlude what they think is the cystic artery or one of its other branches, the surgeon could transect the abnormal duct. The inability for surgeons to assess three-dimensional structures due to two-dimensional images of laparoscopes and no tactile feedback interferes with the recognition of potentially harmful variations in the anatomy.

Routine intraoperative cholangiography has been proposed for the identification of all biliary structures before any division or cutting occurs to reduce the risk of injury. Despite this, intraoperative cholangiography is not a routine procedure in our institution because it requires additional resources that are not routinely available in the operating room, which causes longer operations and the lack of fluoroscopic equipment in every operating room [13, 20]. The debate on the benefit of routine versus selective intraoperative cholangiography continues; however, the use of intraoperative cholangiography is an intervention that forces a surgeon to review the biliary anatomy before any part of the anatomy is divided or cut, ultimately providing a more accurate assessment [2, 5].

The management of bile duct injuries in our population was dependent on intraoperative recognition of the injury. In most cases, the injury was immediately identified, allowing for a primary repair as what is often the only patient-specific option for repair or for the patient to undergo definitive Roux-en-Y hepatico-jejunostomy for a major transection injury [17]. In those patients who had their injuries delayed, the clinical outcomes were significantly poorer and often manifested as peritonitis, sepsis, or secondary biliary cirrhosis. This circumstance creates a need for careful postoperative monitoring of patients who experience any abnormal postoperative symptom, such as persistent abdominal pain, fever, or jaundice, and who need an ultrasound or magnetic resonance cholangiopancreatography study.

This study also has limitations due to its single institution nature and its status as a teaching facility in southern Iraq. As a result of this limitation, it cannot be generalized to any other facilities, private hospitals, or patient demographics and/or healthcare access patterns in other regions. The retrospective nature of many of these procedures led to a significant amount of documentation bias, as it will depend on the complete and consistent documentation by different surgeons regarding the severity of inflammation on presentation and/or the reason an appropriate critical view of safety could not be achieved. Also, while the assessment of intraoperative bleeding and inflammation is based on clinical yet subjective criteria, there are no objective quantitative criteria.

In summary, the rate of occurrence of bile duct injury related to laparoscopic cholecystectomy at Al-Hussein Teaching Hospital is 0.74% and is primarily related to female gender, the severity of inflammation, intraoperative blood loss, differences in anatomy, and procedures performed by junior-level surgeons. To decrease the occurrence of this preventable complication, an institutional change is necessary and emphasized by the requirement to achieve the critical view of safety for all laparoscopic cholecystectomy procedures. In addition, the curriculum for surgical training programs must include a complete discussion of the types of cognitive errors that cause intraoperative bleeding or failure to achieve a critical view and promote the philosophy that conversion from laparoscopic to open surgery is a demonstration of good surgical judgment rather than a failure. The use of selective intraoperative cholangiography and establishing a lower threshold for performing subtotal cholecystectomy in patients with severe inflammation of the gallbladder will greatly improve patient safety and reduce the incidence of iatrogenic biliary injury in hospitals throughout Iraq.

Conclusion

The prevalence of bile duct injury during laparoscopic cholecystectomy at Al-Hussein Teaching Hospital in Samawa, Iraq, is 0.74%. The primary independent risk factors driving this complication include male gender, acute cholecystitis with severe inflammation, intraoperative bleeding obscuring Calot's triangle, the presence of aberrant biliary anatomy, and operations performed by junior surgeons. These findings highlight the critical need for strict adherence to the

Critical View of Safety, improved intraoperative decision-making regarding conversion to open surgery, and enhanced supervised training protocols for resident surgeons in Iraqi teaching hospitals to minimize this devastating complication.

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