Bile duct injuries during laparoscopic cholecystectomy

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LIST OF ABBREVIATIONS

LC - Laparoscopic cholecystectomy

BDIs - Bile duct injuries

CBD - Common bile duct

CHD - Common hepatic duct

RHD - Right hepatic duct

AC - Acute cholecystitis

VBI - Vasculo-biliary injury

ERCP - Endoscopic retrograde cholangiopancreatography

CVS - Critical view of safety

IOC - Intraoperative cholangiography

LUS - Laparoscopic ultrasound

NIRF-C - Near-infrared fluorescent cholangiography

NIH - National Institutes of Health

US - United States

ABSTRACT

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Keywords: bile duct injury, laparoscopic cholecystectomy, risk factors, classification, management.

Laparoscopic cholecystectomy stands as one of the most frequently conducted surgical procedures globally, offering a minimally invasive approach for treating cholecystitis, biliary colic and symptomatic gallbladder stones. Despite its widespread adoption and numerous advantages, such as reduced postoperative pain, shorter hospital stays, and quicker recovery times compared to open surgery, the occurrence of bile duct injuries (BDIs) remains a persistent concern in clinical practice.

This comprehensive review delves into the extensive body of literature surrounding laparoscopic cholecystectomy and its associated bile duct injuries. By meticulously analyzing data from various studies, this review aims to provide a thorough understanding of the incidence, prevalence, risk factors, classification, management strategies, and preventative measures related to BDIs during laparoscopic cholecystectomy.

BDIs during laparoscopic cholecystectomy represent a significant complication, encompassing a spectrum of clinical implications ranging from minor ductal leaks to more severe injuries requiring complex surgical interventions.

By synthesizing the wealth of information available in the literature, this review aims to contribute to the body of knowledge surrounding BDIs during laparoscopic cholecystectomy. With a deeper understanding of the incidence, risk factors, classification, management strategies, and preventative measures associated with BDIs, clinicians can strive to minimize the occurrence of these complications and optimize patient outcomes in clinical practice.

SAŽETAK

Ozljede žučnih vodova tijekom laparoskopske kolecistektomije

Lia-rose Schnitzer

Ključne riječi: ozljeda žučnog voda, laparoskopska kolecistektomija, čimbenici rizika, klasifikacija, upravljanje.

Laparoskopska kolecistektomija jedna je od najčešće provedenih kirurških procedura na globalnoj razini, nudeći minimalno invazivan pristup za liječenje kolecistitisa i bilijarne kolike. Unatoč širokoj primjeni i brojnim prednostima, poput smanjenja postoperativne boli, kraćeg boravka u bolnici i bržeg oporavka u usporedbi s otvorenom operacijom, pojava ozljeda žučnih vodova (BDI) i dalje ostaje trajna briga u kliničkoj praksi.

Ovaj sveobuhvatan pregled istražuje opsežnu literaturu vezanu uz laparoskopske kolecistektomije i pridružene ozljede žučnih vodova. Pažljivom analizom podataka iz različitih studija, ovaj pregled ima za cilj pružiti temeljito razumijevanje učestalosti, prevalencije, čimbenika rizika, klasifikacije, strategija upravljanja i preventivnih mjera vezanih uz BDI tijekom laparoskopske kolecistektomije.

Ozljede žučnih vodova tijekom laparoskopske kolecistektomije predstavljaju značajnu komplikaciju, obuhvaćajući spektar kliničkih implikacija od manjih curenja iz vodova do težih ozljeda koje zahtijevaju složene kirurške intervencije.

Sintetiziranjem bogatstva informacija dostupnih u literaturi, ovaj pregled ima za cilj doprinijeti bazi znanja o BDI tijekom laparoskopske kolecistektomije. S dubljim razumijevanjem učestalosti, čimbenika rizika, klasifikacije, strategija upravljanja i preventivnih mjera povezanih s BDI, kliničari mogu nastojati smanjiti pojavu ovih komplikacija i optimizirati ishode za pacijente u kliničkoj praksi.

INTRODUCTION

The advent of laparoscopic cholecystectomy (LC) in 1985 by Mühe marked a significant milestone in the field of surgery, revolutionizing the management of cholelithiasis. Initially performed under direct scope vision, LC saw further refinement with the introduction of video-laparoscopy by Mouret in 1987, a technique that quickly gained global acceptance thanks to the pioneering efforts of Dubois and Perissat (1).

By 1992, LC had garnered widespread recognition as a safe and effective treatment modality for symptomatic cholelithiasis, with a consensus statement from the National Institutes of Health (NIH) affirming its clinical utility (2). Despite this endorsement, LC presents unique challenges compared to traditional open abdominal surgery. Its reliance on external visual imaging and the absence of tactile feedback pose particular difficulties, especially in cases of acute cholecystitis (AC) characterized by significant inflammation and fibrosis (3).

However, ongoing advancements in optical and surgical instrumentation, coupled with refinements in surgical techniques, have expanded the applicability of LC, leading to its increased utilization even in cases of AC. The establishment of standardized severity assessment criteria for AC has further facilitated its broader adoption in clinical practice.

As LC has become more commonplace, the incidence of bile duct injury (BDI) has emerged as a notable concern, particularly in cases of severe AC. Patients who experience vasculo-biliary injury (VBI) in particular face poor prognoses (4), with the likelihood of BDI escalating in tandem with the severity of AC (5).

In light of these challenges, efforts to establish safe LC procedures based on consensus indicators of surgical difficulty have become paramount. Mitigating the risk of BDI and VBI remains a crucial objective in optimizing patient outcomes. Therefore, this systematic review aims to explore the classification of BDIs, elucidate their risk factors and incidence rates, and evaluate various treatment strategies and preventative measures. By synthesizing existing evidence, this review endeavors to inform clinical practice and enhance patient safety in the realm of LC surgery.

INCIDENCE AND PREVALENCE OF BILE DUCT INJURIES

The incidence and prevalence of bile duct injuries (BDIs) during laparoscopic cholecystectomy (LC) represent critical aspects of understanding the scope and impact of this complication. BDIs often occur due to the misidentification of the common bile duct (CBD) as the cystic duct, highlighting the technical intricacies and challenges inherent in this surgical procedure.

Statistics reveal that the reported incidence of BDIs during LC ranges from 0.3% to 0.7% of approximately 750,000 LC procedures performed annually in the United States (US) (6). Despite advancements in surgical techniques and technology, BDIs continue to pose a significant risk to patient safety, with potentially severe morbidity rates ranging from 25% to 32.4% if not promptly recognized and managed (7).

A comprehensive survey of 77,604 cases conducted across 4,292 US hospitals in 1993 shed further light on the prevalence of BDIs, reporting an incidence of 0.6% among LC procedures (8). This large-scale analysis underscores the importance of recognizing BDIs as a relatively common complication associated with LC, warranting careful consideration and proactive measures to mitigate risks.

Recent research endeavors have continued to investigate the incidence of BDIs, providing updated insights into their prevalence among elective and emergency LC cases. Notably, a recent study reported BDIs in 0.4% and 0.8% of elective and emergency LC procedures, respectively (9). These findings highlight the ongoing need for vigilance and adherence to best practices during both planned and emergent LC surgeries to minimize the occurrence of BDIs and optimize patient outcomes.

Overall, the incidence and prevalence data surrounding BDIs during LC underscore the importance of ongoing surveillance, quality improvement initiatives, and adherence to established guidelines and safety protocols. By remaining vigilant and implementing evidence-based strategies, healthcare professionals can strive to reduce the incidence of BDIs and enhance the safety and efficacy of LC procedures for patients worldwide.

CLASSIFICATION OF BILE DUCT INJURIES

Throughout the years many classifications of BDI's were described, the following section will try to explain them in the simplest way.

- **Bismuth classification**

The first classification of bile duct injury was described by H. Bismuth in 1982. It's based on the location of the injury in the biliary tract and is quite simple.
It includes five types of BDI's according to the distance from the hepatic hilus, the level of injury, the involvement of bile duct bifurcation, and individual right sectoral duct(10).

- **Strasberg classification**

The Strasberg classification is similar to the Bismuth, but incorporates a few additional biliary injuries seen more commonly in the laparoscopic era, most contributively biliary leaks. And so it is known as the Bismuth-Strasberg classification and is the most used one (11). A drawing of the anatomy is depicted in figure 1.

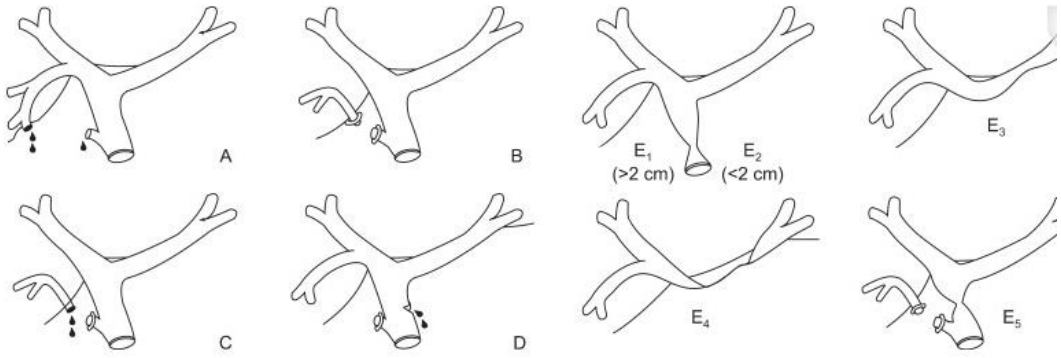

Figure 1.
Strasberg classification of bile duct injuries (12), (13). From: Chun K. Recent classifications of the common bile duct injury. Korean J Hepatobiliary Pancreas Surg. 2014 Aug;18(3):69–72. Copyright © 2014 by The Korean Association of Hepato-Biliary-Pancreatic Surgery.
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- **McMahon classification**

McMahon et al introduced an alternative classification system, differentiating between major and minor biliary injuries. Lacerations encompassing less than 25% of the diameter of the CBD or the cystic-CBD junction were categorized as minor injuries, whereas transection or lacerations exceeding 25% of the CBD diameter, along with postoperative bile duct strictures, were classified as major injuries(14).

- **Stewart-Way classification**

Stewart-Way gives four classes based on the mechanism and anatomy of biliary injury. This classification emerged from the examination of operative reports, shedding light on the human errors and cognitive processes implicated in the mechanisms leading to BDIs.

Class I- two options fit into this class. The first is the injury occurs when the CBD is erroneously identified as the cystic duct, but the mistake is identified before the CBD is divided. The second is the unintentional prolongation of a cut initially made in the cystic duct to accommodate the cholangiogram catheter, which then extends into the CBD.

Class II- involve lateral harm to the CHD, leading to stricture or leakage. Such injuries occur when clips or electro-cautery are applied in close proximity to the CBD, particularly in scenarios characterized by diminished visibility due to severe inflammation or excessive bleeding.

Class III- constituting the majority (approximately 60% of cases)(6), entail the complete severance of the primary bile duct, invariably encompassing the junction between the cystic duct and the common hepatic duct.

Class IV- encompass the transection or leakage of the right hepatic duct (RHD) or the posterolateral sectoral duct, frequently accompanied by damage to the right hepatic artery (15). A drawing of the anatomy is depicted in figure 2.

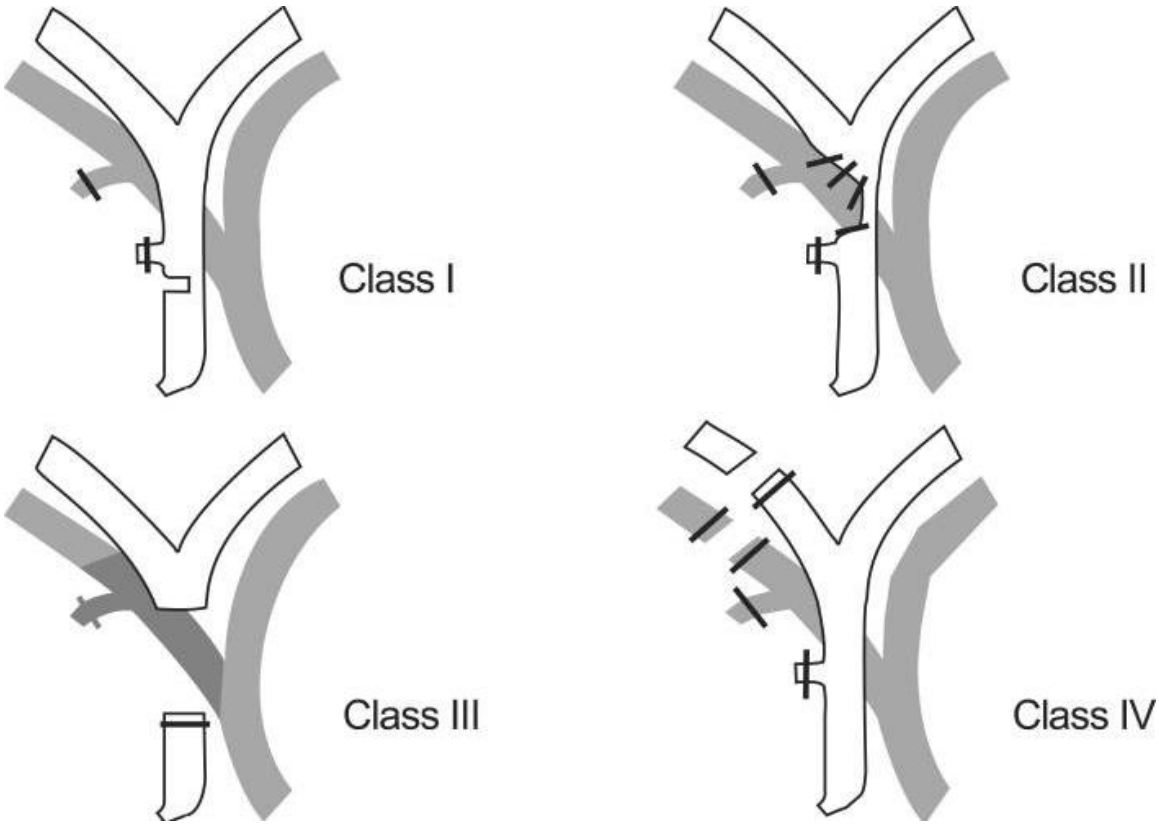

Figure 2.
Stewart-Way classification of bile duct injuries(16), (15). From: Chun K. Recent classifications of the common bile duct injury. Korean J Hepatobiliary Pancreas Surg. 2014 Aug;18(3):69–72.

- **Mattox classification**

The Mattox classification system takes into consideration the types of injuring factors (laceration, contusion, transection, perforation, diversion or interruption of the bile duct) (17).

There are a few more classification systems that are used, this article tries to summaries the ones that are relevant for injuries during LC.

RISK FACTORS OF BILE DUCT INJURIES

Risk factors for bile duct injuries (BDIs) during laparoscopic cholecystectomy (LC) are diverse and can arise from a variety of sources, both intrinsic and extrinsic to the patient. Understanding these risk factors is crucial for surgeons to anticipate and mitigate potential complications.

Anatomic Variants

Several anatomical variations present significant challenges to safe cholecystectomy. These include:

- **Short Cystic Duct:** A short cystic duct can make it difficult to properly differentiate between the cystic duct and the common bile duct (CBD), increasing the risk of misidentification and subsequent injury.
- **Cystic Duct Parallel to the CBD:** When the cystic duct runs parallel to the CBD, it can be challenging to distinguish between the two during dissection, leading to potential injury.
- **Cystic Duct Insertion on the Right Hepatic Duct:** This anatomical variation complicates the procedure by altering the usual landmarks surgeons rely on, increasing the likelihood of accidental damage.
- **Accessory Cystic Duct:** The presence of an additional cystic duct can cause confusion during surgery, as it may be mistaken for the main cystic duct or another structure.
- **Ducts of Luschka:** These small ducts, often located near the gallbladder bed, can be inadvertently injured during dissection if not properly identified and managed.patient condition- Severe obesity, previous hepatobiliary or upper abdominal surgery, and underlying liver conditions such as cirrhosis can hinder visualization and elevate the risk of injury. However, it's noteworthy that 80% of injuries occur even in the absence of these risk factors (19).

Patient Condition

Patient-specific factors can also elevate the risk of BDI during LC:

- **Severe Obesity:** Excess adipose tissue can obscure vital anatomical landmarks, making it more challenging to perform the surgery safely.
- **Previous Hepatobiliary or Upper Abdominal Surgery:** Scar tissue from previous surgeries can distort normal anatomy and create adhesions, complicating the dissection process.

- **Underlying Liver Conditions (e.g., Cirrhosis):** Liver diseases can alter the normal anatomical relationships and vascular structures, increasing the complexity of the surgery and the risk of injury.

  Despite these conditions, it is noteworthy that a significant number of BDIs (approximately 80%) occur even in patients without these specific risk factors, underscoring the inherent risks associated with the procedure (19).

Operator-Related Factors

The surgeon's experience and proficiency are critical in determining the likelihood of BDI:

- **Experience with LCs:** Surgeons who have performed a higher number of LCs typically have lower rates of complications, including BDIs. Experience allows for better anticipation of anatomical variations and improved surgical technique.
- **Advanced Minimally Invasive Techniques:** Early adoption of advanced techniques, such as single-incision laparoscopic surgery, can pose a higher risk of BDI due to the learning curve associated with these procedures. Novice surgeons may face difficulties in navigating these new approaches safely compared to conventional LC methods (20).

Gallbladder Pathology

The condition of the gallbladder itself is a significant determinant of BDI risk:

- **Acute Cholecystitis:** Inflammation associated with acute cholecystitis can lead to adhesions, thickening of the gallbladder wall, and increased bleeding, all of which complicate the surgical field and elevate the risk of BDI (21).
- **Chronic Cholecystitis:** Chronic inflammation can cause fibrosis of the gallbladder fossa or porta hepatis, making dissection more difficult and increasing the likelihood of complications.

Additional Considerations

Beyond the primary categories of risk factors, several additional considerations are relevant:

- **Intraoperative Challenges:** Difficulties encountered during the procedure, such as poor visibility due to bleeding or anatomical distortions, can increase the likelihood of BDI. Surgeons must be prepared to employ alternative strategies, such as converting to open surgery or performing intraoperative cholangiography, to clarify the biliary anatomy.
- **Surgical Tools and Techniques:** Advances in surgical instruments and imaging technologies, such as laparoscopic ultrasound and near-infrared fluorescent cholangiography, can aid in better visualization of the biliary anatomy and potentially reduce the risk of injury.

By recognizing and understanding these multifactorial risk factors, surgeons can take proactive steps to minimize the risk of BDI during laparoscopic cholecystectomy. This includes thorough preoperative planning, meticulous surgical technique, and the judicious use of advanced imaging technologies to enhance the safety and effectiveness of the procedure.

MANAGEMENT AND OUTCOMES

The management and outcomes vary greatly between the different kinds of injuries, some can be repaired intraoperatively and some will only be diagnosed later and would be reasonably solved endoscopically, some are to advanced and will need a connection with the duodenum or even a liver resection and transplant in very sever cases.
A minority of bile duct injuries, ranging from 8% to 33%, are recognized during the initial LC (22). Suspicion of a biliary injury arises typically from unexplained bile drainage. In such cases, surgeons must identify the biliary anatomy cholangiographically to prevent further injury. Intraoperative recognition allows for immediate repair by an experienced surgeon. However, in situations where injuries are noted postoperatively, a multidisciplinary approach is essential for appropriate management.

To explain each method of management and outcome the Strasberg classification will be used.

In type A- a cystic duct leak or leaks from the small ducts in the liver bud three ways can be tried. Most commonly a conservative treatment is being chosen where a drain is placed to drain the bile until the leak closes by itself(19).
An endoscopic biliary stenting done in ERCP, its aim is to decrease pressure in the proximal biliary system. Two weeks after the procedure a try to remove the stent in a follow up ERCP can be done if the patient is asymptomatic and no ongoing leaks are detected(23). If choledocholithiasis is still in place a Sphincterotomy may be necessary to promote free flow of bile across the ampulla without stent insertion. In a limited number of cases, interventional radiology has been documented to utilize coil embolization as a treatment approach for Type A injuries characterized by leakage from the cystic duct stump (24).

In type B- injuries pose unique challenges, typically requiring a tailored approach based on the severity of symptoms and associated complications such as cholangitis. Drainage procedures may be necessary to mitigate symptoms and prevent further complications. In severe cases, hepaticojejunostomy may be warranted to restore biliary flow and alleviate symptoms effectively (19).

Type C injuries, involving injury to the accessory duct, present significant management complexities. Unlike other types, they are not amenable to endoscopic intervention, necessitating a multidisciplinary approach for effective management.

Type D injuries vary in severity, with small injuries potentially manageable through less invasive approaches such as endoscopic sphincterotomy and stent placement. Conversely, larger injuries may necessitate surgical repair to restore biliary integrity and prevent long-term complications.

Type E injuries represent the most severe category, often requiring primary repair or reconstruction due to the extensive damage incurred. The management approach is highly individualized, contingent upon factors such as the extent of the injury and the patient's overall condition. Surgical expertise and careful consideration of the anatomical and physiological factors are paramount in achieving successful outcomes in these challenging cases (25).

Vascular injuries associated with bile duct injuries may require angioembolization, percutaneous drainage, or liver resection. The success of treatment depends on various factors, including the degree of bile duct injury and the anatomical location of the injury (24).

In summary, early recognition, accurate classification, and appropriate management of biliary tract injuries are paramount in ensuring optimal patient outcomes. Collaboration among specialists and adherence to established treatment algorithms are essential in managing these complex injuries effectively.

PREVENTATIVE MEASURES

Various methods have been devised and advocated to prevent BDI's during LC. Some of the most used ones are:

- Critical view of safety (CVS) method
- Infundibular technique
- Antegrade dissection
- Subtotal cholecystectomy
- Anatomic landmarks:
  - Rouviere's sulcus
  - Calot's node
  - B-SAFE method
- Intra-operative cholangiography (IOC)
- Laparoscopic ultrasound (LUS)
- Near-infrared fluorescent cholangiography (NIRF-C)
- Conversion to open surgery

Note: B-SAFE: B, bile duct; S, sulcus of Rouvière; A, hepatic artery; F, umbilical fissure; E, enteric/duodenum(6).

The most used and known one is the "critical view of safety (CVS)," introduced by Strasberg in 1995 (26), considered the gold standard for safe cholecystectomy. This method emphasizes the meticulous identification of biliary structures during dissection, requiring clearance of the hepatocystic triangle from adipose and fibrotic tissues, separation of the lower third of the gallbladder from the cystic plate, and identification of only two structures entering the gallbladder: the cystic duct and cystic artery (27).

The critical view of safety technique serves as a crucial safeguard against bile duct injuries by ensuring a clear visual delineation of anatomical structures. By achieving this view, surgeons minimize the risk of inadvertent damage to the common bile duct or hepatic duct during the dissection process.

In challenging cases where achieving the critical view is difficult due to local inflammation or distorted anatomy, alternative strategies such as the infundibular

technique or antegrade dissection may be employed. The infundibular method involves working closely to the gallbladder infundibulum to reduce the risk of biliary injuries. However, caution is warranted to avoid the deceptive appearance of the "hidden cystic duct" syndrome, which can mislead the surgeon into misidentifying the common bile duct as the cystic duct (28).

Routine intraoperative cholangiography (IOC) has been proposed to enhance the delineation of biliary anatomy and reduce the incidence of bile duct injuries. However, its utility remains a subject of debate due to associated morbidity and mortality (29). Laparoscopic ultrasound (LUS) offers highly sensitive mapping of the extra-hepatic biliary anatomy but is limited by a difficult learning curve (30).

Fluorescence image-guided surgery, such as near-infrared fluorescent cholangiography (NIRF-C), represents a promising advancement in intraoperative imaging, allowing real-time enhanced visualization of the biliary tree. By leveraging fluorescent imaging, surgeons can accurately identify critical anatomical landmarks and avoid inadvertent injuries to the biliary system (31), (32).

Despite ongoing debates, there is growing consensus on the significance of techniques like the critical view of safety and NIRF-C in preventing bile duct injuries during laparoscopic cholecystectomy. These methods underscore the importance of meticulous surgical technique and anatomical awareness to ensure patient safety(33).

In complex cases where achieving a safe dissection proves challenging, conversion to an open approach should be considered without hesitation, emphasizing the importance of experience and caution in biliary surgery. Collaborative efforts, such as the Safe Cholecystectomy program by SAGES, aim to educate and promote the adoption of safety measures like the critical view of safety to minimize the risk of inadvertent injury, particularly in challenging gallbladder cases. By prioritizing patient safety and employing advanced imaging techniques, surgeons can mitigate the risk of bile duct injuries and optimize outcomes in laparoscopic cholecystectomy.

CONCLUSIONS

LC, while widely accepted as a safe and effective treatment for gallbladder disease, carries an inherent risk of BDIs. This comprehensive review has highlighted the significant impact of BDIs, emphasizing the importance of recognizing their incidence, understanding the associated risk factors, and implementing appropriate management strategies.

The incidence of BDIs during laparoscopic cholecystectomy, ranging from 0.3% to 0.7%, underscores the need for vigilance and adherence to best practices. While anatomical variations, patient factors, and surgical experience contribute to the risk of BDIs, a significant proportion of injuries can occur even in the absence of known risk factors, necessitating a high level of caution in every case.

Accurate classification of BDIs is crucial for determining the appropriate management approach, which may range from conservative treatment to complex surgical interventions. Early recognition and prompt multidisciplinary management are essential for optimizing patient outcomes and minimizing long-term complications.

Preventative measures, such as the critical view of safety technique, routine use of intraoperative imaging modalities like cholangiography and near-infrared fluorescent cholangiography, and judicious conversion to open surgery when necessary, have emerged as key strategies to mitigate the risk of BDIs. Ongoing education, refinement of surgical techniques, and the adoption of standardized protocols are imperative to enhance patient safety and ensure the continued safe practice of laparoscopic cholecystectomy.

In conclusion, this review underscores the significance of recognizing and effectively managing bile duct injuries during LC. By fostering a deeper understanding of the risk factors, implementing evidence-based preventative measures, and promoting a culture of safety and vigilance, the medical community can strive to minimize the occurrence of these potentially devastating complications and optimize outcomes for patients undergoing this common surgical procedure.

REFERENCES

1. Miyasaka Y, Nakamura M, Wakabayashi G. Pioneers in laparoscopic hepato-biliary-pancreatic surgery. J Hepato Biliary Pancreat. 2018 Jan;25(1):109–11.

2. NIH Consensus conference. Gallstones and laparoscopic cholecystectomy. JAMA. 1993 Feb 24;269(8):1018–24.

3. Wakabayashi G, Iwashita Y, Hibi T, Takada T, Strasberg SM, Asbun HJ, et al. Tokyo Guidelines 2018: surgical management of acute cholecystitis: safe steps in laparoscopic cholecystectomy for acute cholecystitis (with videos). J Hepatobiliary Pancreat Sci. 2018 Jan;25(1):73–86.

4. Törnqvist B, Zheng Z, Ye W, Waage A, Nilsson M. Long-term effects of iatrogenic bile duct injury during cholecystectomy. Clin Gastroenterol Hepatol. 2009 Sep;7(9):1013–8; quiz 915.

5. Törnqvist B, Waage A, Zheng Z, Ye W, Nilsson M. Severity of Acute Cholecystitis and Risk of Iatrogenic Bile Duct Injury During Cholecystectomy, a Population-Based Case-Control Study. World J Surg. 2016 May;40(5):1060–7.

6. Pesce A, Palmucci S, La Greca G, Puleo S. Iatrogenic bile duct injury: impact and management challenges. Clin Exp Gastroenterol. 2019;12:121–8.

7. Lau WY, Lai ECH, Lau SHY. Management of bile duct injury after laparoscopic cholecystectomy: a review. ANZ J Surg. 2010 Jan;80(1–2):75–81.

8. Deziel DJ, Millikan KW, Economou SG, Doolas A, Ko ST, Airan MC. Complications of laparoscopic cholecystectomy: a national survey of 4,292 hospitals and an analysis of 77,604 cases. Am J Surg. 1993 Jan;165(1):9–14.

9. de'Angelis N, Catena F, Memeo R, Coccolini F, Martínez-Pérez A, Romeo OM, et al. 2020 WSES guidelines for the detection and management of bile duct injury during cholecystectomy. World J Emerg Surg. 2021 Jun 10;16(1):30.

10. Bismuth H, Majno PE. Biliary strictures: classification based on the principles of surgical treatment. World J Surg. 2001 Oct;25(10):1241–4.

11. Tarantino I, Baron TH, Ligresti D. Biliary Surgery Adverse Events, Including Liver Transplantation. In: ERCP [Internet]. Elsevier; 2019 [cited 2024 May 16]. p. 422-431.e1. Available from: https://linkinghub.elsevier.com/retrieve/pii/B9780323481090000444

12. Strasberg SM, Hertl M, Soper NJ. An analysis of the problem of biliary injury during laparoscopic cholecystectomy. J Am Coll Surg. 1995 Jan;180(1):101–25.

13. Sahajpal AK, Chow SC, Dixon E, Greig PD, Gallinger S, Wei AC. Bile duct injuries associated with laparoscopic cholecystectomy: timing of repair and long-term outcomes. Arch Surg. 2010 Aug;145(8):757–63.

14. McMahon AJ, Fullarton G, Baxter JN, O'Dwyer PJ. Bile duct injury and bile leakage in laparoscopic cholecystectomy. Br J Surg. 1995 Mar;82(3):307–13.

15. Chun K. Recent classifications of the common bile duct injury. Korean J Hepatobiliary Pancreat Surg. 2014 Aug;18(3):69–72.

16. Way LW, Stewart L, Gantert W, Liu K, Lee CM, Whang K, et al. Causes and Prevention of Laparoscopic Bile Duct Injuries: Analysis of 252 Cases From a Human Factors and Cognitive Psychology Perspective. Annals of Surgery. 2003 Apr;237(4):460–9.

17. Eastwood D. Trauma. 3rd edition. Injury. 1996 Sep;27(7):531.

18. Nuzzo G, Giuliante F, Giovannini I, Ardito F, D'Acapito F, Vellone M, et al. Bile duct injury during laparoscopic cholecystectomy: results of an Italian national survey on 56 591 cholecystectomies. Arch Surg. 2005 Oct;140(10):986–92.

19. Moghul F, Kashyap S. Bile Duct Injury. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 [cited 2024 May 16]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK546703/

20. Joseph M, Phillips MR, Farrell TM, Rupp CC. Single incision laparoscopic cholecystectomy is associated with a higher bile duct injury rate: a review and a word of caution. Ann Surg. 2012 Jul;256(1):1–6.

21. Georgiades CP, Mavromatis TN, Kourlaba GC, Kapiris SA, Bairamides EG, Spyrou AM, et al. Is inflammation a significant predictor of bile duct injury during laparoscopic cholecystectomy? Surg Endosc. 2008 Sep;22(9):1959–64.

22. Karanikas M, Bozali F, Vamvakerou V, Markou M, Memet Chasan ZT, Efraimidou E, et al. Biliary tract injuries after lap cholecystectomy—types, surgical intervention and timing. Ann Transl Med. 2016 May;4(9):163–163.

23. Siiki A, Vaalavuo Y, Antila A, Ukkonen M, Rinta-Kiikka I, Sand J, et al. Biodegradable biliary stents preferable to plastic stent therapy in post-cholecystectomy bile leak and avoid second endoscopy. Scand J Gastroenterol. 2018;53(10–11):1376–80.

24. Brown CS, Sanogo M, Patel A, Schulman AR, Raghavendran K, Georgoff PE. Management of a Persistent Cystic Duct Stump Leak Following Cholecystectomy With Percutaneous Transabdominal Cystic Duct Stump Embolization. ACG Case Rep J. 2019 Aug;6(8):e00162.

25. Woods MS, Traverso LW, Kozarek RA, Tsao J, Rossi RL, Gough D, et al. Characteristics of biliary tract complications during laparoscopic

cholecystectomy: a multi-institutional study. Am J Surg. 1994 Jan;167(1):27–33; discussion 33-34.

26. Strasberg SM, Brunt LM. Rationale and use of the critical view of safety in laparoscopic cholecystectomy. J Am Coll Surg. 2010 Jul;211(1):132–8.

27. Brunt LM, Deziel DJ, Telem DA, Strasberg SM, Aggarwal R, Asbun H, et al. Safe Cholecystectomy Multi-society Practice Guideline and State of the Art Consensus Conference on Prevention of Bile Duct Injury During Cholecystectomy. Ann Surg. 2020 Jul;272(1):3–23.

28. Strasberg SM, Eagon CJ, Drebin JA. The “hidden cystic duct” syndrome and the infundibular technique of laparoscopic cholecystectomy--the danger of the false infundibulum. J Am Coll Surg. 2000 Dec;191(6):661–7.

29. Flum DR, Dellinger EP, Cheadle A, Chan L, Koepsell T. Intraoperative cholangiography and risk of common bile duct injury during cholecystectomy. JAMA. 2003 Apr 2;289(13):1639–44.

30. Dili A, Bertrand C. Laparoscopic ultrasonography as an alternative to intraoperative cholangiography during laparoscopic cholecystectomy. World J Gastroenterol. 2017 Aug 7;23(29):5438–50.

31. Ishizawa T, Bandai Y, Kokudo N. Fluorescent cholangiography using indocyanine green for laparoscopic cholecystectomy: an initial experience. Arch Surg. 2009 Apr;144(4):381–2.

32. Pesce A, Latteri S, Barchitta M, Portale TR, Di Stefano B, Agodi A, et al. Near-infrared fluorescent cholangiography - real-time visualization of the biliary tree during elective laparoscopic cholecystectomy. HPB (Oxford). 2018 Jun;20(6):538–45.

33. Conrad C, Wakabayashi G, Asbun HJ, Dallemagne B, Demartines N, Diana M, et al. IRCAD recommendation on safe laparoscopic cholecystectomy. J Hepatobiliary Pancreat Sci. 2017 Nov;24(11):603–15.

BIOGRAPHY

Lia-rose Schnitzer is a final-year medical student with a passion for surgical specialties and a keen interest in hepatobiliary surgery. Throughout her medical education, she has demonstrated a strong commitment to academic excellence and clinical practice. She has actively participated in research projects, particularly focusing on surgical outcomes and complications. Her interest in bile duct injuries during laparoscopic cholecystectomy has been shaped by her experiences in surgical rotations. Her goal is to contribute valuable insights to the field of surgical management and patient care. Beyond her academic pursuits, she enjoys volunteering in community healthcare initiatives and is dedicated to lifelong learning.