



Iatrogenic Lesions of the Bile Duct

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Abstract: Introduction: the bile duct is an anatomical element of the human being and is a conduct that transports bile from the liver to the duodenum. Cholecystectomy is one of the most frequent surgical procedures in the world, and therefore the risk of injury to the bile duct. Objective: an exhaustive search of the national and international medical literature on iatrogenic bile duct injury and its variants in a medical and/or surgical setting. Discussion: laparoscopic cholecystectomy has reached at least twice the rate observed compared to open cholecystectomy. The term iatrogenesis is most often misinterpreted as medical malpractice. Iatrogenesis, according to the World Health Organization, is any harmful, unintentional, and unwanted effect that occurs during healthcare. Iatrogenic bile duct injury has catastrophic consequences because it requires reoperation, long-term follow-up, prolonged recovery, and unprecedented morbidity/mortality. The factors involved are the anatomical variants, the intense inflammatory process of the area, the hospital infrastructure and human expertise. Management can be endoscopic and/or surgical, which the latter is the main actor in reconstructions, such as hepatic-jejunum-anastomosis, hepatectomies, etc. Conclusions: cholecystectomy has a high risk of bile duct injury, its incidence is unknown in Mexico,

morbidity is exponential and consequently mortality. Suspecting that it has become the most frequent surgical pathology. An iatrogenic injury to the bile duct is an Armageddon to the patient/health system due to its high morbidity and mortality, its long duration and its high cost.

Keywords: Bile duct, Cholecystectomy, Iatrogenesis, Cholecystitis, Choledocholithiasis, Biliodigestive, Endoscopic retrograde cholangiopancreatography.

INTRODUCTION

The bile duct is an anatomical element in humans, called the biliary system, which is composed of the organs and ducts responsible for the production and transport of bile from the liver to the duodenum, and is subdivided into intrahepatic and extrahepatic structures. [1] John Stough Bobbs (1809-1870), who was the first physician to perform an elective operation on the gallbladder to treat gallstones, on June 15, 1867, on a patient in his office. [2, 3] However, it is also documented that it was in 1882 when Carl Langebuch performed the first conventional cholecystectomy. [4] Acute cholecystitis disease is defined as inflammation of the gallbladder. The pathophysiological mechanism of acute cholecystitis is the obstruction of the cystic duct, which etiologically can be caused by stones, without them, tumors and/or trauma, burns or even multifactorial. [5] It should be noted that due to the conjectures of the day-to-day work as surgeons of the authors of this manuscript, biliary pathology comes to occupy the first place in terms of surgical diseases in Mexico. [6] It is decisive that in the National Health System in Mexico there is no statistical database that contradicts it. [7, 8]

Biliary pathology involves liver, gallbladder, duodenal, pancreatic, or bile duct diseases; however, differential diagnoses should be suspected with systemic sepsis or even with hematologic entities. [9, 10] Acute cholecystitis is more common in women than in men. Gallstones affect 10-15% and the most severe form of gallstone disease can develop in up to 20% of people, suffer recurrent symptoms with biliary colic in 70%, obstruction of the bile ducts 24% or even pancreatitis in 6%. [11, 12] Cholecystitis, which is one of the most common digestive diseases, presents as cholelithiasis and affecting 10% of the world's population, and acute acalculous cholecystitis has been estimated to have an incidence of 2% of all cases in an acute cholecystitis scenario. [13, 14]

Cholecystectomy is one of the most performed abdominal surgical procedures in the world. Bile duct injuries are therefore the most feared and potentially fatal complication of this surgical act. These have been documented with significant morbidity and mortality, with multiple causes, with iatrogenic injury being the most frequent. [15]

It is imperative to define the term iatrogenesis, which in most cases is erroneously interpreted as medical malpractice. Iatrogenesis, according to the World Health Organization, is any harmful, unintentional, and unwanted effect that occurs during health care. Its etymological origin is made up of two Greek words, "iatros", which means physicians, and "genesis", which means origin. [16, 17] Laparoscopic cholecystectomy, which was first introduced in 1987 by the Frenchman Philippe Mouret, has increased the number of gallbladder operations worldwide, and despite its benefits, the incidence of bile duct injury has increased significantly, almost doubling in incidence over the years. a situation that resembles more growth in robotic surgery. [18] Not to mention that cholecystectomy

is common worldwide and varies by region. The history of this procedure is associated with an increased burden of gastrointestinal symptoms, erroneously attributed to a biliary disease for which a cholecystectomy was performed by mistake. [19] In addition, it is necessary to detail that a published study with the diagnosis of biliary etiology disease in a group of 6,665 patients who underwent cholecystectomy (4568 women and 2097 men) with a prevalence of female-to-male ratio of 4:1 and each diagnosis was corroborated with a histological report where it is estimated that choledocholithiasis affects approximately 5-10% of patients with cholelithiasis. although this figure could be underestimated. [20]

It is definite that during laparoscopic or conventional cholecystectomy the impact of bile duct lesions and choledocholithiasis is often overlooked. This situation increases costs without improving the patient's quality of life. Routine intraoperative cholangiography is the preferred option in cases of choledocholithiasis, and to avoid/diagnose the detection of a bile duct lesion, offering the advantage or not, of making the decision of an involvement towards immediate or postponed intraoperative management. [21, 22]

Choledocholithiasis is defined as when a gallstone blocks the common bile duct and does not allow bile to flow, causing bile to accumulate in the liver. [23] Its incidence is variable, ranging from 1% to 15% of patients with cholelithiasis have stones in the common bile duct. Stones form in the intrahepatic biliary tree, called primary hepatolithiasis, which can cause choledocholithiasis, and most cases of choledocholithiasis are secondary to the passage of gallstones from the gallbladder to the common bile duct, so it is estimated to be secondary choledocholithiasis. [24] The presentation of Mirizzi syndrome is acute or chronic cholecystitis with the addition of jaundice, although its incidence is different and uncertain in each geographic region, ranging from 0.5% to 77%, it is a rare condition caused by compression of the common hepatic duct due to stones located in the cystic duct or in the neck of the gallbladder. or to the wall involved but already with fistula, some detail 33%, other classifications 50% and with biliary ileus or not in a cholecystic-enteric fistula in a grade IV a vs IV b. [24, 25] The authors of this manuscript have never detected a fistula in the gallbladder or biliary tree. Only by the difference in pressures null/minimal in the gallbladder/bile ducts against organs such as with, small intestine with much higher pressures, this explains the immediate closure of the duct (fistula) automatically.

On the other hand, in the bile ducts, traumatic neuromas are caused by disorganized regeneration of nerve fibers, following surgical or inflammatory injury, most often after cholecystectomy, airway scanning, or biliary reconstruction. Because these lesions are benign and often small, they can go unnoticed clinically. [26] However, malignant tumors such as hepatocellular carcinoma remain the most common primary liver cancer, usually developing in the context of cirrhosis and chronic liver damage, while bile duct cancers, which include gallbladder, intrahepatic, perihilar, and distal subtypes, originate in the biliary epithelium and exhibit aggressive biological behavior. [27] However, they are a heterogeneous group of malignancies that originate in the epithelial lining of the biliary tree, although individually rare, together they represent approximately 3% of all gastrointestinal cancers, worldwide but with an increasing incidence of behavior. [28] The fact of mentioning all of the above makes a cause of symptoms and clinical signs that emulate an acute/chronic picture of biliary disease but of benign etiology and that do not cease to be a challenge for potential surgical treatment and with the risk of injury to the bile duct or its involvement per se the same pathology of origin. [29] *See figure 1.*



Figure 1: Gallbladder adenocarcinoma infiltrating the liver bed.

Figure taken from the reference: Aizpuru Edna M, Cázares Robles Tania Karina, Castillo García José Jesús, León Merino Guillermo, Gallegos Garza Adriana Cecilia, Flandes Aguilar Ingrid et al. Gallbladder cancer as a histopathological finding after cholecystectomy. Thirteen-year prevalence and incidence at the Angeles Pedregal Hospital. Minutes of the Doctor's Office. Grupo Ángeles [online magazine]. 2022 Mar [cited 2026 Jun 23] ; 20(1): 37-42. [29]

OBJECTIVE

To carry out art history based on an exhaustive search of the national and international medical literature on iatrogenic bile duct injury and its variants, in a medical and/or surgical scenario in its applicability.

DISCUSSION

On the other hand, it is essential to consider the cause of common bile duct injury after blunt abdominal trauma is rare and difficult to diagnose, delay in diagnosis leads to serious morbidity. A previous suspicion of the complete section of the bile duct was confirmed by an emergency laparotomy. [30] There are different mechanisms, isolated or combined, that can produce common bile duct injury in blunt abdominal trauma: compression of the ductal system against the spine by extrinsic compression, a sudden increase in intraluminal pressure in the gallbladder with a short cystic duct following external pressure, and a shear mechanism that produces the avulsion of the common bile duct in its fixed part at the junction with the pancreas. [31] See *figure 2*.



Figure 2

Intraoperative cholangiography image: contrast leakage is evident at the level of the distal common bile duct, intrapancreatic portion. Figure taken from the reference: Illán Riquelme Azahara., Zamora Amorós Carmen., Garrido Benito Beatriz and Oliver García Israel. Bile duct injury in blunt trauma. New trends in infrequent injuries. Chilean Journal of Surgery. 2017; 69(4):277-352. [31]

The study of the incidence of bile duct lesions, where laparoscopic cholecystectomy has achieved at least twice the rate observed compared to open cholecystectomy. Since cholecystectomy is the most frequently performed abdominal operation and the most serious complication associated with this procedure is accidental injury to the common bile duct or any of them. [32] In Mexico, its incidence is unknown, since there is no diagnostic/specific consensus and/or a reliable statistical system of the public or private health system. On the contrary, rates of 0.5% to 1.8% have been documented in developed countries such as England, the United States and Finland. [33, 34, 35]

Lesions of the bile duct in a cholecystectomy is one of the most feared complications, the most common being to confuse the common bile duct with the cystic duct, sectioning it. Because it requires reoperation, long-term follow-up, prolonged recovery and unprecedented morbidity/mortality. They are extremely complex and require personalized treatment, usually in a tertiary center with a multidisciplinary approach. [36, 37]

Converging Factors in Bile Duct Injury

- A determining factor that extremely affects patients who undergo biliary surgery, whether conventional, laparoscopic or robotic, are *the anatomical variations* of the area unique or combined with a very high incidence of both the gallbladder and the bile ducts and the blood circulation itself, which is estimated at up to 53.6%. [38] It is published in a meta-analysis of the anatomy of the common bile duct, which is characterized by substantial variability and affects both its morphology and the level of its junction with the biliary tree. Although many anatomical variants go clinically unnoticed, they do have important practical implications at the time of the surgical

event, as they increase the risk of misidentification of bile structures and iatrogenic lesions during surgical and endoscopic procedures. [39]

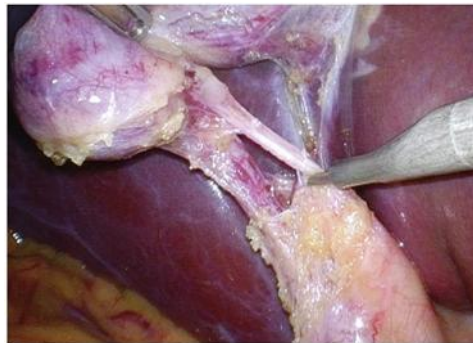
- The *inflammatory process* suffered by patients in the scenarios: acute, chronic or chronic exacerbated biliary pathology. It is a key element that modifies both the anatomy and physiology of the patient, increasing the risk of bile duct injury amalgamating with greater morbidity/mortality. [40] Chronic inflammation of the gallbladder can lead to preneoplastic abnormalities, and chronic cholecystitis is involved in 60-90% of cases. Acute and/or chronic pancreatitis, cholangitis, hepatitis of multiple infectious etiology, immunological, drug, alcoholic, etc. [41, 42, 43] Potentiating firm adhesions at the time of surgery, anatomical deformity, porcelain gallbladder, massive dilation of the bile duct, liver cirrhosis, abscesses, collections, pancreatic pseudocysts, and much more.[44] It is essential to point out that acute pancreatitis is an aseptic or sterile process so intense that it can cause the death of patients or cause morbidity and/or sequelae so transcendental that they lead to a poor quality of life or even death. [45, 46]
- Cholecystectomy is defined as a major surgery that, together with an exploration of the biliary tract, a transduodenal polypectomy, or a duodenal or jejunal biliary-digestive bypass surgery with all its variants, or failing that, a pancreatic resection surgery, is necessary for a certain *hospital infrastructure*, which is basic for the first two procedures in second-level hospitals and the last two in third-level hospitals. [47, 48]
- Advanced imaging and endoscopy techniques have impacted on the training of surgical residents in the field of surgery. It is expressed in the fact that the competence of *human resources* is a determining factor, without intraoperative cholangiography. [49] Thus affecting patient safety. To strengthen expertise in both technique and interpretation, intraoperative cholangiography should be promoted more frequently in training settings. [50]
- *Other risk factors* for bile duct injury include severe obesity, previous surgery, underlying liver disease, unexpected bleeding, surgeon inexperience, and excessive dissection of Calot's triangle. [51]

Regarding the diagnosis of bile duct injury, it can be simple or very difficult, in terms of carrying it out in the same endoscopy/surgery/trauma or even just due to the immediate, mediate or long-term evolution of the patient's surgery, which can be from a few weeks, weeks or even months. This extends so much and explains its high complexity. [52] Intraoperative cholangiography may help visualize biliary anatomy during laparoscopic cholecystectomy, especially in cases with unclear anatomical conditions, and thus help prevent complications such as bile duct injury or a clear diagnosis of injury. [53] Surgeons should strive to minimize the risk of bile duct injury. For patients with suspected bile duct variations, a thorough preoperative evaluation, with imaging including MRI, magnetic resonance cholangiopancreatography, and contrast-enhanced CT scan, is critical. [54] Bile duct injury can lead to serious complications, including bile leakage, biliary stenosis, biliary cirrhosis, portal hypertension, and even liver failure. These complications not only compromise the patient's safety and quality of life. [55] Liver function tests showed elevated bilirubin levels compared with preoperative levels, so proper ligation of the common bile duct and artery is a crucial surgical step. Improper ligation can result in bile leakage,

hemorrhage, conversion to open surgery, and long-term complications, including duct stenosis or recurrent gallstones. [56]

In laparoscopic cholecystectomy, the Critical View of Safety, coined by Strasberg et al., in 1995, has been stipulated. The surgeon gets a vision where, first, excess fat is removed from Calot's triangle, second, only two structures enter the gallbladder, and third, the lower third of the gallbladder is lifted from the cystic plaque. Only then is it safe to section the duct and cystic artery. [32] *See figures 3 and 4.*

Fluorescence cholangiography with indocyanine green achieves real-time visualization of bile structures and has established itself as a promising tool reducing risk, however, the lack of administration protocols should detail the need to reach a consensus to optimize its implementation. [57, 58] Another one-stage treatment approach is to perform both gallbladder removal and removal of ductal stones under a single anesthesia, usually through laparoscopic exploration of the common bile duct or intraoperative endoscopic retrograde cholangiopancreatography. Thus, ensuring the integrity of the bile duct. [59]



Anterior view

Figure 3



Posterior view

Figure 4

Figures taken from the reference: Terho P, Sallinen V, Lampela H, Harju J, Koskenvuo L, Mentula P. The critical view of safety and bile duct injuries in laparoscopic cholecystectomy: a photo evaluation study on 1532 patients. *HPB (Oxford)*. 2021 Dec;23(12):1824-1829. doi: 10.1016/j.hpb.2021.04.017. [32]

Subtotal cholecystectomy is another strategy for preventing bile duct injury in its two variants, "fenestration" and "restorative". Fenestrate does not occlude the gallbladder, but it can suture the cystic duct internally. It has a higher incidence of postoperative biliary fistula but does not seem to be associated with recurrent cholecystolithiasis; and reconstituted subtotal cholecystectomy closes the lower end of the gallbladder, reducing the incidence of postoperative fistulas, but creating a remnant gallbladder, which can lead to recurrence of symptomatic cholecystolithiasis. [60, 61]

Upper abdominal ultrasound is crucial in the first place, but other imaging modalities such as contrast computed tomography, magnetic resonance cholangiopancreatography, and preoperative percutaneous transhepatic biliary drainage can help to delineate complex benign biliary strictures. [62] Knowledge of anatomical damage to the bile duct has given rise to a number of classifications such as Hanover, Lau, Kapoor and Stewart-Way, Strasberg, Bismuth, Neuhaus, Csendes, McMahon, Siewert, Frattaroli and Amsterdam. Not considering the infection, the mechanism of action, the patient's hemodynamic status or the associated comorbidities. [63] The Bismuth 1982 classification is a simple classification based on the location of the injury in the biliary tract, being very useful for prognosis after repair and includes five types of bile duct lesions based on distance from the hilar structure, especially bile duct bifurcation and level of injury. [64] And the other most widely used classification is the Strasberg in 1995 based on Bismuth's first mentioned classification, but it is larger/more complex/descriptive but without an additional benefit from it. [65]

Treatment of bile duct injury can initially be an immediate surgical repair, which can give good results in specialized centers; however, the success rate for primary surgeons performing the repair is only 17-30%. Therefore, timely recognition and early referral are recommended. [66, 67] It may take several months to postpone definitive surgery until the patient is hemodynamically stable and infection-free. [68]

Most cases with bile duct injury (60.8%) were treated with hepaticojejunostomy, followed by 16 (20.3%) with reoperation of the same hepaticojejunostomy and new reconstruction, and one patient underwent liver transplantation for secondary biliary cirrhosis. The overall success rate was 96.2%, with a mortality rate of 2.5%, others up to 4% and a morbidity of 29.1% and in other series of 40-50%. The approach was widely accepted staggered, including control of sepsis, biliary drainage by endoscopic retrograde cholangiopancreatography or by surgical intervention, drainage of intra-abdominal biliary collections, leakage Bili enteric anastomosis. [69, 70] The need for hepatectomy or liver resection is mainly due to long-standing right-sided strictures, liver abscesses, or recurrent cholangitis. [71] That unlike vascular injury, which is the subject of another review, is still debated; although some recommend delayed intervention if vascular repair is not planned, injury to the portal vein and arteries may require urgent hepatectomy and is associated with increased morbidity and mortality. [72]

Biliary reconstruction carries a 5-9% risk of anastomotic failure and an 11-16% risk of stenosis, most develop within 2-3 years. [73] Anastomotic stenoses following repair of an iatrogenic bile duct lesion may progress to secondary biliary cirrhosis, which eventually requires liver transplantation, with significant morbidity of 50% to 60% and mortality of 20% to 30%. [74] Therefore, the selective use of intraoperative cholangiography appears to be a safe and effective strategy, with minimal rates of bile duct injury and diagnosis or detection

of choledocholithiasis or residual stones. Endoscopy was key to treatment success in 69% of patients. Bile duct lesions were 45% of cases [75]

CONCLUSIONS

Cholecystectomy is a surgery with a high risk of bile duct injury, although its actual incidence is unknown in Mexico, morbidity has become exponential and consequently mortality. It is suspected that it has become the most frequent surgical pathology.

It is imperative to train the new generations of surgeons to perform safe cholecystectomies with intraoperative cholangiography, perform bile duct exploration and consequently reparative biliodigestive bypasses in their more than thirty surgical techniques and their different variants of each. Bismuth's classification of biliary tract injury is simple, effective, and useful since it is based on location, allowing to know the prognosis after repair.

In addition, since the intra-hospital infrastructure is decimated in the public health sector in Mexico, it is crucial to insist on the prevention of bile duct injury in any form. Therefore, an injury to the bile duct in the patient and in the health, system is an Armageddon due to its great morbidity and mortality, its long duration and its high cost.

Conflict of Interest

The authors stated that they had no potential conflicts of interest regarding the research, Authorship and/or publication of this article.

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