World Journal of Biology Pharmacy and Health Sciences
eISSN: 2582-5542
Cross Ref DOI: 10.30574/wjbphs
Journal homepage: https://wjbphs.com/

(REVIEW ARTICLE)

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Laparoscopic cholecystectomy versus open cholecystectomy

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World Journal of Biology Pharmacy and Health Sciences, 2024, 17(02), 396–404

Publication history: Received on 15 January 2024; revised on 23 February 2024; accepted on 26 February 2024

Article DOI: https://doi.org/10.30574/wjbphs.2024.17.2.0097

Abstract

This review article provides a comparison of laparoscopic cholecystectomy (LC) versus open cholecystectomy (OC) for the treatment of gallbladder disease. Laparoscopic cholecystectomy, characterized by its minimally invasive approach, has gained popularity over open cholecystectomy due to its perceived advantages in safety, reduced postoperative pain, shorter hospital stays, improved cosmesis, and potential cost savings. However, the choice between the two procedures remains subjective and depends on various factors such as patient characteristics, surgical expertise, and specific clinical scenarios. This review synthesizes current evidence from clinical trials and studies to aid clinicians in making informed decisions regarding the selection of the most appropriate surgical approach for individual patients.

Keywords: Laparoscopic cholecystectomy; Open cholecystectomy; Cholecystitis; Cholelithiasis; Common bile duct (CBD)

1. Introduction

Cholecystitis occurs when the cystic duct, which connects the gallbladder to the common bile duct, becomes blocked by a gallstone (1). This blockage leads to the accumulation of bile within the gallbladder, causing distension and irritation. If left untreated, this can lead to inflammation, infection, and potentially serious complications. Gallstones are indeed quite common, particularly in the Western world (2). They are formed when substances in bile, such as cholesterol or bilirubin, crystallize and solidify within the gallbladder (3). While many people with gallstones remain asymptomatic, they can cause issues like cholecystitis, biliary colic, or complications such as pancreatitis if they block the ducts. Dietary and lifestyle factors, as well as genetics, can contribute to their formation. Gallstone disease indeed represents a substantial economic burden on healthcare systems globally, as evidenced by the significant costs associated with its management in the USA alone (4). The expenses encompass various aspects such as diagnostic procedures, medical treatments, surgical interventions, and potential complications management. This underscores the importance of preventive measures, early detection, and efficient management strategies to mitigate both the clinical and economic impact of cholelithiasis. The prevalence of gallstones can vary widely across different populations and regions. Globally, gallstone prevalence varies from 0.1% to 50.5% (5). Indeed, gallstone-related complications encompass a range of conditions that can affect the biliary system and adjacent organs. Acute cholecystitis, cholangitis, gallstone pancreatitis, common bile duct stones (CBD stones)/choledocholithiasis, and other conditions are gallstone-related problems. The shift from open cholecystectomy (OC) to laparoscopic cholecystectomy (LC) as the preferred treatment for acute cholecystitis (AC) has indeed been significant over the past few decades. In the late 1980s and early 1990s, laparoscopic cholecystectomy rapidly gained popularity and became the standard approach for gallbladder removal. The proportion of cholecystectomies performed laparoscopically increased dramatically during this period, from virtually 0% in 1987

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to approximately 80% by 1992.(6) This transition was driven by the numerous benefits of laparoscopic surgery, including shorter hospital stays, faster recovery times, and reduced postoperative pain compared to open procedures.

2. The history of Cholelithiasis

Antonio Benevieni, a Florentine pathologist, indeed provided one of the earliest documented accounts of gallstones in 1420(7). His report described a woman who had passed away after experiencing abdominal pain. This historical case serves as a milestone in the understanding of gallstone pathology. Indeed, over the centuries, the recognition of biliary colic increased significantly. Physicians and surgeons, including Francis Glisson in 1658, contributed to the medical literature by reporting similar cases (7). Glisson's work furthered the understanding of this condition and its associated symptoms, helping to pave the way for advancements in diagnosis and treatment. The first documented interaction of gallstones and surgery occurred in 1687 when Stal Pert Von Der Wiel (8). while operating on a patient with purulent peritonitis, accidentally discovered gallstones. Despite this early encounter, the treatment of symptomatic gallstone disease remained primitive and largely ineffective until the 18th century. This period saw gradual advancements in surgical techniques and understanding of the condition, eventually leading to more effective treatments for gallstone-related ailments. Jean-Louis Petit, a prominent figure in the history of surgery, indeed made significant contributions to the field of gallbladder surgery. In 1733, Petit proposed the removal of gallstones and drainage of the gallbladder, thereby creating a fistula, as a treatment for patients with empyema (8). This pioneering approach laid the foundation for surgical interventions targeting gallstone-related conditions. Petit successfully performed this procedure in 1743, marking a milestone in the history of gallbladder surgery. Indeed, new methods and procedures allowed gallbladder surgery to continue evolving. A two-stage elective cholecystostomy surgery was introduced by J. L. W. Thudichum in 1859 (9). Through a little incision, the inflamed gallbladder was sutured to the front abdominal wall during the first stage. This made it possible for the gallbladder to empty and offered a way to get rid of gallstones later. With a more regulated and phased approach to treatment, Thudichum's invention marked a substantial advancement in the surgical management of problems connected to gallstones. The account of Dr. John Stough Bobbs' surgical intervention in 1867 is indeed remarkable (9). While operating on a patient with a suspected ovarian cyst, Dr. Bobbs unexpectedly encountered an inflamed and adhered sac containing several solid structures resembling rifle bullets. Upon further exploration, he discovered that the sac was, in fact, the gallbladder filled with multiple gallstones. Dr. Bobbs proceeded to remove the gallstones and performed a cholecystostomy by closing the defect in the gallbladder and leaving it in the abdomen. Remarkably, the patient recovered from the procedure and outlived Dr. Bobbs, highlighting the success and significance of this early gallbladder surgery.

2.1. Conditions requiring cholecystectomy

Cholecystectomy, the surgical removal of the gallbladder, is typically performed to address conditions associated with gallstones or gallbladder disease. Common indications for cholecystectomy include gallstones, which can lead to inflammation (10). bile duct blockage, and severe pain (11). acute cholecystitis, characterized by gallbladder inflammation often triggered by obstructing gallstones; chronic cholecystitis, (12). resulting from recurrent inflammation or prolonged irritation; gallbladder polyps, growths that may be benign or require removal due to potential malignancy; choledocholithiasis, where gallstones obstruct the bile ducts, causing complications like jaundice or pancreatitis; gallbladder dyskinesia, a dysfunction of gallbladder muscles causing similar symptoms to gallstones; porcelain gallbladder, a rare condition associated with increased cancer risk; and gallbladder cancer, necessitating surgical intervention for early-stage cases. Cholecystectomy can be performed through open surgery or minimally invasive methods like laparoscopy or robotic assistance, with the approach tailored to factors such as patient health and surgical expertise (13).

3. Criteria for selecting laparoscopic cholecystectomy or Open cholecystectomy

The decision between LC and OC hinges on different factors, including the health of patient, the severity of gallbladder disease, and the surgeon's proficiency (14). LC is typically favored for patients with good health or minimal comorbidities, and for uncomplicated gallbladder conditions like gallstones (15). Conversely, OC might be indicated for patients with significant medical issues, severe gallbladder diseases such as gangrenous cholecystitis, or complicated anatomical considerations like prior abdominal surgeries or unusual bile duct anatomy. Surgeon experience plays a pivotal role, as laparoscopic techniques require specialized training, although OC can also be safe in skilled hands. Patient preferences, including concerns about recovery time and scarring, are vital, as is the availability of advanced laparoscopic equipment in the hospital. Ultimately, the choice between LC and OC must be tailored to each patient's unique circumstances, ensuring optimal outcomes through collaborative decision-making between the patient and surgical team.

3.1. Comparison of costs associated with LC and OC

The cost comparison between LC and OC involves various factors, including initial procedural costs, hospital stay duration, postoperative complications, recovery time, and indirect costs such as lost productivity (16). LC typically incurs a higher initial procedural cost due to the specialized equipment required, though this may vary depending on factors like hospital pricing and insurance coverage (17). However, LC is associated with shorter hospital stays, fewer postoperative complications, quicker recovery times, and lower indirect costs compared to OC. These advantages often lead to lower overall healthcare costs associated with LC, although individual patient factors and healthcare system characteristics may influence the actual cost comparison.

4. Open cholecystectomy

OC was introduced in the late 19th century and became the gold standard for gallbladder removal until the 1990s when laparoscopic cholecystectomy gained popularity (18). Early open cholecystectomy techniques involved a large subcostal incision, which evolved to smaller incisions and modified approaches, reducing morbidity. Despite the rise of laparoscopic techniques, open cholecystectomy remains relevant in select cases (19). Open cholecystectomy is indicated in cases where laparoscopic approach is contraindicated or technically challenging, such as severe inflammation, extensive scarring, or anatomical variations (20). Additionally, it may be preferred in resource-limited settings with limited access to laparoscopic equipment or expertise. Comparative studies have highlighted higher conversion rates from laparoscopic to open cholecystectomy in complicated cases.

John Stough Bobbs (1809-1870), a prominent Civil War surgeon hailing from Pennsylvania, holds the distinction of being credited with performing one of the earliest recorded operations on the human gallbladder. In 1867, Bobbs conducted a groundbreaking cholecystostomy procedure in Indianapolis, marking a significant milestone in the history of surgical treatment for gallbladder disorders (21). Carl Johann August Langenbuch (1846-1901), a pioneering German surgeon, made significant contributions to the field of hepatobiliary surgery, particularly in the treatment of gallbladder diseases. Langenbuch's groundbreaking work culminated in the first recorded cholecystectomy, a surgical procedure for gallbladder removal, conducted on July 15, 1882, during his tenure as chief of the French section of West Berlin (22).

Before attempting the procedure on human patients, Langenbuch meticulously tested and refined his technique through experimentation on animals and cadavers. This thorough preparation underscores his dedication to surgical innovation and patient safety.

Langenbuch's seminal contribution to cholecystectomy was further solidified by his presentation of a series of 24 patients who underwent the procedure in 1889. He asserted that the outcomes of cholecystectomy were superior to those of alternative surgeries for cholelithiasis prevalent at the time. Langenbuch advocated for cholecystectomy as a comprehensive solution, removing both the gallstones and the organ responsible for their production (23). The ability to assess the condition of the gallbladder and biliary system preoperatively is paramount in identifying suitable candidates for cholecystectomy, ensuring optimal surgical outcomes. One pivotal advancement in this regard occurred in 1918 when Reich introduced a novel technique for visualizing the biliary system using radiography. By inserting bismuth paste and petrolatum into a biliary fistula, Reich enabled the radiographic visualization of the biliary anatomy, facilitating the identification of gallbladder pathologies and guiding surgical decision-making (24). Further progress was made in 1924 by Cole, a surgical resident working in Evarts Graham's laboratory, who achieved a significant milestone in the field of radiology. Cole successfully produced the first positive photograph of a human gallbladder, providing clinicians with a tangible visual representation of the organ's structure and pathology (25). This groundbreaking achievement revolutionized the diagnostic approach to gallbladder diseases, allowing for more accurate preoperative assessments and enhancing surgical planning for cholecystectomy.

The introduction of laparoscopic cholecystectomy (LC) revolutionized the field of gallbladder surgery, offering a less invasive alternative to traditional open cholecystectomy. However, concerns initially arose regarding the suitability of LC in certain patient populations due to perceived relative contraindications, such as prior upper abdominal surgery, pregnancy, and cirrhosis. These factors were thought to increase the complexity and risks associated with laparoscopic procedures (26, 27).

Indeed, with advancements in technology and increasing surgeon expertise in laparoscopic cholecystectomy (LC) over the past 15 years, the indications for opting for an open cholecystectomy (OC) have significantly decreased. Today, the primary indication for performing an OC is typically the conversion from a laparoscopic approach due to the inability to complete the procedure laparoscopically (16). Surgeons may choose to convert to an open approach when faced with challenges related to anatomy that impede safe completion of the laparoscopic procedure. These challenges may include

severe inflammation of the gallbladder, extensive adhesions from prior surgeries or chronic inflammation, anatomical abnormalities such as variations in bile duct anatomy, bile duct injury during dissection, the presence of retained bile duct stones that are difficult to access or remove laparoscopically, or uncontrolled bleeding. While laparoscopic cholecystectomy is generally preferred due to its minimally invasive nature and associated benefits such as shorter hospital stays and faster recovery times, there are situations where conversion to open cholecystectomy becomes necessary to ensure patient safety and optimal surgical outcomes. Surgeons must exercise judgment and skill in assessing intraoperative findings and deciding when conversion to an open approach is warranted. Despite the decreasing frequency of open cholecystectomy as a primary procedure, it remains an essential option in the surgical armamentarium for managing complex cases and unforeseen complications during laparoscopic cholecystectomy. The decision to convert to an open approach should prioritize patient safety and the successful completion of the procedure while minimizing risks and complications.

There are certain specific illnesses related to the gallbladder that may necessitate the implementation of scheduled OC (28)**.** Among these, suspicion of gallbladder carcinoma stands out as a compelling rationale for opting for OC rather than LC. Gallbladder cancer, although relatively rare, carries a significant risk of morbidity and mortality. If gallbladder cancer is suspected or diagnosed intraoperatively during a planned cholecystectomy, the operation should be promptly converted to an open procedure (29)**.** OC provides the surgeon with better visualization and manual dexterity, facilitating complete tumor excision and minimizing the risk of intraoperative tumor spillage or dissemination. Furthermore, OC allows for comprehensive lymph node dissection and assessment of the extent of disease spread, which is essential for accurate staging and determination of further treatment strategies. In cases of suspected or confirmed gallbladder carcinoma, OC remains the preferred approach to ensure adequate oncologic resection and optimize long-term survival outcomes for the patient.

Identifying Mirizzi syndrome, a rare complication of gallstone disease marked by external compression of the common hepatic duct from gallbladder or cystic duct stones, presents preoperative diagnostic hurdles. It is the second leading indication for OC, poses challenges in preoperative diagnosis (30)**.** Its varied clinical presentations can mimic other biliary conditions, complicating accurate diagnosis. While laparoscopic procedures effectively manage type I Mirizzi syndrome with hepatic duct compression, successful laparoscopic treatment demands considerable surgical expertise. However, complex variants may challenge the laparoscopic approach's suitability. Type II Mirizzi syndrome, featuring a cholecystobiliary fistula, poses unique challenges for laparoscopic management, increasing the risk of bile duct injury and complications during dissection (31)**.** Therefore, whether discovered preoperatively or intraoperatively, type II Mirizzi syndrome remains a clear indication for open cholecystectomy. Open cholecystectomy offers several advantages in managing Mirizzi syndrome, especially in cases with potential bile duct injury risks or anatomical complexities. The open approach ensures superior visualization, meticulous adhesion dissection, and safe management of the cholecystobiliary fistula. Additionally, it facilitates concurrent procedures like bile duct exploration or repair, if needed. In some cases, OC may be planned for individuals with cirrhosis, a condition unrelated to gallbladder problems.

Procedure of Open cholecystectomy (OC): OC can be performed using two different approaches: anterograde and retrograde (32, 33)**.** In the anterograde approach, the dissection begins medially in the hepatoduodenal ligament, which is the area where the common bile duct, hepatic artery, and portal vein are located. The surgeon starts by identifying and isolating the cystic duct and cystic artery. Once these structures are identified and secured, the dissection progresses toward the gallbladder, ultimately leading to its removal. Conversely, in the retrograde approach, the dissection starts from the fundus of the gallbladder and progresses downward. The surgeon begins by isolating the fundus of the gallbladder and then works their way down towards the cystic duct and artery. This approach allows for better exposure of the cystic duct and artery before their ligation and division. Both approaches have their advantages and may be chosen based on the surgeon's preference, the patient's anatomy, and the specific characteristics of the case.

4.1. Laparoscopic cholecystectomy

LC is performed to treat gallstones, inflammation of the gallbladder (cholecystitis), or other gallbladder-related conditions. During the procedure, several small incisions are made in the abdomen, through which a laparoscope and specialized surgical instruments are inserted. The surgeon uses the laparoscope to visualize the internal structures of the abdomen, including the gallbladder, on a monitor. The gallbladder is then carefully dissected and removed through one of the small incisions. Laparoscopic cholecystectomy is preferred over traditional open surgery for gallbladder removal because it generally results in less pain, faster recovery times, and smaller scars. It's considered a safe and effective procedure, with a low risk of complications (34)**.**

Dr. Erich Mühe is the first one performing the first LC in 1985 (35). However, Philip Mouret, also a French surgeon, performed the first LC on a human patient in 1987 (36). Dr. Mouret's pioneering work marked a significant milestone in the development of minimally invasive surgical techniques.

It's fascinating to trace the origins of laparoscopic surgery back to the innovative efforts of individuals like Dr. Kalk, who introduced important concepts and techniques that paved the way for the modern practice of laparoscopy. And indeed, the contributions of Ko, Airans, and Cuschieri were instrumental in refining and advancing the procedure through their animal experiments in the early 1980s.

The symptoms for LC are generally similar to those for OC (37). These indications include: Gallstones that cause symptoms such as abdominal pain, nausea, vomiting, and bloating are typically treated with cholecystectomy to prevent further complications. Inflammation of the gallbladder that persists over time can lead to recurrent bouts of abdominal pain, often triggered by the ingestion of fatty foods. Cholecystectomy is often recommended for patients with chronic cholecystitis to alleviate symptoms and prevent complications (38). In some cases, gallstones can block the pancreatic duct, leading to pancreatitis. These indications are frequently observed in both LC and OC procedures. However, the specific approach to treatment may vary depending on factors such as the patient's overall health, the severity of symptoms, and the presence of any complicating factors.

Indeed, in certain situations, conversion from LC to OC may be necessary due to various intraoperative challenges or complications. Excessive bleeding during the laparoscopic procedure may impair visibility and increase the risk of complications. Switching to an open approach allows for better control of bleeding and facilitates surgical intervention if needed. Sometimes, unexpected anatomical variations in the extrahepatic biliary system or associated blood vessels may make it difficult to safely complete the procedure laparoscopically. Open surgery provides better access and visualization, allowing surgeons to address these variations effectively. In cases where there is unanticipated or uncontrolled bile leakage during a laparoscopic procedure, conversion to open surgery may be necessary to adequately address the issue and prevent complications such as bile peritonitis. The decision to convert to an open procedure is typically made by the surgical team based on the patient's safety and the feasibility of completing the operation successfully. While laparoscopic cholecystectomy is preferred for its minimally invasive nature and faster recovery times, converting to an open approach when necessary ensures optimal patient outcomes and reduces the risk of complications.

Certain conditions were once considered absolute contraindications for LC due to concerns about technical challenges or increased risks of complications, advances in surgical techniques, instrumentation, and perioperative management have expanded the eligibility criteria for the procedure. However, they do require careful consideration and specialized approaches to ensure safe and successful outcomes. For example, in obese patients, special attention may be needed to optimize positioning, trocar placement, and pneumoperitoneum management to accommodate the increased abdominal wall thickness and intra-abdominal fat. Similarly, in pregnant patients, the procedure may need to be delayed until after the first trimester to minimize potential risks to the fetus, and precautions may be taken to avoid compression of the inferior vena cava to optimize maternal hemodynamics. In patients with cirrhosis or a history of previous upper abdominal surgeries, careful preoperative assessment and optimization of liver function, coagulation status, and anatomical considerations are essential to mitigate the risks of bleeding, bile duct injury, or other complications.

Overall, while these conditions may require special considerations and careful patient preparation, they are no longer considered absolute contraindications to LC. With appropriate planning, expertise, and multidisciplinary collaboration, laparoscopic cholecystectomy can often be safely performed in patients with these challenging conditions, offering the benefits of minimally invasive surgery while minimizing risks.

5. Procedure of LC

The procedure begins with making a periumbilical incision near the belly button, typically either 12 mm or 5 mm in diameter (39). The decision on the size and placement of the incision depends on various patient-specific factors. Once the incision is made, a trocar is inserted through the incision into the abdominal cavity. The trocar serves as a port for the laparoscope and other surgical instruments. Carbon dioxide gas is gently pumped into the abdominal cavity through the trocar to create a space (pneumoperitoneum) that allows for better visualization and manipulation of the internal organs (40). The pressure is typically maintained at around 15 mmHg (41). Once the abdominal cavity is inflated, a laparoscope is inserted through the trocar. The laparoscope, equipped with a camera and light source, provides a magnified view of the abdominal cavity on a monitor, allowing the surgeon to examine the abdominal organs and locate the gallbladder. During laparoscopic cholecystectomy, the patient is often positioned in the reverse Trendelenburg position, with the head of the bed elevated and the patient's feet lower than their head. Additionally, the right side of

the bed may be elevated. This positioning helps to displace the intestines away from the surgical field and facilitates better access to the gallbladder and surrounding structures. After the initial trocar is placed, three more trocars are inserted into the abdominal cavity to provide additional ports for surgical instruments. One 5 mm trocar is placed two to three fingerbreadths below the costal border, aligned parallel to the anterior axillary line. This trocar provides access for surgical instruments on the right side of the abdomen. During laparoscopic cholecystectomy, an extra 5 mm trocar is commonly added below the costal border along the midclavicular line to allow access for instruments on the left side of the abdomen. Using a locking, atraumatic grasper, the gallbladder fundus is then pulled toward the patient's right shoulder to aid exposure and mobilization for dissection. Placement of the final trocar, typically 12 mm in diameter, is determined by considering the expected position of the gallbladder, especially its cystic forms. This last trocar is usually inserted to the right of the falciform ligament or into its right side, in the epigastrium region, near the midline, and at a slight angle. This trocar make available access for the laparoscope and additional instruments during the dissection and gallbladder removal. The first step involves separating any adhesions and dissecting the hepatocystic triangle. In laparoscopic cholecystectomy (LC), adhesions are commonly found to originate from the duodenum, colon, or omentum. Using traction and countertraction techniques, these adhesions can be gently released, either with minimal effort or with more forceful maneuvers. A gentle grasper is used to securely hold the gallbladder infundibulum from the midclavicular port, exerting pressure toward the patient's right shoulder. Simultaneously, another gentle grasper locks onto the fundus, pulling it back toward the right shoulder. In the hepatocystic triangle, the peritoneum is divided into anterior and posterior sections using hook electrocautery, along with blunt dissection to clear fibrofatty tissue. Maneuvering the gallbladder infundibulum to the right during anterior dissection and to the left during posterior dissection improves efficiency. At this stage, the gallbladder is detached from the lower third of the cystic plate. By pulling the gallbladder forward and to the right, a dissection plane forms between its neck and the liver, continuing until the lower part is completely disconnected from the liver's cystic plate, ensuring no residual structures enter the gallbladder inadvertently from its posterior aspect.

The surgeon's confidence in identifying the cystic artery and cystic duct is crucial for a successful cholecystectomy. The fibroadipose tissue within the hepatocystic triangle must be meticulously dissected and removed. This triangular area is formed by the cystic duct, common hepatic duct, and liver edge, and it houses the cystic artery. Clearing this area allows for better visualization of the structures within it. The gallbladder should be dissected and separated from the liver bed, ensuring that it is fully mobilized, especially from the lower third of the cystic plate. This maneuver exposes the cystic duct and artery more clearly, facilitating their identification. The surgeon should confirm that only two structures are entering the gallbladder, namely the cystic duct and cystic artery. Any additional structures may indicate aberrant anatomy or pathology that requires careful evaluation before proceeding with division.

Intraoperative cholangiogram (IOCG) is indeed a valuable tool in certain situations during cholecystectomy (42)**.** In cases where the biliary anatomy is not clearly visualized or there are variations in the anatomy, an IOCG can provide real-time imaging of the bile ducts, allowing the surgeon to accurately identify their location and course (43)**.** This helps in avoiding inadvertent injury to the bile ducts during dissection. If there is suspicion of stones within the bile ducts (choledocholithiasis), an IOCG can confirm their presence, size, and location. This information guides the surgeon in deciding whether additional procedures, such as common bile duct exploration or sphincterotomy, are necessary to remove the stones safely. While the use of IOCG may not definitively prevent bile duct injuries, it can aid in their early detection. By visualizing the contrast flow through the bile ducts during the cholangiogram, any abnormalities such as strictures, leaks, or transections can be identified intraoperatively. This allows for immediate corrective measures to be taken to minimize the consequences of bile duct injury.

It's worth noting that the effectiveness of IOCG in preventing bile duct injuries is still subject to debate and may depend on various factors such as surgeon experience, patient anatomy, and the complexity of the procedure. However, its role in intraoperative assessment and management of biliary pathology remains significant.

After the gallbladder is successfully removed from the cystic plate during a cholecystectomy, the next step involves ensuring hemostasis and checking for any potential bile leaks (44)**.** The port through which the laparoscopic instruments were inserted is closed. This closure is usually done using sutures or other closure techniques to secure the port site and prevent any potential herniation or leakage of abdominal contents. The operating field is carefully inspected for any signs of bile leakage or bleeding.

The gallbladder is enclosed in a laparoscopic retrieval bag and then taken out. In cases where the gallbladder shows no signs of inflammation and contains relatively small stones, a swift removal via an incision can be opted for, decreasing the risk of wound infections and lowering costs. Typically, a 12 mm periumbilical incision is utilized for gallbladder extraction, although an alternative method employs a 12 mm subxiphoid port. It's advisable to meticulously inspect the

liver bed and ensure hemostasis by clipping both before and during the gallbladder's removal to secure closure of the cystic duct. Local anesthesia can be applied to the port sites, allowing for their removal under direct observation.

5.1. Complications of Laparoscopic Cholecystectomy

Whether biliary or non-biliary, minor problems are usually managed conservatively. However, severe side effects, particularly those affecting the blood vessels or bile ducts, might be fatal and may require switching to an open surgical procedure for treatment. Complications following laparoscopic cholecystectomy can occur in between 0.5 and 6% of cases. The most significant complications are linked to a high death rate: damage to the common bile duct has an incidence of 0.1-0.6%,(45, 46)**.** while damage to big blood arteries can range from 0.04 to 1.22%,(47). depending on the study. Smith et al (48)**.** studied 1,009 patients from 1989 to 1991, revealing a mortality rate of 0.38%, a complication rate of 10.9%, a conversion rate of 3%, and a bile leak/injury rate of 0.5%. Conversely, Wilson et al., in a study of 180 patients between 1990 and 1991, observed a mortality rate of 0%, a complication rate of 9%, a conversion rate of 6%, and a biliary damage rate of 1.1%. Notably, Smith et al.'s study indicated a higher complication rate and a lower conversion rate compared to Wilson et al.'s findings (49)**.** Radunovic et al. conducted a study from 2005 to 2014 involving 740 patients who underwent laparoscopic cholecystectomy (LC). Their findings revealed a mortality rate of 0%, a complication rate of 13.1%, a conversion rate of 3.91%, and a bile duct injury rate of 1.89%. In a separate study, Agarwal et al (50)**.** examined 100 patients between 2017 and 2019 in Udaipur, India. They reported a mortality rate of 0%, a complication rate of 18%, a conversion rate of 6%, and a biliary injury rate of 6%. Similarly, Triantafyllidis et al.(51) conducted research from 2000 to 2008 involving 1,009 patients, revealing a mortality rate of 0%, a complication rate of 9.51%, a conversion rate of 1.39%, and a bile duct injury rate of 1.49%.

6. Common Complications of both laparoscopic cholecystectomy (LC) and open cholecystectomy

Complications of both laparoscopic cholecystectomy (LC) and open cholecystectomy (OC) can include bile duct injury, leading to bile leakage, infection, or obstruction; excessive bleeding requiring transfusions or further intervention; surgical site infections causing pain, fever, and potentially requiring antibiotics; postoperative pain or abdominal discomfort necessitating pain management; gallstone spillage contributing to complications like abscess formation or peritonitis; adverse reactions to anesthesia such as respiratory issues or allergic reactions; increased risk of deep vein thrombosis (DVT) and pulmonary embolism (PE) due to prolonged immobility; potential organ damage to nearby structures like the liver or intestines; development of incisional hernias, particularly after OC; and digestive problems such as diarrhea or difficulty digesting fatty foods, which can be temporary or long-term (51)**.**

7. Conclusion

Laparoscopic cholecystectomy is generally favored over open cholecystectomy due to its safety, efficacy, reduced postoperative pain, improved cosmesis, and potential cost savings. However, the choice between the two procedures should be made on a case-by-case basis, considering individual patient factors and surgical expertise.

Compliance with ethical standards

Acknowledgment

I am very thankful to my supervisor Shao Ying Mei, Abuduhaiwaier abuduhelili and Ba dengcairenanrui.

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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