SURGICAL MANAGEMENT OF CHOLELITHIASIS, A LITERATURE REVIEW

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ABSTRACT

INTRODUCTION

Cholelithiasis, commonly called gallstone disease, represents a widespread medical condition characterized by various clinical manifestations, including biliary colic, cholecystitis, and other complications.

The article integrates findings from pivotal studies to thoroughly comprehend the prevailing surgical strategies, outcomes, and prospective advancements in the management of cholelithiasis.

MATERIAL AND METHODS

Literature search was searched from Google Scholar, Pubmed, Medscape and a narrative analysis was performed using keywords cholelithiasis, surgical management.

RESULTS

Surgical practices for managing cholelithiasis have evolved significantly, placing a strong priority on less invasive techniques i.e. Laparoscopic cholecystectomy. Open cholecystectomy is still a crucial surgical option for patients with complicated illnesses such severe inflammation, cancer, or anatomical difficulties that make laparoscopic procedures impractical. Lithotripsy and dissolution therapy are valuable options for CBDS management, especially for patients unfit for surgery.

CONCLUSION

Surgical management especially laparoscopic cholecystectomy is gold standard for cholelithiasis in terms of hospital stay, surgery time, aesthetics, pain management and postoperative complications.

KEYWORDS

Cholelithiasis, Cholecystitis, Cholecystectomy, Lithotripsy

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INTRODUCTION

Cholelithiasis, the condition characterized by the formation of gallstones in the gallbladder, is a prevalent gastrointestinal disorder, with a significant impact on healthcare system worldwide. It can lead to severe complications, including cholecystitis, pancreatitis, and cholangitis.[1] Its frequency is 3–21. 9% globally, 4–15% in Asia, and 4.87% in Nepal overall.[2,3] There are three kinds of gallstones: cholesterol either mixed stones or pigment (black or brown). More than 80% of patients with cholelithiasis have cholesterol gallstones, and the pathophysiology involves both systemic and local components (i.e., the gallbladder and bile). The higher frequency of cholesterol gallstone formation in Asia may also be correlated with dietary factors, climate, fertility, and family history. Gallstones are becoming more common in Nepal, where they are one of the main surgical diseases. However, there aren't many research to back it up.[2] Two-thirds of gallstones are asymptomatic and the incidence of developing symptoms from gallstones is 1-4% per year.[3] Cholecystectomy is the only effective treatment for gallstones, and 90% of these can be done laparoscopically. Early operations have become more popular in recent years. It is believed that longer outpatient wait times for elective laparoscopic cholecystectomy for symptomatic gallstones are linked to worse quality of life and increased morbidity from gastrointestinal symptoms. A meta-analysis of randomized controlled trials revealed no benefit in terms of morbidity or conversion rates to open procedures for postponing laparoscopic cholecystectomy for acute cholecystitis. If laparoscopic cholecystectomy is performed within 48 hours of the first acute admission, lower rates of conversion to open have been documented in calculous acute cholecystitis. However, compared to interval laparoscopic cholecystectomy, it has been proposed that urgent laparoscopic cholecystectomy increases expenses and resource consumption.[3] The main treatment option for symptomatic patients has changed throughout time, and surgery is frequently required.[1]

History and clinical examination

Biliary colic, which is characterized by an immediate onset of discomfort in the right upper quadrant of the abdomen or epigastrium (dermatomes T8/9) due to a brief impaction of the gallstone in the gallbladder's neck, is the most common presentation for patients. The pain is often moderate to severe in intensity and is characterized by stability. Usually, it begins suddenly and without variations, doesn't go away with a bowel movement, and peaks in about an hour. As the stone comes loose, the pain usually goes away over the course of one to five hours; if it persists for longer, there may be problems like calculus cholecystitis, biliary pancreatitis etc. Within ten years, about 90% of people who first experience biliary colic experience recurrent pain (two-thirds within two years). With the possible exception of persistent upper abdomen discomfort, physical examination results following an episode are often normal.[4,5] Over the past two decades, much has been learned about the epidemiology of this condition and its risk factors (Table 1).[6]

Table 1. Risk factors for gallstones

Demographics Family history, female sex, increasing age, specific races (e.g., Chilean Indians, Mexican Americans, Pima Indians)
Dietary Diet high in calories and refined carbohydrates, low in fiber and unsaturated fats; total parenteral nutrition
Lifestyle Low-grade physical activity, pregnancy and multiparity, prolonged fasting, rapid weight loss
Associated conditions Alcoholic cirrhosis, bariatric surgery, diabetes mellitus, dyslipidemia, estrogen therapy or use of oral contraceptives, gallbladder or intestinal stasis, hyperinsulinism, metabolic syndrome, obesity* *

* * Obesity defined as body mass index greater than 30 kg per m2 . Adapted from Portincasa P, Moschetta A, Palasciano G. Cholesterol gallstone disease. Lancet. Copyright 2006;368(9531):234, with permission from Elsevier

Diagnosis

Gallstones are frequently unintentionally found during abdominal computed tomography or ultrasonography. Within five to twenty years of diagnosis, only 10 to 20% of asymptomatic people will develop symptoms. About 2% of people experience symptomatic gallstone development annually on average.[7] Table 2 summarizes the tests used to diagnose gallstones.[8]

Table 2. Diagnostic Studies for Gallstones and Complications of Gallstones

Diagnostic Study	Accuracy	Comment
Ultrasonography	High specificity (>98%) and sensitivity (>95%) for identifyin gallstones; false-negative rate of 1% to 4%	Inexpensive; noninvasive; first-line test for patients with suspected gallstones or acute cholecystitis; provides anatomic information, such as presence of polyps, common bile duct diameter, and parenchymal hepatic abnormalities
Hepatobiliary iminodiacetic acid scan	High sensitivity (97%) and specificity (77%) for the diagnosis of acute cholecystitis; normal findings virtually rule out acute cholecystitis	Useful to visualize the biliary tree and to assess liver and gallbladder function; can diagnose or rule out biliary dyskinesia. Hepatobiliary iminodiacetic acid is normally taken up by the liver and excreted into bile, where it fills the gallbladder and can be detected with a gamma camera; failure of hepatobiliary iminodiacetic acid to fill the gallbladder at two hours after injection is indicative of cystic duct obstruction
Magnetic resonance cholangiopancreatography	High sensitivity (97%) and specificity (98%) for identifying gallstones	Noninvasive; can identify gallstones anywhere in the biliary tract. Reserved for cases in which choledocholithiasis is suspected
Computed tomography	Sensitivity of 79% and specificity of 100% for identifying gallstones	Superior to ultrasonography in visualizing the biliary tree and distal common bile duct, but higher cost and radiation exposure make it a second-line option to ultrasonography
Endoscopic retrograde cholangiopancreatography	Sensitivity of 85% to 87% and specificity of 100% for determining normal biliary system, bile duct obstruction, and choledocholithiasis	Diagnostic and therapeutic; usually performed in conjunction with endoscopic retrograde sphincterotomy and gallstone extraction. In studies was 94% effective for stone removal
Plain abdominal radiography	-	Useful for excluding other causes of acute abdominal pain (e.g., intestinal obstruction, visceral perforation, renal stones, chronic calcific pancreatitis)

High-income countries for an early and accurate diagnosis, use modern imaging methods including EUS, MRCP and high-resolution ultrasonography while low-to-middle-income countries with limited access to sophisticated imaging, particularly in rural regions, ultrasound serves as the main diagnostic technique.[9-11]

Management

The management of cholelithiasis involves surgical and non-surgical approaches. While laparoscopic cholecystectomy is the standard, other techniques and therapies may be considered based on patient comorbidities and preferences. In a Cochrane review of laparoscopic cholecystectomy vs. open cholecystectomy, laparoscopic surgery was similar to the open procedure in complication rates and surgical time, but resulted in a shorter hospital stay (three fewer days; 95% confidence interval, 2.3 to 3.9 days) and shorter convalescence period (22 fewer days; 95% confi¬dence interval, 8 to 37 days).[12]

Laparoscopic cholecystectomy

Laparoscopic cholecystectomy (LC) is the gold standard for symptomatic gallstones and uncomplicated acute cholecystitis. It offers minimal invasiveness, reduced pain, shorter hospital stays, and faster recovery compared to open surgery. Nevertheless, it requires four cuts and can provide the surgeon with ergonomic and technological difficulties. Because only one umbilical incision is made, one-port laparoscopy is thought to be an even less invasive procedure that can lead to an even quicker recovery and improved physical appearance.[2,13]

Recent studies highlight its safety even in acute conditions when performed urgently. It reduced postoperative pain, morbidity, Shorter hospitalization and faster return to normal activities. However Bile duct injury occurs in 0.3% to 0.7%. Gallbladder perforation with stone spillage, occasionally leading to abscess formation.[2,8,12,14]

Open cholecystectomy

Open cholecystectomy remains an essential surgical option for patients with complex conditions such as severe inflammation, malignancy, or anatomical challenges that preclude laparoscopic approaches. The procedure involves a larger abdominal incision, allowing for direct visualization and manipulation of the gallbladder and surrounding structures. It is particularly valuable in cases where dense adhesions or significant infection complicate laparoscopic access.[15]

It provides greater surgical control and access to surrounding tissues, effective for patients with complicated or advanced gallbladder disease and facilitates simultaneous management of associated biliary or hepatic pathology.[15]

However, following open cholecystectomy there will be longer hospital stay and recovery period compared to laparoscopic cholecystectomy. It is associated with higher postoperative morbidity, including risks of infection, hernia, and delayed wound healing.[13]

Open cholecystectomy is indicated in case of failure laparoscopic approach due to severe inflammation or technical challenges and suspected or confirmed gallbladder carcinoma. It is done when there is need for extensive exploration or repair of adjacent structures, such as bile ducts.[15]

Despite advancements in minimally invasive surgery, open cholecystectomy retains a vital role in managing complex gallbladder disease. Continued refinement in surgical techniques and preoperative imaging ensures its utility as a safe and effective option for select patients.[12,15]

The gold standard for minimally invasive treatment with a quicker recovery is laparoscopic cholecystectomy in high income countries where in low to mid income countries due to a lack of resources, open cholecystectomy is more usual, with laparoscopic treatments mostly available in urban areas.[9-11]

Pain management

There are various group of drugs for the management of pain in symptomatic cholelithiasis Effective pain management in biliary colic includes: Nonsteroidal anti-Inflammatory drugs (NSAIDs) which are used to reduce inflammation and control pain. Opioids are reserved for severe cases, though associated with sphincter of Oddi dysfunction, anti spasmodics alleviate biliary spasm. Among them NSAIDs are safe and effective for pain control in biliary colic, and reduce the likelihood of further complications.[5,16]

Non-surgical alternatives

Dissolution therapy

Dissolution therapy provides a non-invasive approach for managing certain cases of cholelithiasis. This method involves the use of oral bile acids, such as ursodeoxycholic acid (UDCA), to dissolve cholesterol gallstones.. Ideal candidates for this therapy include patients with small, radiolucent stones and a functioning gallbladder. While dissolution therapy offers a safe alternative for patients unfit for surgery, its effectiveness is limited. Fewer than 10% of patients with symptomatic gallstones are candidates for this therapy. Complete dissolution typically requires prolonged treatment, often extending for months or even years. Moreover, recurrence rates remain high once therapy is discontinued. Side effects, including mild diarrhoea and elevated liver enzymes, are generally manageable . Lifestyle modifications, including maintaining a healthy weight and dietary adjustments, may enhance the success of dissolution therapy. Despite its limitations, dissolution therapy remains a valuable option for select patients who cannot undergo surgical interventions.[17]

Because surgical access is so common in high income countries, ursodeoxycholic acid's use is restricted for non-surgical candidates, while in low to mid income countries where surgery is prohibitively expensive, medical treatment is a more common option.[9-11]

Extracorporeal shock wave lithotripsy (ESWL)

Lithotripsy is an effective treatment for common bile duct stones (CBDS), offering minimally invasive stone fragmentation without compromising the bile duct (CBD) wall or requiring sphincterotomy. However, it is not definitive for managing cholecysto-choledocholithiasis due to high recurrence rates associated with lithogenic bile in the gallbladder. Additionally, stone fragmentation can increase the risk of migration into the CBD.[18,19]

Despite limitations, lithotripsy is advantageous as a single-session procedure and is suitable for patients who have undergone cholecystectomy or cannot undergo surgery.

However, its use is limited by the need for specialized equipment and skilled personnel.

Techniques of lithotripsy
1. Mechanical lithotripsy:
- Performed after failed endoscopic sphincterotomy using a Dormia basket or balloon catheter.
- Success rate: 80%-90%.
- Limited efficacy for stones larger than 3 cm or impacted stones.
2. Electrohydraulic lithotripsy (EHL):
- Uses high-frequency hydraulic pressure waves.
- Success rate: 74%-98%.
- Requires precise probe placement and skilled operators.
3. Laser lithotripsy:
- Fragments stones under fluoroscopic guidance or via direct cholangioscopy.
- Success rate: 93%-97%; complication rate: 4%-13%.
- Modern holmium lasers improve precision but are costly.
4. Extracorporeal shock-wave lithotripsy (ESWL):
- Non-invasive and guided by ultrasound or fluoroscopy.
- Requires anesthesia; multiple sessions often needed.
- Recurrence rate: ~14% over 1-2 years.

Lithotripsy is a valuable option for CBDS management, especially for patients unfit for surgery. However, high recurrence rates and limited availability of resources and expertise restrict its widespread adoption. It remains a secondary option to more definitive treatments.[18-21]

Recent advances and future directions in cholelithiasis management.[22-24]

Surgery involving a single incision (SILS)
Because of its minimum access requirements and aesthetic advantages, SILS is being used more and more for cholecystectomy. Although it has been found to increase recovery outcomes, it calls for specific tools and highly qualified surgeons. This method is chosen due to its lower postoperative discomfort and scarring and is frequently used for benign gallbladder illnesses.

Robotic cholecystectomy at a single site (RSSC)
An important development in robotic technology that offers improved accuracy and dexterity is RSSC. It speeds up healing, lessens postoperative pain, and enhances cosmetic results. Higher expenses and a learning curve for surgeons are obstacles, though continuous advancements in imaging technology and robotics are meant to tackle these issues. It is anticipated that advancements in digital imaging, instrument re-engineering, and robotic arm flexibility would further advance robotic single-site cholecystectomy (RSSC). While addressing existing restrictions like as expense and limited instrument mobility, these improvements seek to make the process more accessible, efficient, and intuitive.

In order to make robotic systems more feasible for regular usage in smaller institutions, research is concentrating on bringing down their costs. In order to maximize cost-effectiveness, this involves increasing the number of instances per system.

Mini-laparoscopic cholecystectomy
This method has been shown to produce superior cosmetic outcomes, need fewer analgesics, and speed up recovery. Skilled surgeons believe it to be safe and practical.

Research of novel surgical methodologies
Creation of hybrid procedures, including merging endoscopic and laparoscopic techniques in certain situations. Advanced mini-laparoscopic procedures and retroperitoneal natural orifice translumenal endoscopic surgery (NOTES) are promising examples.

Focused application of AI and imaging
Incorporating artificial intelligence (AI) into intraoperative navigation and preoperative planning. Artificial intelligence (AI) solutions have the ability to increase accuracy, improve patient outcomes, and support in-the-moment decision -making during treatments.

Worldwide training and access
Increasing low and middle income nations access to cutting-edge technologies by creating affordable substitutes and prioritizing international surgical training to standardize practices.

CONCLUSION

The management of cholelithiasis has evolved significantly, with laparoscopic cholecystectomy emerging as the gold standard for most patients due to its safety, efficacy, and rapid recovery. Non-surgical approaches like dissolution therapy and lithotripsy offer alternatives for specific cases but have limited utility due to lower effectiveness and higher recurrence rates. Open cholecystectomy remains a crucial option in complicated scenarios. Future research should focus on optimizing techniques and exploring novel therapeutic options to improve outcomes.

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