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A CROSS-SECTIONAL STUDY FOR FORECASTING DIFFICULT LAPAROSCOPIC CHOLECYSTECTOMY THROUGH ULTRASONOGRAPHIC EVALUATION

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Abstract

Introduction: There are several indications for performing a cholecystectomy, the most common of which is symptomatic cholelithiasis, also known as "biliary colic. Laparoscopic cholecystectomy is considered as the gold standard procedure for the definitive management of gallstones and other gallbladder diseases. Laparoscopic cholecystectomy (LC) is the standard treatment for symptomatic cholelithiasis. However, the optimal timing of the procedure remains a topic of debate. Early laparoscopic cholecystectomy (ELC) has been shown to provide better clinical outcomes than delayed laparoscopic cholecystectomy (DLC) in cases of acute cholecystitis. One notable risk during LC is the potential need to convert to open cholecystectomy, particularly in patients with comorbid conditions, advanced age, a history of abdominal surgery, or low serum albumin levels. Research indicates that ELC is a safe approach that can reduce hospital stays and healthcare costs compared to DLC. Ultrasonography is the preferred imaging method for detecting gallstones and other gallbladder diseases and is also effective for monitoring the progression of cholecystitis and other gallbladder diseases. Surgical procedures can vary in complexity from straightforward cases with clearly defined Calot's triangle to more challenging ones with obscured anatomy, which may necessitate conversion to an open surgery

Objective of the study

- The use of pre-operative ultrasonographic findings in patients with chronic calculous cholecystitis and other gallbladder diseases to predict potential challenges during laparoscopic cholecystectomy and to correlate these pre-operative findings with intra-operative observations

Materials and methods: Sixty one patients with gallbladder diseases requiring laproscopic cholecystectomy attending the outpatient department and admitting at wards of General Surgery at RAICHUR INSTITUTE OF MEDICAL SCIENCES,RAICHUR, during the period 1st November 2024 to May 30th 2025, were selected and evalvated clinically, heamatologically and radiologically in collabaration with radiology department and then patients were operated. Preoperative

ultrasonographic parameters were recorded, including gallbladder size, wall thickness, gallstone number and mobility, and common bile duct diameter. Intraoperative parameters such as total operation time, dissection time of Calot's triangle, gallbladder stripping time, any difficulties during extraction or spillage, and the need for conversion to open surgery were also documented

Results: In the current study, ultrasound findings predicted an easy surgery in 63.3% of patients and a difficult surgery in 37.7%. Among those with ultrasound reports indicating a difficult surgery, 22 patients indeed experienced difficult procedures, while only 2 did not—a statistically significant association (**p = 0.001**).

For gallbladder wall thickness, the **positive predictive value (PPV)** was **91.5%**, with a **sensitivity of 65%** and **specificity of 97%**. In the case of a contracted gallbladder, the PPV was **95%** (**p = 0.002**). Additionally, the PPVs for stone impaction and common bile duct (CBD) dilatation were **96%** and **100%**, respectively

Interpretation &Conclusion: Preoperative ultrasonography can serve as an effective screening tool for anticipating potential difficulties during laparoscopic cholecystectomy. In many cases, it reliably predicts the level of surgical complexity. This information can help the surgeon better prepare for the specific challenges that may arise with each patient

Keywords: Gallbladder stones, laparoscopic cholecystectomy, open cholecystectomy, Ultrasonography.

Ultrasound (US) is a relatively low-cost, noninvasive imaging technique commonly used to detect biliary ductal dilation . When properly performed, it can offer valuable diagnostic information to aid in the management of hepatobiliary conditions[1]. Despite being operator dependent, ultrasound is widely accessible in most healthcare settings and is typically the first-line imaging modality for evaluating suspected biliary disease[2].

The normal gallbladder appears as an anechoic (fluid-filled), oval-shaped structure. While the position of the gallbladder fundus may vary, the neck of the gallbladder consistently aligns with the interlobar fissure of the liver[3]. On ultrasound, the gallbladder wall should appear as a thin, smooth, echogenic line and should not measure more than 3 mm in thickness. In patients who have not fasted, the gallbladder may be contracted, which can cause the wall to appear thickened[4].

Abnormal thickening of the gallbladder wall may indicate various pathological conditions, including acute or chronic cholecystitis, cholangitis, hepatitis, hepatic failure, cirrhosis, pancreatitis, congestive heart failure, renal failure, hypoalbuminemia , malignancy, or human immunodeficiency virus (HIV) infection[5].

Biliary obstruction can result from a variety of causes, including (1) gallstones, (2) tumors, (3) inflammatory conditions, (4) rare congenital anomalies, and (5) external compression, such as in Mirizzi syndrome[6]. Advances in imaging—particularly the use of high-frequency transducers and modern noninvasive techniques like harmonic imaging—have enhanced resolution and improved bile duct visualization by increasing the contrast-to-noise ratio. Ultrasound, when combined with CT or MRCP to assess the extent of disease, plays a key role in helping interventional radiologists, gastroenterologists, and surgeons plan appropriate treatment[7].

Cholelithiasis is a disease prevalent worldwide because it is a disease prevalent worldwide because of an imbalance of bile salt and cholesterol concentrations that leads to precipitation inside the gallbladder[8].

Symptomatic gallstone disease typically presents as biliary colic and may progress to acute cholecystitis in up to 20% of untreated cases. Younger patients are at greater risk of developing complications over their lifetime, with smaller stones particularly linked to an increased risk of pancreatitis. Potential complications of cholelithiasis include cholecystitis, obstruction or compression of the common bile duct (as seen in Mirizzi syndrome), pancreatitis, cholangitis, and, in rare cases, gallbladder cancer[9]. Around 65% of patients with acute cholecystitis also show signs of chronic cholecystitis, marked by fibrosis and chronic inflammation of the gallbladder wall[10].

Regardless of the underlying cause, nearly all cases of symptomatic or complicated gallstone disease are managed with cholecystectomy[11].

The management of gallstone disease has significantly advanced over the past two decades, particularly with the introduction of laparoscopic cholecystectomy[12]. Surgical techniques have progressed from same-day elective laparoscopic procedures and early intervention for cholecystitis to more modern approaches such as single-port laparoscopic cholecystectomy and even robotic-assisted surgeries[13].

Early evaluations of complications associated with laparoscopic cholecystectomy revealed a higher incidence of bile duct injuries (ranging from 0.2% to 0.8%) compared to those seen with open cholecystectomy (0.1% to 0.25%). Prior abdominal surgeries can pose technical challenges during laparoscopy, particularly with trocar placement, exposure, and visualization. Importantly, conversion to an open cholecystectomy should not be viewed as a complication, but rather as an appropriate surgical decision in complex cases. The conversion rate ranges from 5% to 10% worldwide[14].

AIM

To evaluate the use of preoperative ultrasonographic findings in patients with chronic calculous cholecystitis for predicting potential difficulties during laparoscopic cholecystectomy and to correlate these preoperative ultrasound results with intraoperative findings observed during the procedure

Materials and methods:

Setting: This is a cross sectional study done on 61 patients between November 1st 2024 to May 30th 2025.

This study was conducted at the department of General Surgery, with collaberation of department of raidology at RAICHUR INSTITUTE OF MEDICAL SCIENCES, RAICHUR. Patients fulfilling the inclusion and exclusion criteria were approached, explained about the study and were requested for enrolment. They were provided with a patient information sheet either in Kannada or English (depending upon their choice). Only those patients who volunteered for participation after fully satisfying themselves about the nature of the study and who gave written consent for this study were included. Ethical clearence taken..

Conduct of study

Patients were recruited for the purpose of the study.

In the cases who had given consent for the study, history was collected and thorough physical examination done at the time of admission. Data collection included age, sex, and clinical presentation and thorough USG examination at radiology department.

Study Population and Methodology

The study included patients of both genders, aged 15 years and older, who had experienced one or more episodes of acute cholecystitis, and other gallbladder diseases were scheduled for elective laparoscopic cholecystectomy (LC), and had undergone a detailed preoperative ultrasound (US) examination a few days prior to surgery.

Preoperative Ultrasound Assessment

Four ultrasound parameters were evaluated in all patients:

1. **Gallbladder size** – classified as normally distended or contracted.
2. **Gallbladder wall thickness**.
3. **Gallstone mobility** – either freely mobile or impacted in the gallbladder neck.
4. **Common bile duct (CBD) diameter** – categorized as either less than 8 mm or more than 8 mm.

All ultrasound examinations were performed by trained ultrasonographers using the same equipment settings. Patients were instructed to fast prior to the examination and were assessed in both supine and alternative positions to evaluate gallstone mobility. The ultrasound findings were used as preoperative indicators of potentially difficult surgery if any of the following criteria were met:

- Contracted gallbladder
- Gallbladder wall thickness > 5 mm
- Impacted gallstone in the neck of the gallbladder
- CBD diameter > 8 mm

Intraoperative Assessment During LC

The following intraoperative parameters were recorded:

1. **Total duration of surgery** – classified as less than or more than 90 minutes (measured from first port insertion to skin closure).
2. **Time to dissect Calot's triangle** – less than or more than 20 minutes.
3. **Time to separate the gallbladder from its fossa** – less than or more than 20 minutes.
4. **Difficulty in gallbladder extraction** – including cases requiring port enlargement or associated with bile or stone spillage.
5. **Conversion to open cholecystectomy**, if necessary.

A case was considered a **difficult laparoscopic cholecystectomy** if any of the following criteria were met:

- Total operative time exceeded 90 minutes.
- Dissection of Calot’s triangle took more than 15 minutes.
- Gallbladder removal from its fossa took more than 15 minutes.

Inclusion Criteria

Both genders, age more than l5 years old

1. Symptomatic cholilithiasis.
2. Patients had previous one or more attacks of acute cholicystitis.
3. Blood dyscrasias
4. Fistulization of gallbladder and gallstone ileus
5. Emphysematous gallbladder
6. Cholangitis
7. Perforation of gallbladder/abscess (relative)
8. Severe cholecystitis (relative)
9. Suspicion for gallbladder cancer stage 1A and 1B.

Exclusion Criteria

1. Patients who are unfit for general anesthesia.
2. History of previous upper abdominal surgery.
3. Patient refusal.
4. Presence of concomitant choledocholithiasis.
5. Patients with abnormal liver function tests (LFTs).

Laparoscopic Cholecystectomy: Technique and Key Considerations

The laparoscopic approach has become the standard method for performing cholecystectomy. It replicates the traditional open technique, using a neck-to-fundus dissection approach, as will be detailed below. The procedure begins with the patient in a supine position. General anesthesia with endotracheal intubation is administered, prophylactic antibiotics are given, and sequential

compression devices are applied to both lower extremities. The abdomen is then thoroughly prepped and draped in a sterile fashion[15].

Typically, access to the peritoneal cavity is achieved using an open (Hasson) technique at the umbilicus, through which pneumoperitoneum is established. Alternatively, a Veress needle may be used; correct intraperitoneal placement is confirmed via a saline drop test. Once confirmed, the Veress needle is replaced with a 5-mm port, and insufflation is initiated. A laparoscope is introduced either through the Hasson port or the initial 5-mm port, and a diagnostic laparoscopy is performed to rule out any iatrogenic injury from port placement[16].

Under direct visualization, three additional 5-mm ports are inserted: two in the right upper quadrant and right flank, and one in the subxiphoid region. If the initial umbilical access was via the Veress technique, a 10-mm port is instead placed in the subxiphoid region to accommodate the laparoscope, along with the two lateral ports.

The patient is then positioned in reverse Trendelenburg with a left lateral tilt to enhance exposure of the right upper quadrant. An assistant surgeon uses a grasper through one lateral port to retract the gallbladder fundus cephalad, elevating it over the liver. Another grasper is often used to manipulate the infundibulum laterally and anteriorly, thereby aligning the cystic duct away from the common bile duct.

Dissection begins with an incision in the peritoneum on the underside of the gallbladder using hook electrocautery. This is extended toward the anterior portion of the hepatoduodenal ligament. Excessive traction can cause the common bile duct to tent, increasing the risk of misidentifying it as the cystic duct. Careful blunt dissection in the triangle of Calot is then performed to identify the cystic duct, the common bile duct, and their junction with the gallbladder.

A grasper may be used to palpate the cystic duct for stones, which can be gently milked back into the gallbladder, mirroring techniques used in open surgery. If there is concern for a common bile duct stone, an intraoperative cholangiogram may be performed. If a stone is identified or palpable, the common bile duct may be opened and explored.

Dissection of the cystic duct and artery within Calot's triangle follows. At this point, the **"critical view of safety"** technique is employed to prevent bile duct injuries. This technique involves three essential steps:

1. Complete clearance of fat and fibrous tissue from Calot's triangle without exposing the common bile duct.
2. Dissection of the gallbladder base from the liver (cystic plate).
3. Visualization of only two structures entering the gallbladder — the cystic duct and the cystic artery — seen circumferentially.

This technique creates two anatomical "windows": one between the cystic duct and artery, and another between the artery and the liver bed. Ensuring adequate dissection of the gallbladder off the liver bed, particularly in cases of acute cholecystitis, helps to confirm that only the cystic structures remain to be divided.

Once the anatomy is clearly identified, the cystic duct is clipped and transected as close to the gallbladder as possible to avoid injury to the common bile duct. Though the length of the cystic duct stump was once thought to contribute to postcholecystectomy syndrome, current understanding emphasizes the importance of avoiding ductal injury over stump length.

After correctly identifying and isolating the cystic artery (and ensuring it is not a right hepatic artery), it is clipped and sharply transected.

With both the cystic artery and duct divided, the gallbladder neck is freed, and dissection from the hepatic fossa begins. Upward traction on the gallbladder neck facilitates visualization and dissection of the peritoneum and alveolar connective tissue between the gallbladder and liver. This step is completed using a combination of electrocautery and blunt dissection, progressing toward the fundus until the gallbladder is entirely removed.

Occasionally, aberrant bile ducts (e.g., ducts of Luschka) may be encountered draining into the gallbladder fossa from the right or common hepatic ducts. These can be clipped and divided if necessary. If a postoperative bile leak occurs from these ducts, it often resolves spontaneously.
The gallbladder bed and cystic artery stump are then inspected for hemostasis.

Lessons Learned and Safety Measures
Complications from laparoscopic cholecystectomy, particularly bile duct injuries, have led to significant advancements in technique. The most serious of these — common bile duct injury — often results from misidentification of the biliary anatomy, such as confusing the common bile duct with the cystic duct. The **"critical view of safety"** method, introduced by Strasberg in 1995, has since become an essential safety measure to minimize the risk of such injuries and is now considered a standard part of laparoscopic cholecystectomy[17].

STATISTICALANALYSIS

Data were entered into Microsoft Excel 2019 and subsequently imported into SPSS (Statistical Package for the Social Sciences) version 24. Categorical data are presented as frequencies and percentages. An independent t-test was employed to assess differences in parametric variables between groups. A p-value of less than 0.05 was considered statistically significant."

RESULTS

1. The total patient sample of the present study was 61 patients with mean age 46.5+13.5, the age group of the patients ranged from 18 to 70 years. The most prevalent sample was female 76%, while male formed 24%.

SEX DISTRIBUTION OF PATIENTS WITH GALLBLADDER DISEASE

SEX	MALE	FEMALE
PERCENTAGE	76	24

2. In the current study, the results showed that 63.3% of patients had ultrasound interpretations predicting an easy surgery, while 37.7% had findings suggesting a difficult surgery.

EASE OF PERFORMING LAPROSCOPIC CHOLICYSTECTOMY

EASE OF DOING SURGERY	EASY SURGERY	DIFFICULT SURGERY
PERCENTAGE	63.3	37.7

3. Based on the findings of the current study, 72.1% of participants had normal gallbladder wall thickness, while 27.8% showed thickening. A contracted gallbladder was observed in 29.5% of cases. In terms of stone mobility, 42.6% of the stones were impacted, and 4 % of all participants had a dilated common bile duct (CBD).
4. In terms of intraoperative findings, 8.8% of patients had a total operative time exceeding 90 minutes. Dissection of Calot's triangle took more than 20 minutes in 34.4% of cases, while gallbladder stripping from the liver bed exceeded 20 minutes in 25.3% of patients. Additionally, 32.3% experienced difficult extraction or spillage, and 1% required conversion to an open procedure
5. The present study found that all 22 patients predicted to have difficult surgeries based on ultrasound (US) results indeed experienced difficult procedures. In contrast, only 2 patients who were expected to have simple surgeries based on US findings actually had difficult surgeries. This correlation between US predictions and surgical difficulty was statistically significant ($p = 0.001$). The ultrasound showed a sensitivity of 91% and a specificity of 95%, with a positive predictive value of 92% and an overall accuracy of 94%

DISTRIBUTION OF THE ENTIRE PATIENT SAMPLE BASED ON ULTRASOUND PARAMETERS.

USG PARAMETERS	NUMBER	PERCENTAGE
WALL THICKNESS		
NORMAL	44	74.5
THICKENED	17	25.5
SIZE		
NORMAL DISTENTION	43	70.49
CONTRACTED	18	29.50
STONE MOBILITY		
MOBILE	35	57.37
IMPACTED	26	42.6
CBD DIAMETER		
NORMAL	58	95.08
DIALATED	3	4
TOTAL	61	100

6. Gallbladder wall thickness showed a significant predictive value for difficult surgery. Among 17 patients with increased wall thickness, 15 experienced a difficult procedure, demonstrating a statistically significant association ($p = 0.001$). The positive predictive value was 91.5%, with a sensitivity of 65% and specificity of 97%. The overall accuracy of using gallbladder wall thickness to predict surgical difficulty was 86%
7. In evaluating gallbladder size as a predictor of difficult surgery, all but one patient with a contracted gallbladder experienced a challenging procedure, demonstrating a statistically significant association ($p = 0.002$). The positive predictive value was 95%, with sensitivity, specificity, and accuracy reported at 53%, 98%, and 83%, respectively
8. The results showed that only 1 out of 26 patients with an impacted stone underwent an easy surgery, indicating a statistically significant association ($p = 0.001$). The positive predictive value was 96%, with a sensitivity of 70.6%, specificity of 98.5%, and an overall diagnostic accuracy of 89.2%
9. Regarding the correlation between CBD diameter and surgical difficulty, all three patients with a dilated CBD experienced a difficult procedure, showing a statistically significant association ($p = 0.013$). The positive predictive value was 100%, while sensitivity, specificity, and accuracy were 9%, 100%, and 69%, respectively.

DISCUSSION

Gallstone disease is among the most common gastrointestinal conditions. Preoperative ultrasound remains the primary imaging modality for patients scheduled for cholecystectomy, as it offers a sensitive method for assessing gallbladder characteristics. Laparoscopic cholecystectomy has become the gold standard and preferred surgical approach for symptomatic cholelithiasis over the past few decades. While often straightforward, the procedure can become challenging due to factors such as distorted anatomy from dense adhesions in Calot's triangle, gallbladder empyema, contracted gallbladder, previous upper abdominal surgeries, and acute cholecystitis.

Several prior studies have explored the correlation between ultrasound findings and the intraoperative difficulty of laparoscopic cholecystectomy (LC), with some developing independent scoring systems. In our study, the age group with the highest proportion of cases (30–43 years) aligned with previous findings. The majority of patients with gallstones were female (74%), consistent with other studies on gallstone disease.

Regarding ultrasound parameters—widely considered the most effective preoperative imaging tool for evaluating gallbladder condition—our findings showed gallbladder wall thickening in 27.8% of

patients, contracted gallbladder in 29.5%, and limited stone mobility in 42.6%. Common bile duct (CBD) dilation was observed in only 4.% of cases.

A significant association was found between preoperative ultrasound findings and surgical difficulty ($p = 0.001$), supporting the results of Griffiths EA et al. In our cohort, 91% of patients with ultrasound features suggestive of a difficult procedure indeed underwent complex surgeries, similar to the findings of Chand P. et al. Among the ultrasound parameters we analyzed, gallbladder wall thickness significantly affected both the duration of surgery and the complexity of gallbladder extraction, with a p-value of 0.001. It had a positive predictive value of 91.5%, sensitivity of 65%, and specificity of 97%, aligning with results from Raman SR et al. and Chand et al.

Gallbladder size was also considered, classified as either normally distended or contracted. A contracted gallbladder, often the result of repeated inflammation and adhesions in Calot's triangle, was strongly associated with increased surgical difficulty. Nearly all cases with a contracted gallbladder resulted in difficult surgeries ($p = 0.002$), with a positive predictive value of 95%, echoing findings by Bansal A. et al.

The presence of a stone impacted in the gallbladder neck was another strong predictor of surgical difficulty ($p = 0.001$), with a positive predictive value of 96%, in line with some studies, though contrary to others. Additionally, as found in our study and those by Siddiqui et al. and Nassar AH et al., a CBD diameter greater than 8 mm was a significant predictor of surgical complexity ($p = 0.013$).

Despite some studies, such as Carmody et al., suggesting limited usefulness of preoperative ultrasound in predicting surgical difficulty, our low conversion rate may be attributed to strict adherence to fundamental surgical principles. These include safe first port entry, ensuring proper visualization, minimal use of electrocautery in Calot's triangle, complete identification of structures before clipping, appropriate traction, and effective hemostasis.

CONCLUSIONS

Preoperative ultrasonography can serve as a valuable diagnostic tool for anticipating potential difficulties during laparoscopic cholecystectomy. In many cases, it reliably predicts the level of surgical complexity. This information can help the surgeon better prepare for the specific challenges that may arise with a given patient.

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