

Research Article

A Study of Pre-Operative Predictors of Difficult Laparoscopic Cholecystectomy

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Abstract

Background: Laparoscopic cholecystectomy (LC) is the preferred surgical procedure for gallstone disease worldwide. However, LC is not entirely risk-free, and approximately 2–15% of procedures require conversion to open cholecystectomy due to intraoperative difficulties. **Objectives:** To evaluate the epidemiological profile, clinical manifestations, and factors influencing the difficulty of laparoscopic cholecystectomy in patients with cholelithiasis, with particular emphasis on identifying predictive variables associated with difficult LC. **Materials and Methods:** This prospective study was conducted at NCMCH, Israna, Panipat, Haryana, and included 90 patients admitted for elective laparoscopic cholecystectomy. Informed written consent was obtained from all participants. Preoperative clinical and ultrasonographic parameters were analyzed and correlated with intraoperative difficulty levels. Data were analyzed using SPSS version 24.0. **Results:** Among the 90 patients, LC was categorized as *easy* in

50%, *difficult* in 33.3%, and *very difficult* in 16.7% of cases. Increased surgical difficulty was significantly associated with older age, male gender, prolonged duration of pain, and recent acute attacks. Ultrasonographic findings such as over-distended gallbladder, increased gallbladder wall thickness, single large stones, and stones impacted in the neck of the gallbladder showed a significant correlation with higher difficulty levels. Most procedures were completed within one hour, and the conversion rate to open cholecystectomy was 8.9%. **Conclusion:** Surgical difficulty during laparoscopic cholecystectomy is significantly influenced by patient-related factors such as age and gender, clinical presentation, and specific ultrasonographic findings. Early identification of these predictors can assist surgeons in preoperative planning, reduce operative time and complications, and improve overall patient outcomes.

Keywords: Cholelithiasis, Gallstone disease, Laparoscopic cholecystectomy,

Open cholecystectomy, Difficult laparoscopic cholecystectomy

INTRODUCTION

Laparoscopic cholecystectomy (LC) has gained worldwide acceptance as the preferred surgical procedure for the management of gallbladder diseases, including gallstone disease, chronic cholecystitis, symptomatic cholelithiasis, biliary dyskinesia, acalculous cholecystitis, and gallstone pancreatitis.[1,2] Owing to its minimally invasive nature, LC has largely replaced open cholecystectomy and is now considered the procedure of choice. The advantages of LC include smaller incisions, reduced intraoperative blood loss, decreased postoperative pain, shorter hospital stay, faster recovery, improved cosmetic outcomes, and a lower incidence of postoperative complications such as paralytic ileus.[1–4]

Cholelithiasis is one of the most common digestive disorders worldwide and poses a significant public health burden.[5] In the United States, gallstones affect approximately 20 million individuals, with nearly one million new cases diagnosed annually.[6] The prevalence of cholelithiasis varies widely based on geographic, ethnic, and demographic factors. In India, the prevalence is estimated to be around 4%, with a rising trend attributed to lifestyle changes and dietary westernization.[7] The pathogenesis of gallstone disease is multifactorial, involving genetic susceptibility, metabolic disturbances, and environmental factors. Supersaturation of bile with cholesterol, impaired gallbladder motility, and altered enterohepatic circulation contribute to cholesterol crystal formation and stone development.[7]

Clinically, cholelithiasis commonly presents with episodic biliary colic, characterized by right upper quadrant

pain that may radiate to the epigastrium, back, or shoulder.[8] Although a large proportion of patients remain asymptomatic, approximately 20–25% develop complications such as acute cholecystitis, choledocholithiasis, cholangitis, biliary pancreatitis, or gallstone ileus, which necessitate timely surgical intervention.[9]

Historically, open cholecystectomy (OC) was the standard treatment for gallbladder disease. However, the advent of laparoscopic techniques has revolutionized surgical management by offering a safer and less invasive alternative.[10] The National Institutes of Health (NIH) Consensus Development Conference has endorsed laparoscopic cholecystectomy as the treatment of choice for symptomatic gallstone disease, citing its superior postoperative outcomes and reduced morbidity.[11] Despite its advantages, LC is not devoid of challenges. Factors such as dense adhesions, inflammation, anatomical variations, bile or stone spillage, prolonged operative time, and the potential need for conversion to open surgery continue to pose intraoperative difficulties.[12]

Identification of predictive factors associated with difficult laparoscopic cholecystectomy is crucial for effective preoperative planning, informed patient counseling, and optimal utilization of surgical resources. Recognizing these variables can help surgeons anticipate technical challenges, reduce operative time, minimize complications, and improve overall surgical outcomes. Therefore, the present study aims to analyze the epidemiological trends, clinical presentation, and ultrasonographic predictors influencing the difficulty of laparoscopic cholecystectomy in patients with cholelithiasis.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted in the Department of General Surgery at NCMCH, Israna, Panipat, Haryana. A total of 90 patients admitted for elective laparoscopic cholecystectomy (LC) over a period of one year were enrolled. Informed written consent was obtained from all participants or their attendants prior to inclusion in the study.

Inclusion Criteria

- Patients aged ≥ 18 years
- Patients scheduled for elective laparoscopic cholecystectomy
- No history of acute cholecystitis or hospitalization for more than 24 hours in the preceding six weeks
- Negative Murphy's sign at the time of admission
- Willingness to participate and provision of informed written consent

Exclusion Criteria

- Pregnancy and pediatric patients
- Deranged liver function tests, including:
 1. Obstructive jaundice (elevated serum bilirubin)
 2. Suspected or confirmed choledocholithiasis (elevated alkaline phosphatase)
 3. Positive serology for hepatitis B or C virus or evidence of liver cirrhosis (elevated OT/PT)
 4. Suspected common bile duct obstruction
- History of collagen vascular disorders, bile duct injury, gallbladder mass suspicious of malignancy, or acute cholecystitis within the previous six weeks
- Patients on hepatotoxic drugs
- Obesity (body mass index >30 kg/m²)
- Patients who refused consent or withdrew consent at any stage of the study
- Patients who developed complications related to anesthesia or had significant pre-existing renal, pulmonary, or cardiac comorbidities

Operative Procedure

All patients were kept nil per oral for at least eight hours prior to surgery. Laparoscopic cholecystectomy was performed under general anesthesia using carbon dioxide pneumoperitoneum maintained at a pressure of 12 mm Hg. A standard four-port technique was employed, comprising two 10-mm ports and two 5-mm ports.

The operative time was recorded from the skin incision to the closure of the last port. Dissection was carried out within the safe anatomical zone to achieve the critical view of safety. Intraoperative findings, including the presence of adhesions, bile or stone spillage, bleeding, and other technical difficulties, were meticulously documented. All procedures were performed by experienced surgeons, each of whom had completed more than 150 laparoscopic cholecystectomies.

Based on intraoperative findings and operative time, procedures were categorized as *easy*, *difficult*, or *very difficult*.

Postoperative Management and Data Analysis

Postoperatively, patients were shifted to the surgical ward and monitored for complications. Discharge was planned after drain removal and clinical stabilization.

Preoperative clinical and ultrasonographic parameters were compared with intraoperative difficulty levels to assess predictors of difficult laparoscopic cholecystectomy. Data were entered into Microsoft Excel and analyzed using SPSS software. Statistical analysis was performed to determine associations between preoperative variables and surgical difficulty.

Table no.1: Grading criteria as per the level of difficulty

Level of difficulty	Inference	Grading
No difficulty	Operation performed routinely.	No difficult+ slightly difficult =easy
Slightly difficult	Procedure done with minor complications.	
Difficult	Procedure done with multiple complications leading to contemplated conversion to open procedure.	difficult+ extremely difficult = difficult
Extremely difficult	Multiple uncontrollable complications leading to contemplation to open procedure.	

RESULTS

The present study evaluated the difficulty of laparoscopic cholecystectomy (LC) in 90 patients based on demographic, clinical, ultrasonographic, and intraoperative parameters. Of the total cases, LC was categorized as *easy* in 50% (n = 45), *difficult* in 33.3% (n = 30), and *very difficult* in 16.7% (n = 15).

Demographic Factors

The study population comprised 64 females (71.1%) and 26 males (28.9%). A statistically significant association was observed between gender and surgical difficulty, with males experiencing a higher proportion of difficult and very difficult procedures (p = 0.042).

Regarding age distribution, 66 patients were below 50 years and 24 were aged

50 years or above. Increasing age was significantly associated with higher difficulty levels (p = 0.00001). The mean age of patients undergoing easy, difficult, and very difficult LC was 37.8 years, 44.2 years, and 47.1 years, respectively.

Clinical Parameters

A history of continuous mild pain was absent in 59 patients, while the remaining reported varying degrees of pain. A statistically significant association was found between the presence of prolonged pain and increased surgical difficulty (p = 0.001). With respect to acute attacks, 39 patients (42.7%) had no history of acute attacks, 38 (42.2%) had experienced a single episode, and 13 patients had multiple episodes. A significant correlation was observed between the

number of acute attacks and LC difficulty ($p = 0.0508$). Additionally, the timing of the most recent acute episode showed a significant association with surgical difficulty, with recent episodes (≤ 3 months) being linked to higher difficulty levels ($p = 0.022$).

Comorbidities and Laboratory Findings

Most patients (66.7%, $n = 60$) had no associated comorbidities. Among those with comorbid conditions, hypertension and diabetes mellitus were the most common. Prior surgical history was absent in 60% ($n = 54$) of patients, while lower segment caesarean section (LSCS) was the most frequently reported previous surgery.

Total leukocyte count (TLC) was $<10,000/\text{mm}^3$ in 90% of patients and $>10,000/\text{mm}^3$ in 9%. No statistically significant association was found between TLC and surgical difficulty ($p = 0.397$).

Ultrasonographic Findings

Gallbladder distension was normal in 60%, contracted in 32%, and over-distended in 8.9% of cases. A significant association was noted between gallbladder distension and difficulty level ($p = 0.024$).

Stone characteristics significantly influenced LC difficulty. Single gallstones were present in 32.2% ($n = 29$) of patients, while 67.8% ($n = 61$) had multiple stones. Single large stones were significantly associated with difficult and very difficult LC ($p = 0.000$). Stone location also showed a strong correlation, with stones impacted in the gallbladder neck posing greater

surgical difficulty compared to stones located in the lumen ($p = 0.001$). Stone size ≥ 1.5 cm was significantly associated with increased difficulty ($p = 0.0001$).

Gallbladder wall thickness was normal (≤ 3 mm) in 73 patients and increased (>3 mm) in 17 patients. Increased wall thickness showed a highly significant association with difficult LC ($p = 0.0001$). Pericholecystic fluid was present in only 8.9% of patients and did not show a significant correlation with difficulty ($p = 0.100$).

The common bile duct (CBD) was normal (≤ 7 mm) in most cases, with a small proportion showing dilatation (>7 mm). CBD diameter did not show a statistically significant association with surgical difficulty ($p = 0.074$).

Intraoperative Findings

Intraoperatively, 80 patients had a normal gallbladder, while 8 had mucocoele and 3 had pyocoele. Adhesions were absent in 58.9% of cases, while 26.7% had flimsy adhesions and 14.4% had dense adhesions, with increasing adhesion severity correlating with increased difficulty.

The duration of surgery was less than one hour in 61.1% ($n = 55$) of cases, between 1 and 1.5 hours in 25.6% ($n = 23$), and more than 1.5 hours in 13.3% ($n = 12$). Dissection was rated as easy in 56.7% ($n = 51$), moderately difficult in 20% ($n = 18$), and difficult in 12.3% ($n = 11$).

Conversion to open cholecystectomy was required in 8.9% ($n = 8$) of cases. Bile spillage was minimal, with 85.3% of patients experiencing no spillage during the procedure.

Table no.2: Baseline characteristics of patients

Parameters	Variables	Number (Percent)
Age Gr	≤ 50 years	66 (73.3%)
	54 (72%)	24 (26.7%)
Gender	Male	64 (71.1%)
	Female	26 (28.9%)
Difficulty level	Difficult	30 (33.3%)

	Easy	45 (50%)
	Very Difficult	15 (16.7%)
Comorbidities	Diabetes mellitus	6 (6.7%)
	Deep vein thrombosis	2 (2.2%)
	Hypertension	15 (16.7%)
	Hypertension+ Hypothyroidism	2 (2.2%)
	Hypertension+ Diabetes mellitus	4 (4.4%)
	Hypothyroidism	5 (5.6%)
	Hypothyroidism	1 (1.1%)
	Tuberculosis	1 (1.1%)
Surgical Past History	ERCP	5 (5.6%)
	Hysterectomy	4 (4.4%)
	LSCS	16 (17.8%)
	Tubal Ligation	4 (4.4%)
	Tubal Ligation + LSCS	2 (2.2%)
	Tubectomy	3 (3.3%)
	Umbilical Hernia + Hysterectomy	2 (2.2%)
Total leucocyte count	≤10,000 WBCs per microlitre	81 (90%)
	>10,000 WBCs per microlitre	9 (10%)
Stone location	Lumen	79 (87.8%)
	Neck	10 (11.1%)
	Lumen+ Neck	1 (1.1%)
Operative time	<1 hour	55 (61.1%)
	1- 1.5 hour	23 (25.6%)
	>1.5 hour	12 (13.3%)
Adhesions	Absent	53 (58.9%)
	Flimsy adhesions	24 (26.7%)
	Dense adhesions	13 (14.4%)
Dissection	Easy difficulty level	51 (56.7%)
	Moderate difficulty level	18 (20%)
	Difficult	11 (12.2%)
Complications	Conversion to open cholecystectomy	8 (8.8%)
	Bile Spillage	14 (15.6%)

Table no.3: Lab data at different timelines

Parameters	Variables	Difficult	Easy	Very difficult
Duration of H/O Continuous pain	Absent	20	34	5
	1 min	5	6	0
	2 min	4	5	1
	3 min	0	2	4
	5 min	0	0	1
	10 min	0	0	1

	1 year	0	1	1
Number of acute attacks	None	8	28	3
	1	13	20	5
	2	6	1	5
	3	1	0	0
Last episode of acute attack	Absent	10	27	3
	2 months ago	16	16	5
	3 months ago	4	2	5
	4 months ago	0	0	1
	5 months ago	0	1	1
	10 months ago	0	1	0
Gall bladder status	Contracted	7	21	3
	Distended	15	27	9
	Overdistended	5	0	3
Number of stone	Single	15	4	8
	Multiple	14	43	6
Size of stone	<1.5 cm	22	49	2
	≥1.5 cm	6	1	10
GB wall thickness	≤3 mm	23	45	5
	>3 mm	6	2	9
Pericholecystic Fluid	Absent	25	46	11
	Present	3	2	3
CBD status	Dilated	2	6	3
	Normal	26	42	10
Gall bladder status	Mucocele	6	0	2
	Normal	24	47	9
	Pyocele	0	0	3

DISCUSSION

The present study evaluated various predictive factors influencing the difficulty of laparoscopic cholecystectomy (LC) and demonstrated significant associations between surgical complexity and selected demographic, clinical, and ultrasonographic parameters.

In this study, 73.3% of patients were below 50 years of age, while 26.7% were aged 50 years or above. A statistically significant association was observed between increasing age and surgical difficulty ($p = 0.036$). Older patients were more likely to experience difficult or very difficult LC, which may be attributed to age-related changes such as reduced tissue elasticity, increased vascular fragility, and chronic inflammatory changes around Calot's triangle. These findings are consistent with reports by Yang et al.[13] and Karim et al.[14], who also

identified advancing age as a predictor of difficult LC.

A female predominance (70.7%) was observed in the study population, reflecting the higher prevalence of gallstone disease among women, particularly during the reproductive years. This observation aligns with studies by Vivek et al.[15] and Philip et al.[16] and is commonly attributed to hormonal influences such as estrogen-mediated cholesterol supersaturation of bile. Despite the female predominance, male patients were found to have a significantly higher likelihood of difficult LC ($p = 0.042$). This may be explained by delayed presentation, recurrent inflammatory episodes, and increased fibrosis around Calot's triangle in males, making dissection technically more challenging.

Clinical symptomatology also played a significant role in predicting operative difficulty. A history of continuous mild pain was present in 34.4% of patients

and showed a significant association with increased surgical difficulty ($p = 0.010$). Persistent pain likely reflects chronic inflammation, leading to fibrotic changes and adhesions, as supported by Strasberg et al.[17] and Berci et al.[18]. Similarly, the number of acute attacks demonstrated a significant correlation with LC difficulty, corroborating findings by Singh et al.[19], Nassar et al.[20], and Tongyoo et al.[21], who emphasized that repeated inflammatory episodes result in distorted anatomy and dense adhesions.

The timing of the most recent acute pain episode also significantly influenced surgical difficulty ($p = 0.0001$). Patients with recent attacks were more likely to experience difficult LC, likely due to unresolved inflammation. This observation is in agreement with previous studies by Singh et al.[19], Bhandari et al.[22], and Ramirez-Giraldo et al.[23]. In contrast, comorbidities such as hypertension and diabetes mellitus did not show a significant association with operative difficulty ($p = 0.537$), consistent with findings reported by Philip et al. Similarly, total leukocyte count was not a reliable predictor of surgical complexity ($p = 0.397$).

Ultrasonographic parameters emerged as important predictors of difficult LC. Gallbladder status—whether distended, contracted, or over-distended—showed a significant association with surgical difficulty ($p = 0.024$), a finding consistent with studies by Singh et al.[19], Elgammal et al.[24], and Di Buono et al.[25]. Increased gallbladder wall thickness (>3 mm) was strongly associated with difficult LC ($p = 0.003$), reflecting chronic inflammation and fibrosis, which complicate dissection and increase the likelihood of prolonged operative time and conversion to open surgery.

Stone-related factors also influenced operative complexity. A significant association was found between the number of stones and surgical difficulty ($p = 0.0001$), with single, impacted stones posing greater challenges than multiple stones. Stone location was another critical factor, with stones located in the gallbladder neck or both the neck and lumen being associated with higher difficulty levels ($p = 0.002$), possibly due to inflammation, edema, and the risk of Mirizzi syndrome. Larger stone size was also significantly associated with increased difficulty ($p = 0.004$), consistent with observations by Elgammal et al.[24] and Al Zoubi et al.[26].

Pericholecystic fluid was present in only 8.9% of cases and did not show a statistically significant association with surgical difficulty. Intraoperatively, shorter operative times were generally associated with fewer complications, with 61.1% of surgeries completed within one hour. Adhesions were noted in 41.1% of cases, and dense adhesions were a major contributor to increased surgical difficulty. Conversion to open cholecystectomy was required in 8.9% of patients, primarily due to poor visualization and inability to safely delineate anatomy. Bile spillage occurred in 15.6% of cases, underscoring the importance of meticulous surgical technique to minimize postoperative complications.

LIMITATIONS

The primary limitation of this study is the relatively small sample size, which may restrict the generalizability of the findings. Additionally, the study was conducted at a single center, and long-term follow-up was not included. Larger, multicenter studies with extended follow-up periods would help validate these findings and establish stronger predictive models for difficult laparoscopic cholecystectomy.

CONCLUSION

This study demonstrated that the difficulty of laparoscopic cholecystectomy is significantly influenced by factors such as older age, male gender, prolonged mild pain, and recent or recurrent acute attacks. Ultrasonographic predictors—including over-distended gallbladder, increased gallbladder wall thickness, single large stones, and stones impacted in the gallbladder neck—were strongly associated with increased surgical complexity. Early recognition of these predictive factors can assist surgeons in preoperative planning, patient counseling, and selection of surgical strategies, thereby reducing operative time, minimizing complications, and improving overall patient outcomes.

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Ethical approval and Consent

Approval was taken from the relevant ethics committee and written informed consent was taken from each patient to publish his details while maintaining confidentiality.