

Research Article

Preoperative Prediction of Difficult Laparoscopic Cholecystectomy Using Clinical, Sonographic and Biochemical Parameters: A Retrospective Study

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ABSTRACT

Background: Laparoscopic cholecystectomy (LC) is the gold standard for the surgical management of gallbladder disease. A subset of cases, however, proves technically difficult, resulting in prolonged operative time or conversion to open cholecystectomy. Preoperative identification of such cases allows more informed surgical planning, resource allocation, and patient counselling.

Aim: This study aimed to preoperatively predict difficult laparoscopic cholecystectomy and the likelihood of conversion to open cholecystectomy (OC) using a combination of clinical parameters, sonographic findings, and biochemical markers. The secondary objective was to correlate the composite clinico-sonographic scoring with intraoperative findings.

Methods: A retrospective study was carried out on 88 patients who underwent elective laparoscopic cholecystectomy at PESIMSR Hospital, Kuppam, over a period of 18 months. Clinical parameters, ultrasonographic findings, and biochemical markers were recorded and statistically correlated with intraoperative findings and total duration of surgery.

Results: The majority of patients were female (67.1%), with a mean age of 41 years. Prolonged surgery (>2 hours) was associated with male gender, presence of comorbidities, prior abdominal surgery, elevated alkaline phosphatase (ALP), and abnormal total leukocyte count (TLC). Sonographic features, including gallbladder wall thickening, pericholecystic fluid, multiple calculi, and a distended gallbladder, correlated significantly with increased surgical difficulty. Only one patient (1.1%) required conversion to open surgery.

Conclusion: Preoperative assessment combining clinical, sonographic, and biochemical parameters is an effective and reproducible strategy for predicting difficult LC. Systematic use of this composite approach can aid surgical planning, improve patient counselling, and help minimise intraoperative and postoperative complications.

Keywords: Laparoscopic Cholecystectomy, Difficult Cholecystectomy, Conversion to Open Surgery, Alkaline Phosphatase, Gallbladder Ultrasonography, Preoperative Prediction.

INTRODUCTION

Laparoscopic cholecystectomy has evolved into the gold standard for gallbladder removal since it gained widespread acceptance in the early 1990s. Its rapid adoption across surgical practice was driven by well-documented advantages over conventional open cholecystectomy, including reduced postoperative pain, shorter hospital stay, faster convalescence, and superior cosmetic outcomes³. Progressive standardisation of operative technique and structured training curricula endorsed by professional surgical bodies have further strengthened the safety profile and reproducibility of the procedure across diverse clinical settings.

More recent innovations, including robotic-assisted cholecystectomy, single-incision laparoscopic surgery (SILS), and natural orifice transluminal endoscopic surgery (NOTES), continue to refine minimally invasive approaches to biliary disease, with the shared goal of minimising surgical trauma while preserving the safety benchmarks established by conventional laparoscopy³.

Despite these benefits, laparoscopic cholecystectomy is not without risk. Recognised complications include haemorrhage, surgical site infection, bile leak, and bile duct injury, the last of these representing a particularly serious concern due to the technical complexity of dissection in an inflamed or distorted Calot's triangle¹. Early recognition and prompt

management of such complications remain essential to achieving optimal outcomes and limiting long-term morbidity.

Postoperative recovery following uncomplicated LC is typically smooth, characterised by early mobilisation, gradual resumption of oral intake, and comparatively short hospitalisation. Structured follow-up continues to play an important role in assessing wound healing, functional recovery, and the timely detection of delayed complications such as bile duct strictures or retained calculi¹.

Certain clinical circumstances limit the feasibility of a purely laparoscopic approach, including severe cardiopulmonary disease, advanced cirrhosis with portal hypertension, haemodynamic instability, acute cholecystitis with dense local inflammation, and anatomically altered or aberrant biliary anatomy, as exemplified by conditions such as Mirizzi syndrome⁷. In such circumstances, timely conversion to open surgery may be required to safeguard patient safety, and multiple predictive statistical models have been proposed to anticipate this need before it arises intraoperatively^{5,6}.

When performed in appropriately selected patients, laparoscopic cholecystectomy demonstrates high success rates, exceeding 95% in most large series, with excellent long-term outcomes including sustained symptomatic relief and measurable improvement in quality of life^{9,10}.

To further enhance surgical safety and outcomes, numerous predictors of operative difficulty and complication risk have been developed and validated in different populations. Anatomical landmarks such as Rouvière's sulcus have been proposed as reliable intraoperative reference points for safe dissection⁴, while the introduction of the "Critical View of Safety" concept by Strasberg, subsequently reinforced by multisociety consensus guidelines, has meaningfully reduced the incidence of bile duct injury and underscored the importance of both preoperative planning and intraoperative verification before any structure is divided¹¹. Collectively, these predictors assist in risk stratification, surgical planning, patient counselling, and appropriate allocation of operating room resources.

Nonetheless, the reliability of any predictive scoring system depends heavily on the accuracy of the underlying clinical data, the quality of preoperative imaging, and the experience of the operating surgeon, and

reported predictive accuracy therefore remains variable across different patient populations and healthcare settings². Given this variability, there remains a clear rationale for generating population-specific data correlating readily available preoperative clinical, sonographic, and biochemical parameters with intraoperative difficulty, which formed the basis for the present study.

Gallstone disease remains one of the most common surgical problems encountered worldwide, and the steadily rising incidence of cholelithiasis across both developed and developing populations has correspondingly increased the volume of laparoscopic cholecystectomies performed each year. This growing case volume makes it increasingly important for individual units to characterise their own predictors of operative difficulty rather than relying solely on data extrapolated from other populations, since local variation in disease presentation, imaging thresholds, and surgical expertise can meaningfully influence which parameters carry the greatest predictive value.

Aims and Objectives

Primary Objective

To predict difficult laparoscopic cholecystectomy and the likelihood of conversion to open surgery using preoperative clinical, sonographic, and biochemical parameters.

Secondary Objective

To correlate clinico-sonographic findings with intraoperative difficulty and total operative duration.

MATERIALS AND METHODS

Study Design: Retrospective observational study.

Setting: Department of General Surgery, PESIMSR Hospital, Kuppam, Andhra Pradesh.

Duration: March 2024 to March 2025 (18 months).

Sample Size: 88 patients who underwent elective laparoscopic cholecystectomy during the study period.

Inclusion Criteria

Patients who underwent elective laparoscopic cholecystectomy during the study period were included.

Exclusion Criteria

Patients with choledocholithiasis and those in whom open cholecystectomy was planned from the outset were excluded from analysis.

Parameters Studied

Clinical parameters: age, gender, and body mass index (BMI); presence of comorbidities

(notably diabetes mellitus and hypertension); and history of previous abdominal surgery.

Sonographic parameters: gallbladder wall thickness, presence of pericholecystic fluid, number of calculi, and overall gallbladder status (contracted versus distended).

Biochemical parameters: serum alkaline phosphatase (ALP) and total leukocyte count (TLC).

Outcome Measures

Duration of surgery, intraoperative difficulty, and rate of conversion to open cholecystectomy were recorded as the primary outcome measures for correlation with the preoperative parameters listed above.

Data for each patient were retrieved from case records, operative notes, preoperative ultrasonography reports, and laboratory registers, and cross-checked for completeness before being entered into a structured data collection sheet. Intraoperative difficulty was assessed from the documented operative findings and the operating surgeon's notes, and duration of surgery was defined as the interval from skin incision to skin closure. Patients were stratified into two groups based on operative duration, less than 2 hours and greater than 2 hours, and each preoperative variable was then compared between the two groups to identify parameters independently associated with prolonged or technically difficult surgery.

Statistical Analysis

Data were entered and analysed using SPSS software. Categorical variables were compared using the chi-square test, and a **p-value < 0.05** was considered statistically significant throughout the analysis.

RESULTS

A total of 88 patients who underwent elective laparoscopic cholecystectomy were included in the final analysis. Preoperative clinical, sonographic, and biochemical parameters were systematically correlated with intraoperative findings, total duration of surgery, and rate of conversion to open procedure.

Demographic Profile

The majority of patients belonged to the 31–40 years age group, followed by the 41–50 years and 21–30 years groups. Most surgeries were completed within 2 hours; however, prolonged operative duration (>2 hours) was disproportionately more common in the 31–40 years age group, as illustrated in Figure 1 below.

Females constituted the majority of cases, accounting for 67.1% of the study population. Despite this female preponderance overall, prolonged surgery was relatively more frequent among male patients compared to female patients, suggesting gender as an independent contributor to operative complexity.

Age Distribution Correlated with Duration of Surgery

Age Group	Surgery Duration <2 Hrs	Surgery Duration >2 Hrs
21–30	13	5
31–40	19	10
41–50	18	6
51–60	7	5
61–70	1	1
Above 70	2	1

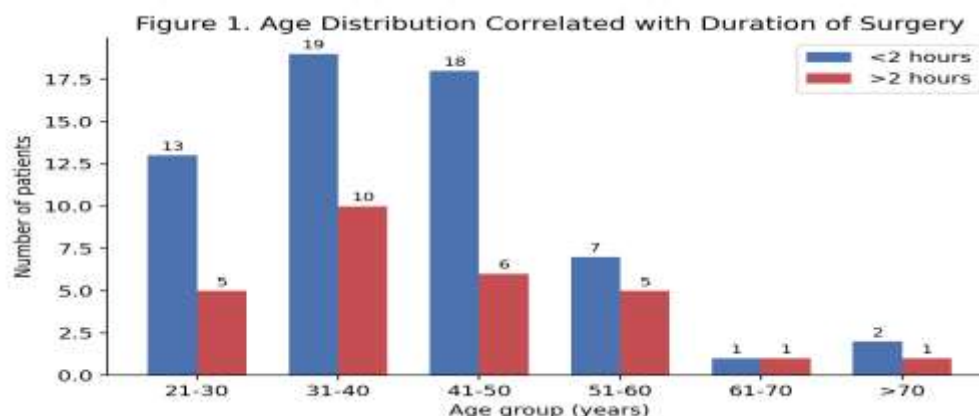


Figure 1. Age Distribution of Cases Correlated With Duration of Surgery

Comorbidities

Patients with pre-existing comorbidities showed a slightly higher incidence of prolonged surgery (>2 hours) compared to those without

comorbidities, although this difference did not reach statistical significance on chi-square testing.

Presence of Comorbidities	Surgery Duration <2 Hrs	Surgery Duration >2 Hrs
Yes	23	14
No	35	16

Previous Surgical History

A history of prior abdominal surgery was associated with an increased likelihood of prolonged operative duration, most plausibly

reflecting technical difficulty arising from intra-abdominal adhesions encountered during port entry and dissection.

H/O Previous Surgery	Surgery Duration <2 Hrs	Surgery Duration >2 Hrs
Yes	25 (67.6%)	12 (32.4%)
No	39 (73.5%)	14 (26.5%)

Biochemical Parameters

The majority of patients (87.5%) had alkaline phosphatase (ALP) values within the normal range. Elevated ALP (>120 U/L) was associated with prolonged surgery in 63.6% of affected

cases, indicating a possible link between biliary tract inflammation or subclinical obstruction and increased operative difficulty, as shown in Figure 2.

ALP Range (U/L)	Surgery Duration <2 Hrs	Surgery Duration >2 Hrs
<30	-	-
30-120	55	22
>120	4	7

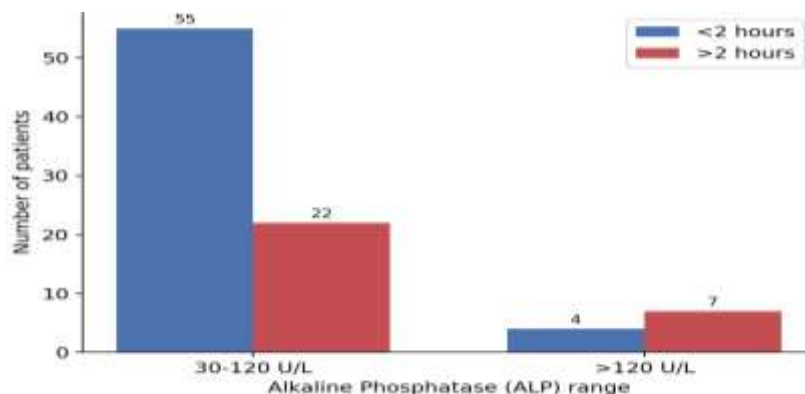


Figure 2. Correlation between ALP Levels and Duration of Surgery

Total leukocyte count (TLC) was within normal limits in 80.6% of patients. Elevated TLC was associated with increased operative duration,

consistent with an underlying inflammatory pathological process contributing to surgical difficulty, as depicted in Figure 3.

TLC Range ($\times 10^3/\mu\text{L}$)	Surgery Duration <2 Hrs	Surgery Duration >2 Hrs
<4	-	-
4-11	49	22
>11	10	7

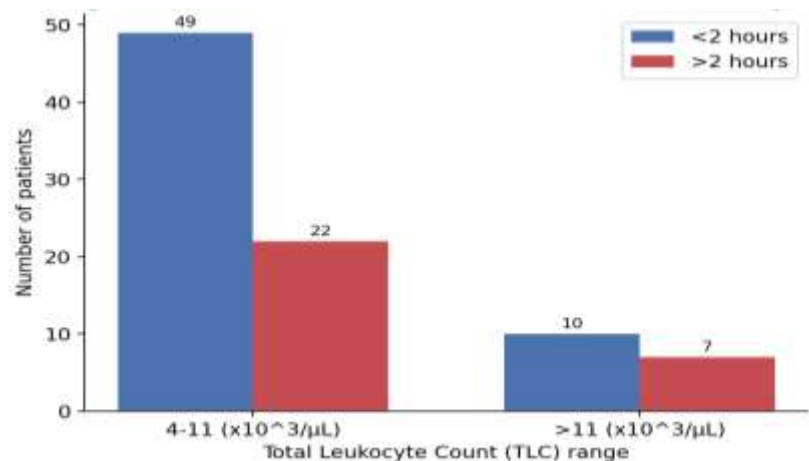


Figure 3. Correlation of TLC Levels with Duration of Surgery

Ultrasonographic Findings

Gallbladder wall thickening, pericholecystic fluid collection, a distended gallbladder, and multiple calculi were all strongly associated with prolonged surgery (>2 hours). Patients with pericholecystic fluid on preoperative ultrasonography had a mean operative time of approximately 160 minutes, reflecting the additional technical difficulty posed by an oedematous and friable gallbladder wall.

Conversion Rate

Conversion from laparoscopic to open cholecystectomy occurred in a single patient (1.1%) due to dense adhesions extending to the falciform ligament, precluding safe laparoscopic dissection and necessitating an open approach to complete the procedure safely.

DISCUSSION

Laparoscopic cholecystectomy remains the gold standard for the management of symptomatic gallbladder disease owing to its well-established advantages of reduced postoperative pain, shorter hospital stay, early recovery, and superior cosmetic outcomes compared with open surgery³. However, intraoperative difficulty and, occasionally, conversion to open surgery continue to pose meaningful challenges even in high-volume centres.

This study evaluated preoperative predictors of difficult LC in a cohort of 88 patients at PESIMSR, Kuppam, thereby addressing an important gap in locally generated data. The demographic profile observed, with a clear predominance of female patients and a majority of cases occurring between 21 and 50 years of age, was broadly consistent with previously published series^{9,10}.

Clinical factors such as prior abdominal surgery and the presence of comorbidities were associated with increased operative difficulty, most plausibly due to adhesion formation and altered tissue planes^{5,6}. Nevertheless, a substantial proportion of patients without comorbidities also experienced technically difficult LC, underscoring the need for additional, complementary predictive parameters beyond clinical history alone.

Ultrasonographic findings, including gallbladder wall thickening, pericholecystic fluid collection, gallbladder distension, and multiple calculi, emerged as strong predictors of difficult surgery in this cohort. These findings are consistent with previous work emphasising the pivotal role of preoperative imaging, including identification of reliable anatomical landmarks, in risk stratification prior to surgery⁴.

Biochemical markers also contributed meaningfully to the prediction of operative complexity in this series. Elevated alkaline phosphatase and total leukocyte count were associated with underlying inflammation and possible biliary obstruction, both of which are recognised contributors to increased surgical difficulty⁸. Similar associations between elevated inflammatory or cholestatic markers and complicated LC have been reported in prior literature¹.

Comparison with other published series demonstrated broadly similar trends in demographic distribution, predictive factors, and clinical outcomes, although some variability was evident, likely attributable to differences in sample size, study methodology, and underlying population characteristics^{2,9}. Most comparable studies have similarly relied on a combination of clinical, sonographic, and biochemical parameters to construct composite predictive models rather than any single

isolated factor, an approach that this study's findings support.

CONCLUSION

This study highlights the importance of comprehensive preoperative evaluation using clinical, sonographic, and biochemical parameters in predicting difficult laparoscopic cholecystectomy. Factors such as predominance of the younger age group (21–50 years), female preponderance, presence of comorbidities (notably diabetes and hypertension), and prior abdominal surgery were all found to significantly influence operative complexity.

Ultrasonographic findings, including gallbladder wall thickening, distension, pericholecystic fluid, and multiple calculi, were strong predictors of prolonged surgery. Biochemical markers such as elevated alkaline phosphatase and total leukocyte count were associated with increased operative difficulty, reflecting underlying inflammation or biliary pathology. Intraoperative challenges, particularly dense adhesions and an oedematous gallbladder, further contributed to surgical difficulty and, in one case, necessitated conversion to open surgery.

Overall, combined clinico-sonographic and biochemical assessment serves as a reliable and practical tool for anticipating difficult LC, enabling more informed surgical planning, risk stratification, and patient counselling. Early identification of high-risk cases can improve operative outcomes, reduce the incidence of complications, and optimise the utilisation of surgical resources.

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