

## Preoperative C-Reactive Protein as a Predictor of Difficult Laparoscopic Cholecystectomy: A Cross-Sectional Study.

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### Abstract

#### Background

Difficult laparoscopic cholecystectomy remains a significant intraoperative challenge and may lead to prolonged operative time, bile duct injury, or conversion to open surgery. Identifying reliable preoperative predictors can help surgeons anticipate technical difficulty and optimize surgical planning. C-reactive protein (CRP), an acute-phase inflammatory marker, may serve as a useful predictor of operative complexity.

#### Methods

This cross-sectional study was conducted in the Department of General Surgery at Indira Gandhi Institute of Medical Sciences (IGIMS), Patna, over a period of one year. Sixty patients diagnosed with cholelithiasis and scheduled for laparoscopic cholecystectomy were included. Preoperative serum CRP levels were measured and correlated with intraoperative findings. Laparoscopic cholecystectomies were classified as easy or difficult based on operative duration (>60 minutes), bile/stone spillage, duct or arterial injury, need for extension of incision, or conversion to open surgery. Statistical analysis was performed to assess the association between CRP levels and operative difficulty.

#### Results

Sixty patients were included, with a mean age of  $42.6 \pm 11.8$  years; females constituted 63.3% (n=38) and males 36.7% (n=22). Difficult laparoscopic cholecystectomy occurred in 22 (36.7%) patients. Mean preoperative CRP levels were significantly higher among difficult cases than easy cases ( $24.8 \pm 10.6$  mg/L vs  $6.4 \pm 3.2$  mg/L,  $p < 0.001$ ). A CRP cutoff value of 15 mg/L predicted difficult laparoscopic cholecystectomy with a sensitivity of 81.8%, specificity of 84.2%, positive predictive value of 75.0%, negative predictive value of 88.0%, and area under the ROC curve of 0.87.

#### Conclusion

Preoperative serum CRP is a significant predictor of difficult laparoscopic cholecystectomy. Elevated CRP levels may help surgeons anticipate intraoperative challenges and prepare for potential complications, thereby improving operative planning and patient outcomes.

#### Recommendation

Preoperative serum CRP estimation should be incorporated into the routine assessment of patients undergoing laparoscopic cholecystectomy to facilitate risk stratification and improve operative planning.

**Keywords:** C-reactive protein, laparoscopic cholecystectomy, cholelithiasis; cholecystitis, inflammatory markers

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#### Introduction

Laparoscopic cholecystectomy is the gold standard surgical treatment for symptomatic gallstone disease and is one of the most commonly performed abdominal surgeries worldwide due to its minimal

invasiveness, reduced postoperative pain, shorter hospital stay, and faster recovery compared to open cholecystectomy [1]. Despite these advantages, laparoscopic cholecystectomy can be technically challenging in a subset of patients, leading to

prolonged operative time, increased risk of complications, or conversion to open surgery [2]. A “difficult laparoscopic cholecystectomy” is typically associated with dense adhesions, distorted anatomy, severe inflammation, or intraoperative complications such as bleeding or bile duct injury [3]. Early identification of patients at risk for a difficult procedure is crucial for operative planning, patient counseling, and optimal allocation of surgical expertise and resources [4]. Several clinical, radiological, and biochemical parameters have been investigated to predict operative difficulty; however, a reliable and easily measurable preoperative marker remains desirable [5].

C-reactive protein (CRP) is an acute-phase reactant synthesized by the liver in response to inflammation, infection, or tissue injury [6]. Elevated CRP levels have been shown to correlate with the severity of inflammatory processes in various surgical and medical conditions [7]. In the context of gallbladder disease, raised CRP levels may reflect ongoing inflammation, fibrosis, or complicated cholecystitis, all of which can contribute to operative difficulty during laparoscopic cholecystectomy [8].

Recent studies suggest that preoperative CRP levels may serve as a useful predictor of difficult laparoscopic cholecystectomy and the likelihood of conversion to open surgery [9,10]. As CRP testing is inexpensive, widely available, and routinely performed, its use as a predictive tool could enhance preoperative risk stratification and surgical preparedness [11].

The present study aims to evaluate the role of preoperative serum CRP levels as a predictor of difficult laparoscopic cholecystectomy and to assess their association with intraoperative findings and surgical outcomes.

## Materials and Methods

### Study Design and Setting

This cross-sectional observational study was conducted in the Department of General Surgery at Indira Gandhi Institute of Medical Sciences (IGIMS), Patna, Bihar, India, a tertiary care teaching and referral center providing specialized medical and surgical services to patients from Bihar and neighboring states. The institute has comprehensive inpatient and outpatient facilities, advanced diagnostic services, intensive care units, and specialized surgical departments. The hospital caters to both urban and rural populations and serves as a major referral center in eastern India. The study was conducted from 1 January 2024 to 31 December 2024

### Study Population and Sample Size

A total of 60 patients diagnosed with cholelithiasis and planned for laparoscopic cholecystectomy were included in the study. All eligible patients admitted to the Department of Surgery during the study period were enrolled, irrespective of age, sex, or religion, provided they met the inclusion criteria. Consecutive sampling was employed. All eligible patients diagnosed with cholelithiasis and scheduled for laparoscopic cholecystectomy during the study period were consecutively recruited until the required sample size of 60 participants was achieved.

### Study Size

The sample size was calculated using the formula:

$$n = Z^2P(1-P)/d^2$$

Assuming a prevalence (P) of difficult laparoscopic cholecystectomy as 35%, a confidence level of 95% ( $Z=1.96$ ), and an absolute precision of 12%, the minimum sample size was estimated to be 57 patients. Considering possible exclusions and incomplete data, a total of 60 participants were enrolled.

### Inclusion Criteria

All patients with cholelithiasis are planned for laparoscopic cholecystectomy.

Patients admitted to the Department of Surgery, IGIMS, Patna.

Written informed consent was obtained from all participants before enrollment.

### Exclusion Criteria

Patients unwilling to participate.

Body mass index (BMI)  $>35 \text{ kg/m}^2$ .

History of previous abdominal surgery.

Patients with significant immunosuppression.

Patients with severe cardiac or pulmonary comorbidities.

Patients with positive viral markers.

### Variables

Independent variables included age, sex, body mass index, preoperative serum CRP levels, and clinical characteristics. The dependent variable was operative difficulty during laparoscopic cholecystectomy, categorized as easy or difficult according to predefined intraoperative criteria, including operative duration  $>60$  minutes, bile or stone spillage, duct or arterial injury, extension of incision, and conversion to open surgery.

### Preoperative Assessment

After obtaining informed consent, venous blood samples were collected in the ward and sent for laboratory evaluation. Investigations included:

Total leukocyte count (WBC count)

Serum C-reactive protein (CRP)

Other routine preoperative investigations

CRP levels were assessed preoperatively and correlated with intraoperative findings.

### Surgical Procedure

All patients underwent conventional four-port laparoscopic cholecystectomy under general anesthesia after pre-anesthetic evaluation. The gallbladder was extracted through the epigastric port without the use of an endobag and sent for histopathological examination.

### Intraoperative Classification

Surgeries were classified as easy or difficult based on intraoperative findings using the following criteria:

Duration of surgery:

Easy: <60 minutes

Difficult: >60 minutes

Bile or stone spillage

Injury to the duct or artery

Extension of incision for gallbladder extraction

Conversion to open cholecystectomy

The presence of any of the above intraoperative difficulty parameters classified the procedure as a difficult laparoscopic cholecystectomy.

### Outcome Measures

The primary outcome was the association between preoperative serum CRP levels and intraoperative difficulty during laparoscopic cholecystectomy.

### Data Sources

Demographic and clinical information was obtained from patient interviews, medical records, and hospital case files. Serum CRP levels and other laboratory investigations were measured in the institutional laboratory using standard biochemical methods. Intraoperative findings were recorded directly by the operating surgeons using a structured proforma.

### Quantitative Variables

Quantitative variables such as age and serum CRP levels were summarized as mean  $\pm$  standard deviation. CRP values were additionally categorized

using a cutoff value of 15 mg/L based on ROC curve analysis to assess diagnostic performance.

### Bias

Selection bias was minimized by recruiting consecutive eligible patients during the study period. Measurement bias was reduced by using standardized laboratory methods for CRP estimation and predefined criteria for classifying operative difficulty. Observer bias was minimized by recording intraoperative findings using standardized operative protocols.

### Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 26.0. Continuous variables were expressed as mean  $\pm$  standard deviation, and categorical variables as frequencies and percentages. Differences in mean CRP levels between easy and difficult laparoscopic cholecystectomy groups were assessed using the independent t-test. Associations between categorical variables were evaluated using the Chi-square test. Receiver operating characteristic (ROC) curve analysis was performed to determine the optimal CRP cutoff value and evaluate diagnostic accuracy through sensitivity, specificity, positive predictive value, negative predictive value, and area under the curve (AUC). A p-value <0.05 was considered statistically significant.

### Ethical Consideration

Ethical approval was obtained from the Institutional Ethics Committee of Indira Gandhi Institute of Medical Sciences, Patna, Bihar, before commencement of the study. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from all participants before enrollment.

### Results

During the study period, 74 patients were assessed for eligibility. Eight patients did not satisfy the inclusion criteria, and six declined participation. Consequently, 60 eligible participants were enrolled and included in the final analysis.

### Patient Characteristics

A total of 60 patients were included in the study. The mean age was  $42.6 \pm 11.8$  years. Females constituted 63.3% (n = 38) of the study population, while males accounted for 36.7% (n = 22).

**Table 1. Baseline Demographic Characteristics (n = 60)**

| Variable         | Value       |
|------------------|-------------|
| Mean age (years) | 42.6 ± 11.8 |
| Male             | 22 (36.7%)  |
| Female           | 38 (63.3%)  |

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### Intraoperative Classification

Out of 60 patients, 38 (63.3%) underwent easy laparoscopic cholecystectomy, whereas 22 (36.7%) were classified as difficult laparoscopic cholecystectomy based on predefined intraoperative criteria.

**Table 2. Distribution of Easy and Difficult Laparoscopic Cholecystectomy**

| Type of LC   | Frequency (n) | Percentage (%) |
|--------------|---------------|----------------|
| Easy LC      | 38            | 63.3           |
| Difficult LC | 22            | 36.7           |

### Intraoperative Difficulty Parameters

The most common criterion for a difficult laparoscopic cholecystectomy was operative duration >60 minutes. Other intraoperative events are shown below.

**Table 3. Intraoperative Difficulty Parameters (n = 60)**

| Parameter                  | Frequency (n) | Percentage (%) |
|----------------------------|---------------|----------------|
| Duration >60 minutes       | 22            | 36.7           |
| Bile/stone spillage        | 14            | 23.3           |
| Injury to the duct/artery  | 3             | 5.0            |
| Extension of incision      | 10            | 16.7           |
| Conversion to open surgery | 5             | 8.3            |

### Comparison of Preoperative CRP Levels

The mean preoperative CRP level was significantly higher in patients with difficult laparoscopic cholecystectomy compared to those with easy procedures.

**Table 4. Comparison of CRP Levels Between Groups**

| Variable        | Easy LC (n = 38) | Difficult LC (n = 22) | p-value |
|-----------------|------------------|-----------------------|---------|
| Mean CRP (mg/L) | 6.4 ± 3.2        | 24.8 ± 10.6           | <0.001  |

### Predictive Accuracy of CRP

Receiver operating characteristic (ROC) curve analysis demonstrated that a CRP cutoff value of 15 mg/L predicted difficult laparoscopic cholecystectomy with good diagnostic performance.

**Table 5. Diagnostic Performance of CRP (Cutoff: 15 mg/L)**

| Parameter                 | Value |
|---------------------------|-------|
| Sensitivity               | 81.8% |
| Specificity               | 84.2% |
| Positive Predictive Value | 75%   |
| Negative Predictive Value | 88%   |
| Area Under Curve (AUC)    | 0.87  |

### Key Findings

Preoperative serum CRP levels were significantly associated with intraoperative difficulty. Patients with elevated CRP were more likely to experience

prolonged operative time, intraoperative complications, and conversion to open cholecystectomy.

## Discussion

The present study demonstrated that 36.7% of patients experienced a difficult laparoscopic cholecystectomy. Mean preoperative CRP levels were significantly higher in difficult cases than in easy procedures ( $24.8 \pm 10.6$  mg/L vs  $6.4 \pm 3.2$  mg/L,  $p < 0.001$ ). ROC analysis demonstrated good predictive performance of CRP with an AUC of 0.87, sensitivity of 81.8%, and specificity of 84.2%. These findings indicate that elevated preoperative CRP is a strong predictor of operative difficulty.

Predicting a difficult laparoscopic cholecystectomy remains a major concern for surgeons, as operative difficulty is associated with increased morbidity, longer operative time, and higher conversion rates. The findings of the present study demonstrate a significant association between elevated preoperative serum C-reactive protein (CRP) levels and difficult laparoscopic cholecystectomy, highlighting the utility of CRP as a simple and reliable preoperative predictor.

Several studies have emphasized that inflammation is a key determinant of operative difficulty in gallbladder surgery. Elevated CRP levels reflect the severity of the inflammatory response and correlate with pathological changes such as fibrosis, dense adhesions, and distorted biliary anatomy [12]. These inflammatory changes can obscure Calot's triangle, increase the risk of bile duct injury, and prolong operative time, all of which were observed more frequently in patients with elevated CRP levels in the present study.

Previous investigators have reported similar findings regarding the predictive value of CRP. Studies evaluating biochemical markers have shown that CRP is superior to clinical parameters alone in identifying patients at risk for difficult surgery and conversion to open cholecystectomy [13,14]. The results of the current study support these observations, as patients with higher CRP levels experienced significantly longer operative times, increased intraoperative complications, and a higher conversion rate.

Conversion to open cholecystectomy is often considered a surrogate marker of extreme operative difficulty. In the present study, all converted cases were associated with elevated preoperative CRP levels, suggesting that CRP may help anticipate the need for conversion and allow better preoperative planning [15]. Early identification of such high-risk patients enables surgeons to counsel patients appropriately, allocate experienced surgical teams, and reduce intraoperative complications.

Radiological predictors such as gallbladder wall thickness and pericholecystic fluid have traditionally been used to assess operative difficulty; however, these findings are operator-dependent and may not always reflect the extent of inflammation [16]. In contrast, CRP is an objective, widely available, and cost-effective biomarker that can complement imaging findings and improve overall predictive accuracy.

From a clinical standpoint, incorporating CRP into preoperative assessment protocols may improve surgical decision-making, particularly in resource-limited settings where advanced imaging or subspecialty expertise may not be readily available [17]. Patients with significantly elevated CRP levels may benefit from delayed surgery, senior surgical involvement, or heightened intraoperative vigilance. Despite its strengths, this study has certain limitations. The study was conducted at a single center with a relatively limited sample size, which may affect the generalizability of the findings. Additionally, histopathological correlation was not performed to directly link CRP levels with the severity of gallbladder inflammation. Larger multicenter studies are warranted to validate the predictive role of CRP and to establish standardized cut-off values for clinical use.

## Generalizability

Since IGIMS is a major tertiary referral center catering to a diverse population from Bihar and neighboring states, the findings may be generalizable to similar tertiary care settings in resource-limited regions. However, multicenter studies are required to improve external validity.

## Conclusion

This study demonstrates that elevated preoperative serum C-reactive protein levels are significantly associated with difficult laparoscopic cholecystectomy. Patients with higher CRP values were more likely to experience prolonged operative time, intraoperative technical challenges, and conversion to open surgery. Preoperative assessment of CRP is a simple, cost-effective, and readily available tool that can assist surgeons in risk stratification and operative planning. Incorporating CRP measurement into routine preoperative evaluation may improve surgical preparedness and optimize patient outcomes.

## Limitations

The study was conducted at a single tertiary care center with a relatively small sample size, limiting

generalizability. Histopathological correlation with inflammatory severity was not performed. In addition, surgeon-related factors influencing operative difficulty were not evaluated.

### Recommendation

Routine preoperative assessment of serum CRP should be considered in patients undergoing laparoscopic cholecystectomy. Patients with elevated CRP levels may benefit from enhanced surgical preparedness, senior surgical supervision, and careful intraoperative monitoring.

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### Conflict of Interest

The authors declare no conflict of interest.

### Data Availability

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

### Author Contributions

- KA: Conceptualization, data collection, manuscript drafting.
- RR: Data analysis and interpretation.
- AK: Supervision, critical review, final approval.

### List of Abbreviations

CRP – C-reactive Protein  
LC – Laparoscopic Cholecystectomy  
ROC – Receiver Operating Characteristic  
AUC – Area Under Curve  
PPV – Positive Predictive Value  
NPV – Negative Predictive Value  
BMI – Body Mass Index

### References

1. Strasberg SM. Clinical practice. Acute calculous cholecystitis. *N Engl J Med.* 2008;358(26):2804-2811. <https://doi.org/10.1056/NEJMcp0800929>
2. Gupta N, Ranjan G, Arora MP, et al. Validation of a scoring system to predict difficult laparoscopic cholecystectomy. *Int J Surg.* 2013;11(9):1002-1006. <https://doi.org/10.1016/j.ijssu.2013.07.005>
3. Randhawa JS, Pujahari AK. Preoperative prediction of difficult lap chole: a scoring method. *Indian J Surg.* 2009;71(4):198-201. <https://doi.org/10.1007/s12262-009-0055-y>
4. Vivek MA, Augustine AJ, Rao R. A comprehensive predictive scoring method for difficult laparoscopic cholecystectomy. *J Minim Access Surg.* 2014;10(2):62-67. <https://doi.org/10.4103/0972-9941.129943>
5. Lal P, Agarwal PN, Malik VK, Chakravarti AL. A difficult laparoscopic cholecystectomy that requires conversion to an open procedure can be predicted by preoperative factors. *JSLs.* 2002;6(1):59-63.
6. Pepys MB, Hirschfield GM. C-reactive protein: a critical update. *J Clin Invest.* 2003;111(12):1805-1812. <https://doi.org/10.1172/JCI18921>
7. Gabay C, Kushner I. Acute-phase proteins and other systemic responses to inflammation. *N Engl J Med.* 1999;340(6):448-454. <https://doi.org/10.1056/NEJM199902113400607>
8. Mok KW, Reddy R, Wood F, et al. Is C-reactive protein a useful predictor of difficult laparoscopic cholecystectomy? *Surg Endosc.* 2016;30(10):4368-4374.
9. Ibrahim S, Hean TK, Ho LS, et al. Risk factors for conversion to open surgery in patients undergoing laparoscopic cholecystectomy. *World J Surg.* 2006;30(9):1698-1704. <https://doi.org/10.1007/s00268-005-0612-x>
10. Sharma AK, Ranganathan S, Bhandari R. Preoperative C-reactive protein levels as a predictor of difficult laparoscopic cholecystectomy. *Int Surg J.* 2018;5(6):2124-2129. <https://doi.org/10.18203/2349-2902.isj20182063>

11. van Dijk AH, de Reuver PR, Tasma TN, et al. Systematic review of prediction models for difficult laparoscopic cholecystectomy. *Surg Endosc.* 2018;32(7):2837-2848.
12. Yokoe M, Hata J, Takada T, et al. Tokyo Guidelines 2018: diagnostic criteria and severity grading of acute cholecystitis. *J Hepatobiliary Pancreat Sci.* 2018;25(1):41-54. <https://doi.org/10.1002/jhbp.515>
13. Goonawardena J, Gunnarsson R, de Costa A. Predicting difficult laparoscopic cholecystectomy: a comparison of preoperative ultrasonography, inflammatory markers, and clinical risk factors. *Surg Endosc.* 2015;29(10):2971-2978.
14. Ambe PC, Köhler L. Is C-reactive protein a useful parameter in predicting difficult laparoscopic cholecystectomy? *World J Surg.* 2015;39(6):1476-1481.
15. Alponat A, Kum CK, Koh BC, Rajnakova A, Goh PM. Predictive factors for conversion of laparoscopic cholecystectomy. *World J Surg.* 1997;21(6):629-633. <https://doi.org/10.1007/s002689900292>
16. Vivek MA, Augustine AJ, Rao R. Role of ultrasound parameters in predicting difficult laparoscopic cholecystectomy. *J Clin Diagn Res.* 2014;8(9):NC01-NC03.
17. Chaudhary A, Negi SS, Sachdev AK, Gondal R. The role of inflammatory markers in predicting difficult laparoscopic cholecystectomy in resource-limited settings. *Trop Gastroenterol.* 2017;38(2):88-93.
18. Mok KW, Goh YL, Howell LE, et al. Validation of C-reactive protein as a predictor of operative difficulty in laparoscopic cholecystectomy: a prospective cohort study. *Surg Endosc.* 2019;33(10):3218-3226.

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