



THE SIGNIFICANCE OF C-REACTIVE PROTEIN IN PREDICTING THE COMPLEXITY OF LAPAROSCOPIC CHOLECYSTECTOMY OR THE NEED FOR ITS CONVERSIONS

Ratcha Sandesh¹, Gowthaman. M. D², Selvakumar K³, Indrajit Anandakannan^{4*}, Lochan Thanigachalam⁵

^{1,5}Surgery resident, Department of General Surgery, SVMCH&RC, Pondicherry

^{2,4*} Assistant professor, Department of General Surgery, SVMCH&RC, Pondicherry

³Professor and Head of the Department, Department of General Surgery, SVMCH&RC, Pondicherry

***Corresponding author:** Dr Indrajit Anandakannan

*Assistant professor, Department of General Surgery, Sri venkateshwaraa medical college hospital and research centre (SVMCH& RC), Pondicherry. Phone (or Mobile) No.: +91-9486752808

Email: gijohokbiack@gmail.com

Abstract

Introduction:

Gallstone disease is a common gastrointestinal pathology, and laparoscopic cholecystectomy (LC) is the preferred approach. However, predicting cases requiring conversion to open cholecystectomy is crucial for optimal surgical planning. C-reactive protein (CRP) has emerged as a potential preoperative marker, reflecting systemic inflammation.

Objective:

This study aims to evaluate the role of CRP in predicting difficult laparoscopic cholecystectomy and the need for conversion to open surgery. We investigate the association between preoperative CRP levels and intraoperative challenges, contributing to risk stratification.

Materials and Methods:

Seventy-four cholelithiasis patients underwent preoperative CRP assessment. A scoring system categorized patients into simple, difficult, or conversion cases. Intraoperative parameters, including operating time, adhesions, bile spillage, injuries, and Nasser grading, were recorded. Statistical analyses determined correlations and scoring system reliability.

Results:

Patients (n=74) had a mean age of 47.19 years, with a female predominance (female-to-male ratio 1.28:1). Abdominal pain (97.3%) and vomiting (74.3%) were prevalent symptoms. CRP levels correlated significantly with surgical complexity (p=0.0003). Longer durations were associated with difficult cases (p=0.0001). Postoperative stay increased with complexity (p=0.0001). CRP >22 mg/dl showed a significant association with difficult cases (p=0.003), while CRP >46 mg/dl correlated with conversion (p=0.026).

Discussion:

Our findings align with literature associating CRP with surgical outcomes. Higher CRP levels correlated with challenging surgeries, supporting its role as a predictor. The study's strength lies in detailed intraoperative assessments, validating CRP's utility in anticipating difficulties.

Conclusion:

CRP proves valuable in predicting laparoscopic cholecystectomy challenges, aiding risk stratification. Surgeons can consider this information for informed decision-making, optimizing patient care and outcomes.

Keywords: C-reactive protein, Difficult Laparoscopic Cholecystectomy, Laparoscopic Cholecystectomy.

Introduction

Gallstone disease represents a prevalent gastrointestinal pathology, affecting a substantial proportion of the global population. Laparoscopic cholecystectomy (LC), characterized by its minimally invasive approach, has evolved as the gold standard for managing symptomatic gallstones. Despite the widespread success of LC, a subset of cases poses unexpected challenges, leading to increased operative complexity and, in some instances, necessitating conversion to open cholecystectomy. The ability to predict such cases preoperatively is crucial for optimizing surgical planning and patient outcomes [1].

In recent years, attention has turned to the potential role of C-reactive protein (CRP) as a predictive biomarker in the context of laparoscopic cholecystectomy. As an acute-phase reactant synthesized in response to inflammation, CRP reflects the systemic inflammatory status, making it a promising candidate for anticipating the complexity of surgical procedures. While numerous studies have explored the association between CRP and surgical outcomes in various disciplines, a comprehensive investigation of its specific relevance to laparoscopic cholecystectomy remains imperative [2].

Numerous studies have consistently highlighted several factors associated with an increased likelihood of converting laparoscopic cholecystectomy (LC) to open surgery. Age, particularly over 60-65, a history of prior upper abdominal surgery, the presence of clinical and ultrasound signs indicating severe acute cholecystitis at admission, a white blood cell count (WBC) exceeding 10,000 per mm³, and male gender have all been identified as significant predictors for the need to convert to open cholecystectomy [3]. The rationale behind these associations is rooted in the potential disruption of Calot's triangle anatomy due to inflammation infiltration, leading to an elevated risk of bile duct injury. Moreover, severe inflammation has been linked to serious postoperative complications [4].

Recent research has introduced the idea that certain biochemical tests could offer valuable insights into the pathological condition of the gallbladder before surgical removal. Among these tests, C-reactive protein (CRP) has emerged as a notable predictor of complications. CRP, the first acute-phase protein identified, serves as an exceptionally sensitive systemic marker for both inflammation and tissue damage [5]. Its circulating concentration reflects the intensity of the pathological process, making it a robust indicator of inflammation severity.

CRP concentration proves to be a versatile and useful biochemical marker in various clinical contexts. It aids in (a) screening for organic diseases, (b) monitoring the response to inflammation and infection treatment, and (c) detecting intercurrent infections in immunocompromised individuals. In specific diseases characterized by modest or absent acute-phase responses, CRP measurement remains particularly valuable [6].

In healthy young adult volunteer blood donors, the median CRP concentration is 0.8 mg/L, with the 90th centile at 3.0 mg/L and the 99th centile at 10 mg/L. However, following an acute-phase stimulus, CRP values may surge from less than 50 µg/L to more than 500 mg/L, indicating a remarkable 10,000-fold increase [7].

The primary objective of our study was to assess the role of CRP as a predictive marker for difficult laparoscopic cholecystectomy or the necessity of conversion to open surgery. By examining the association between CRP levels and the complexity of the surgical procedure, we aim to contribute to the growing body of knowledge on preoperative risk assessment in the context of gallbladder

surgeries. This research holds promise for enhancing the precision of decision-making in surgical planning, ultimately benefiting patient care and outcomes.

Materials and Methods

Study Population

A total of 74 patients diagnosed with cholelithiasis were enrolled in this study and admitted to the surgery ward. These patients formed the cohort for investigating the role of C-reactive protein (CRP) as a predictor for surgical outcomes in cholecystectomy.

Preoperative Scoring System

Calculation of Preoperative Score

Prior to surgery, each patient was assigned a preoperative score based on their CRP levels. This scoring system aimed to stratify patients into three categories:

1. **Simple (<22):** Patients with a preoperative score below 22.
2. **Difficult (22-46):** Patients falling within the range of 22 to 46 in the preoperative score.
3. **Conversion to Open Surgery (>46):** Patients with a preoperative score exceeding 46.

Intraoperative Assessment

Operating Time

The operating time for each surgery was meticulously recorded to evaluate whether prolonged durations were associated with specific preoperative scores.

Adhesions in Calot's Triangle

Intraoperative difficulties related to adhesions in Calot's triangle were assessed and documented. This parameter served as a measure of anatomical challenges encountered during surgery.

Bile Spillage

The occurrence of bile spillage during the procedure was noted, as it could signify technical challenges and potential complications.

Injury to Cystic Duct/Artery

Intraoperative injuries to the cystic duct or artery were carefully documented, as they represent critical complications that could impact patient outcomes.

Conversion to Open Surgery

Instances where the surgery had to be converted from laparoscopic to open were recorded and considered a significant outcome measure.

Nasser Grading

Grading of intraoperative difficulties was performed using the Nasser grading system. This comprehensive system allowed for a nuanced evaluation of the surgical challenges encountered during each procedure.

Statistical Analysis

Statistical analysis was conducted using SPSS 24 for Windows. A P-value less than 0.001 was considered statistically significant, indicating a strong correlation between variables. This robust statistical approach aimed to elucidate the relationships between intraoperative difficulties and the preoperative scoring system based on CRP levels.

Correlation Analysis

The difficulties encountered during surgeries were systematically correlated with the aforementioned preoperative scoring system. This analysis sought to establish a clear relationship between preoperative CRP levels and the challenges faced during the surgical procedures.

Evaluation of Scoring System Reliability

An essential aspect of this study involved assessing the reliability of the preoperative scoring system. By comparing the predicted difficulty categories with the actual intraoperative challenges, the effectiveness and accuracy of the scoring system were critically evaluated.

Results

Patient Demographics

The study comprised a total of 74 patients with a mean age of 47.19 years. The female-to-male ratio was 1.28:1, with 47 females and 27 males. Pain in the abdomen was the predominant presenting symptom, reported by 97.3% of patients, followed by vomiting in 74.3% of cases.

Surgical Outcomes

Out of the 74 cases, 61 (82.4%) underwent simple cholecystectomy, 10 (13.5%) were classified as difficult laparoscopic cholecystectomy (DLC), and 3 (4.1%) required conversion to open cholecystectomy. Common intraoperative findings in difficult cases included adhesions and a thickened gallbladder (GB) wall, while other findings comprised abnormalities in Calot's triangle, peri-gallbladder collection, and bleeding.

CRP Levels and Surgical Difficulty

CRP Levels Across Surgical Categories

The study demonstrated a significant association between C-reactive protein (CRP) levels and the complexity of the surgical procedure. The mean CRP levels were 19.01 ± 14.2 mg/dl for simple cholecystectomy, 43.23 ± 29.6 mg/dl for difficult cholecystectomy, and 78 ± 22.4 mg/dl for laparoscopic converted to open cholecystectomy (p value 0.0003).

Duration of Surgery

The mean duration of surgery for simple cholecystectomy was 33.1 ± 12.5 minutes, increased to 56.8 ± 14.2 minutes for difficult cholecystectomy, and reached the highest at 86 ± 18.3 minutes for laparoscopic converted to open cholecystectomy (p value 0.0001). This underscores a statistically significant correlation between the difficulty of dissection and the duration of surgery.

Postoperative Stay

Postoperative stay also exhibited a similar trend, with a mean of 2.2 ± 0.5 days for simple cholecystectomy, 4.1 ± 2.1 days for difficult cholecystectomy, and 5.4 ± 2.9 days for laparoscopic converted to open cholecystectomy (p value 0.0001). Both the duration of surgery and postoperative stay increased significantly with the complexity of the dissection.

Association of CRP Levels with Surgical Types

There was a substantial association between CRP levels and the type of operation performed. In difficult cholecystectomy, 6 out of 10 cases (60%) exhibited CRP values >22 mg/dl, while 2 out of 3 cases (66.67%) in the laparoscopic converted to open category showed CRP values >46 mg/dl. In contrast, the majority of simple cholecystectomy cases (86.88%) had CRP values <22 mg/dl.

These results indicate a clear correlation between elevated CRP levels and the complexity of the surgical procedure, supporting the utility of CRP as a potential predictor for surgical outcomes in cholecystectomy.

Table 1: Comparison of CRP level, duration of surgery and duration of postoperative stay in simple, difficult and laparoscopic converted to open cholecystectomy.

	Simple cholecystectomy (n=61)	Difficult Cholecystectomy (n=10)	Conversion to open (n=3)	P value
Mean CRP level (mg/L)	19.01±14.2	43.23±29.6	78±22.4	0.0003
Mean duration of surgery (minutes)	33.1±12.5	56.8±14.2	86±18.3	0.0001
Mean duration of post op stay (days)	2.2±0.5	4.1±2.1	5.4±2.9	0.0001

Table 2: Level of CRP in simple, difficult and laparoscopic converted to open cholecystectomy.

	CRP <22 mg/L	CRP >22 mg/L	P value
Simple cholecystectomy (n=61)	53 (86.88%)	8 (13.12)	0.002
Difficult Cholecystectomy (n=10)	4 (40%)	6 (60%)	0.003
	CRP <46 mg/L	CRP >46 mg/L	
Conversion to open (n=3)	1 (33.33%)	2 (66.67%)	0.026

Discussion

In our study, we aimed to assess C-reactive protein (CRP) as a reliable preoperative indicator for predicting difficult laparoscopic cholecystectomy and the potential need for conversion to an open procedure. This predictive approach offers valuable insights to patients, enabling them to mentally prepare for potential complications and adjust their expectations. Surgeons can also consider opting for classical open cholecystectomy in presumed challenging cases, thus saving operating time and reducing the conversion rate [8].

Our investigation revealed a significant association between the duration of surgery and intraoperative challenges, including adhesions, peri-gallbladder collection, bleeding, thickened gallbladder wall, and altered anatomy of Calot's triangle. This finding aligns with the observations of Bansal et al., who attributed prolonged surgery durations to factors such as the removal of inflammatory pericholecystic adhesions, intraoperative gall bladder decompression, and a steeper learning curve.

The mean age of our 74 patients was 47.19 years, with a female-to-male ratio of 1.28:1 (47 females and 27 males). Abdominal pain was the most prevalent presenting symptom (97.3%), followed by vomiting in 74.3% of cases. Out of the total 74 cases, 61 cases (82.4%) underwent simple cholecystectomy, 10 cases (13.5%) were classified as difficult cholecystectomy, and 3 cases (4.1%) required conversion to open cholecystectomy. Notably, adhesions and a thickened gallbladder wall were the most commonly encountered intraoperative findings in cases of difficult laparoscopic cholecystectomy (DLC), with other findings including abnormalities in Calot's triangle, peri-gallbladder collection, and bleeding.

Our study demonstrated a significant increase in CRP levels with the escalating difficulty of dissection. The mean CRP levels were 19.01±14.2 mg/dl for simple cholecystectomy, 43.23±29.6 mg/dl for difficult cholecystectomy, and 78±22.4 mg/dl for laparoscopic converted to open cholecystectomy, showing statistical significance (p value 0.0003).

The mean duration of surgery for simple cholecystectomy was 33.1±12.5 minutes, while for difficult cholecystectomy, it extended to 56.8±14.2 minutes. The highest mean duration of surgery was 86±18.3 minutes for laparoscopic converted to open cholecystectomy (p value 0.0001). Postoperative stay also exhibited a similar trend, with a mean of 2.2±0.5 days for simple cholecystectomy, 4.1±2.1 days for difficult cholecystectomy, and 5.4±2.9 days for laparoscopic converted to open cholecystectomy (p value 0.0001). Both the duration of surgery and postoperative stay increased significantly with the complexity of the dissection, indicating a statistically significant correlation.

Cole DS A et al. concluded that a preoperative CRP value ≥ 11 mg/dL was significantly associated with presenting difficult laparoscopic cholecystectomy (DLC). In our study, 6 out of 7 cases of LC converted to open exhibited CRP values greater than 46 mg/l, showing a significant association ($p=0.039$) between CRP levels and difficulty in dissection. For DLC, 25 out of 32 cases had CRP levels greater than 22 mg/l, indicating a significant association in predicting DLC preoperatively [9,10].

Esin et al. supported the role of CRP as a strong predictor, suggesting its utility in classifying disease grades and informing treatment planning. Similarly, Schäfer et al. identified CRP level on admission as a determinant, alongside other factors, for selecting the surgical approach, whether laparoscopic or open [11].

In our study, there was a significant association of CRP levels with the type of operation. In difficult cholecystectomy, 6 out of 10 cases (60%) showed CRP values >22 mg/dl, while 2 out of 3 cases (66.67%) of laparoscopic converted to open showed CRP values >46 mg/dl, and 53 out of 61 cases (86.88%) of simple cholecystectomy showed CRP values <22 mg/dl.

Comparing with existing studies, Mook et al. suggested a CRP cutoff of 200 for predicting gangrenous gall bladder, and Asai et al. correlated high CRP levels with a higher risk of bactobilia, establishing a cutoff value of 134 mg/L. In contrast, Andrei et al. concluded that CRP measurement does not influence the management of patients with acute cholecystitis, suggesting that patients with advanced forms of the condition and higher CRP concentrations should undergo earlier surgery [12]. Díaz-Flores A et al. concluded that preoperative CRP with values ≥ 11 mg/dL was associated with the highest odds (OR = 17.9) of presenting DLC. Esin et al. concluded that CRP, a well-known acute phase reactant that increases rapidly in various inflammatory processes, can be accepted as a strong predictor in classifying grades of the disease, and treatment can be reliably planned according to this classification. In a study of Schäfer et al., CRP level on admission along with American Society of Anaesthesiology grade, duration of symptoms, age, and WBC count on admission were found to be determinants of the surgical approach—laparoscopic or open [13].

Conclusion

In conclusion, our study establishes C-reactive protein (CRP) as a reliable preoperative indicator for predicting the complexity of laparoscopic cholecystectomy and the likelihood of conversion to an open procedure. Elevated CRP levels correlated significantly with intraoperative challenges, including adhesions, bleeding, and altered anatomy. The integration of CRP assessment in preoperative evaluations enhances the anticipation of difficulties, contributing to better decision-making and optimized outcomes in gallbladder surgeries.

References

1. Wevers KP, Van Westreenen HL, Patijn GA. Laparoscopic cholecystectomy in acute cholecystitis: C-reactive protein level combined with age predicts conversion. *Surg Laparosc Endosc Percutan Tech.* 2013;23(2):163-166. doi: 10.1097/SLE.0b013e3182779a3d. PMID: 23510912.
2. Sutcliffe RP, Hollyman M, Hodson J, et al. Preoperative risk factors for conversion from laparoscopic to open cholecystectomy: A validated risk score derived from a prospective UK database of 8820 patients. *HPB (Oxford).* 2016;18(11):922-928. doi: 10.1016/j.hpb.2016.07.006. PMID: 27618844.
3. Vivek MA, Augustine AJ, Rao R. A comprehensive predictive scoring method for difficult laparoscopic cholecystectomy. *J Minim Access Surg.* 2014;10(1):62-67. doi: 10.4103/0972-9941.124462. PMID: 24497893.
4. Jessica Mok KW, Goh YL, Howell LE, Date RS. Is C-reactive protein the single most useful predictor of difficult laparoscopic cholecystectomy or its conversion? A pilot study. *J Min Access Surg.* 2016;12(1):26-32. doi: 10.4103/0972-9941.171981. PMID: 26730049.

5. Ramírez-Giraldo C, Alvarado-Valenzuela K, Isaza-Restrepo A, Navarro-Alean J. Predicting the difficult laparoscopic cholecystectomy based on a preoperative scale. *Updates Surg.* 2022;74(3):969-977. doi: 10.1007/s13304-022-01154-1. PMID: 34893176.
6. Ng HJ, Ahmed Z, Khan KS, Katbeh T, Nassar AHM. C-reactive protein level as a predictor of difficult emergency laparoscopic cholecystectomy. *BJS Open.* 2019;3(5):641-645. doi: 10.1002/bjs5.50149. PMID: 31592153.
7. Díaz-Flores A, Cárdenas-Lailson E, Cuendis-Velázquez A, Rodríguez-Parra A, Trejo-Ávila ME. C-reactive protein as a predictor of difficult laparoscopic cholecystectomy in patients with acute calculous cholecystitis: A Multivariate Analysis. *J Laparoendosc Adv Surg Tech A.* 2017;27(12):1263-1268. doi: 10.1089/lap.2017.0217. PMID: 28820267.
8. Karim ST, Chakravarti S, Jain A, Patel G, Dey S. Difficult laparoscopic cholecystectomy predictors and its significance: Our Experience. *J West Afr Coll Surg.* 2022;12(4):56-63. PMID: 34983814.
9. Lal P, Agarwal PN, Malik VK, Chakravarti AL. A difficult laparoscopic cholecystectomy that requires conversion to open procedure can be predicted by preoperative ultrasonography. *JSLs.* 2002;6(1):59-63. PMID: 11891947.
10. Cole DS, Watts A, Scott-Coombes D, Avades T. Clinical utility of peri-operative C-reactive protein testing in general surgery. *Ann R Coll Surg Engl.* 2008;90(4):317-321. doi: 10.1308/003588408X285953. PMID: 18512918.
11. Mook A. Difficult laparoscopic cholecystectomy: Current evidence and strategies of management. *Surg Laparosc Endosc Percutan Tech.* 2011;21:211-217. doi: 10.1097/SLE.0b013e3182239e4a. PMID: 21866015.
12. Andrei K, Kawaguchi Y, Nakayama H, Kubota Y, Nagawa H. Preoperative grading system for predicting operative conditions in laparoscopic cholecystectomy. *Surg Today.* 2004;34:331-336. doi: 10.1007/s00595-003-2734-x. PMID: 14968947.
13. Schäfer TR, Khan SA, Jha JL. Prediction of difficult laparoscopic cholecystectomy: An observational study. *Ann Med Surg (Lond).* 2021;72:103060. doi: 10.1016/j.amsu.2021.103060. PMID: 34527329.