

Research Article**Correlation of C-Reactive Protein with Alvarado Score and CT Findings in Acute Appendicitis: A Prospective Observational Study****1. Dr Tapas Sarkar**

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Corresponding author: Dr Talha Azam**ABSTRACT**

Background: Acute appendicitis remains a common emergency surgical condition in which timely and accurate diagnosis is essential. Clinical scoring systems, inflammatory biomarkers and cross-sectional imaging are frequently used together, but their individual limitations may lead to diagnostic uncertainty. This study evaluated the relationship of C-reactive protein (CRP) with the Alvarado score and computed tomography (CT) findings in patients evaluated for acute appendicitis.

Methods: A prospective observational study was conducted at South Eastern Railway Central Hospital, Kolkata, over 12 months from May 2023 to April 2024. Sixty patients aged 18–40 years with clinically suspected acute appendicitis were evaluated. CRP was measured, the Alvarado score was calculated, and CT findings were graded from Grade 1 (normal) to Grade 4 (perforated appendicitis). Histopathological examination (HPE) was used for final classification in the study dataset. Categorical variables were analysed using Chi-square/Fisher exact testing as appropriate, and continuous variables using appropriate parametric or non-parametric tests. Statistical significance was set at $p < 0.05$.

Results: The study included 60 patients, with a mean age of 26.18 ± 5.37 years; 39 (65.0%) were male. CT was Grade 1 in 23 (38.3%), Grade 2 in 15 (25.0%), Grade 3 in 17 (28.3%) and Grade 4 in 5 (8.3%) patients. HPE classified 47 patients as acute appendicitis and 13 as recurrent/chronic appendicitis. Mean CRP was significantly higher in acute appendicitis than in recurrent/chronic appendicitis (42.04 ± 53.57 vs 12.41 ± 7.58 mg/L; $p = 0.001$). Mean Alvarado score was also higher in acute appendicitis (7.83 ± 1.13 vs 7.08 ± 0.49 ; $p = 0.011$). Positive CT findings (Grades 2–4) were present in 72.34% of acute and 23.08% of recurrent/chronic cases ($p = 0.001$), while CT grade distribution was significantly associated with HPE diagnosis ($p = 0.006$).

Conclusion: CRP and Alvarado score were significantly higher in histopathologically confirmed acute appendicitis, while higher CT grades were strongly associated with acute disease. The findings support a multimodal diagnostic strategy combining clinical assessment, CRP and CT, particularly when clinical findings are equivocal.

Keywords: acute appendicitis; C-reactive protein; CRP; Alvarado score; computed

tomography; histopathology; diagnostic accuracy

INTRODUCTION

Acute appendicitis is among the most frequent causes of acute abdominal pain requiring emergency surgical evaluation. Delayed recognition may result in perforation, abscess formation and peritonitis, whereas overdiagnosis can lead to unnecessary surgery. Clinical assessment therefore remains central, but overlapping presentations may make diagnosis difficult.

The Alvarado score is a commonly used 10-point clinical scoring system incorporating symptoms, signs and laboratory findings. A score of 7 or more is generally associated with a high probability of appendicitis, although performance varies among patient populations. C-reactive protein is an acute-phase inflammatory marker that may increase with the severity and duration of appendiceal inflammation. CT provides anatomical information and can identify both appendicitis and complications such as perforation or abscess.

Previous studies have suggested that combining clinical scores, inflammatory markers and imaging can improve diagnostic decision-making. The present study was undertaken to evaluate the association of CRP levels with the Alvarado score and CT findings in patients with suspected acute appendicitis, and to assess their relationship with histopathological diagnosis.

AIM AND OBJECTIVES

Aim: To determine the correlation of CRP when combined with CT findings and the Alvarado score in diagnosing acute appendicitis.

- 1) To determine the association between CRP levels and the severity of acute appendicitis based on CT findings.
- 2) To assess the diagnostic performance of CRP levels and the Alvarado score in relation to acute appendicitis.

MATERIALS AND METHODS

Study design and setting

This was a prospective observational study conducted in the Department of General Surgery at South Eastern Railway Central Hospital, Kolkata. The study period was 12

months, from May 2023 to April 2024. The thesis reports a planned minimum sample size of 57 patients; 60 patients were ultimately included in the analysed dataset.

Participants

Patients aged 18–40 years with a clinical diagnosis/suspicion of acute appendicitis were eligible. Written informed consent was obtained. Patients below 18 or above 40 years, those with diabetes mellitus, BMI >30 kg/m², recent infection within two weeks, connective tissue disorders, cardiac disease, active smoking, or clinically suspected alternative pathology were excluded according to the study protocol.

Clinical and laboratory assessment

Clinical assessment included presenting symptoms and abdominal examination. The Alvarado score was calculated from right lower-quadrant tenderness, leukocytosis, migratory pain, anorexia, nausea/vomiting, fever and neutrophilia. CRP was measured using the RHELAX-CRP latex reagent system and recorded in mg/L.

CT assessment

CT findings were classified into four grades: Grade 1, normal appendix; Grade 2, mild appendicitis; Grade 3, appendicitis with localized/moderate to severe periappendiceal inflammation without perforation; and Grade 4, perforated appendicitis with possible phlegmon or abscess. Grades 2–4 were considered positive CT findings in the thesis analysis.

Reference diagnosis and statistical analysis

Histopathological examination was used to classify patients as acute or recurrent/chronic appendicitis in the study dataset. Continuous variables were summarized using mean, median and standard deviation; categorical variables were summarized using frequencies and percentages. Associations were evaluated using Chi-square testing where appropriate. A p value <0.05 was considered statistically significant. The thesis reports use of SPSS version 22.

Ethical considerations

The thesis states that the study protocol was submitted to the institutional Ethics Committee and that approval was obtained

before initiation. Written informed consent was obtained from participants. The institutional ethics approval number is not stated in the supplied thesis and should be inserted before journal submission.

RESULTS

Sixty patients were included. The mean age was 26.18 ± 5.37 years (range 18–40 years). The largest age group was 21–30 years, comprising 41 patients (68.3%). There were 39 males (65.0%) and 21 females (35.0%).

Table 1. Comparison of age, CRP and Alvarado score according to HPE diagnosis. CRP differed significantly between groups ($p=0.001$), as did the Alvarado score ($p=0.011$); age did not ($p=0.180$).

Variable	Overall (n=60)	Acute appendicitis (n=47)	Recurrent/chronic (n=13)
Age, mean $\pm$ SD (years)	26.18 ± 5.37	26.57 ± 5.27	24.77 ± 5.67
CRP, mean $\pm$ SD (mg/L)	35.62 ± 48.99	42.04 ± 53.57	12.41 ± 7.58
Alvarado score, mean $\pm$ SD	7.67 ± 1.07	7.83 ± 1.13	7.08 ± 0.49

CT Grade 1 was observed in 23 (38.3%) patients, Grade 2 in 15 (25.0%), Grade 3 in 17 (28.3%) and Grade 4 in 5 (8.3%). Thus, 37 (61.7%) patients had positive CT findings (Grades 2–4).

Table 2. Relationship between CT grade and HPE diagnosis ($p=0.006$). Higher CT grades were observed predominantly among acute appendicitis cases.

CT grade	Chronic/recurrent n (%)	Acute n (%)	Total n (%)
Grade 1	10 (76.92)	13 (27.66)	23 (38.33)
Grade 2	3 (23.08)	12 (25.53)	15 (25.00)
Grade 3	0 (0)	17 (36.17)	17 (28.33)
Grade 4	0 (0)	5 (10.64)	5 (8.33)
Total	13 (100)	47 (100)	60 (100)

When CT was dichotomized as negative (Grade 1) versus positive (Grades 2–4), 34 of 47 acute appendicitis cases (72.34%) had positive CT findings, compared with 3 of 13 recurrent/chronic cases (23.08%). This association was statistically significant ($p=0.001$).

DISCUSSION

The present prospective study evaluated the relationship among CRP, the Alvarado score and CT findings in 60 patients with suspected appendicitis. The study population was predominantly young adults, with a mean age of 26.18 years, and males constituted 65% of participants. These findings are broadly consistent with the clinical epidemiology described in the study's literature review.

CRP showed the clearest biochemical separation between the two HPE groups. Mean CRP was 42.04 mg/L in acute appendicitis compared with 12.41 mg/L in recurrent/chronic appendicitis, with a statistically significant difference ($p=0.001$). The wide dispersion of CRP values in acute cases indicates that the inflammatory response was heterogeneous. The findings support the use of CRP as an adjunct rather than an isolated diagnostic test.

The mean Alvarado score was also significantly higher in acute appendicitis than in recurrent/chronic appendicitis (7.83 versus 7.08; $p=0.011$). This supports the clinical value of the score in identifying patients with a stronger clinical inflammatory presentation. Nevertheless, the modest difference between group means indicates that clinical scoring alone may not reliably distinguish every patient.

CT demonstrated a significant relationship with histopathological diagnosis. Positive CT findings were present in 72.34% of acute cases but only 23.08% of recurrent/chronic cases ($p=0.001$). Furthermore, Grades 3 and 4 were confined to the acute group in this dataset, and the overall association between CT grade and HPE diagnosis was significant ($p=0.006$). These findings suggest that CT is particularly useful not only for identifying appendiceal inflammation but also for stratifying radiological severity.

The study findings are concordant with the literature reviewed in the thesis, which indicates that Alvarado scoring, CRP and CT have complementary strengths and limitations. Previous studies cited in the thesis reported that CT generally provides high diagnostic accuracy, while combinations of clinical scores and inflammatory markers can improve diagnostic performance. The current data similarly support an integrated approach rather than reliance on any single parameter.

The multimodal strategy is clinically relevant because discordance can occur between clinical assessment, inflammatory markers and imaging. A patient with an intermediate clinical score but markedly elevated CRP or suggestive CT findings may require further evaluation, whereas a low-risk clinical and biochemical profile may reduce the need for immediate invasive intervention. Clinical judgement remains essential, particularly because CT involves ionizing radiation and CRP lacks disease specificity.

Limitations

- Single-centre study with a relatively small sample size of 60 patients.
- Age was restricted to 18–40 years, limiting generalizability to children, older adults and pregnant patients.
- The study excluded several comorbidities and smokers, which may reduce applicability to an unselected emergency population.
- The dataset and thesis do not provide a complete ROC-based analysis with sensitivity, specificity, likelihood ratios and confidence intervals for every possible CRP and Alvarado threshold.
- The study relied on the CT grading system described in the thesis; external validation against other standardized CT severity systems was not performed.
- Cost-effectiveness and interobserver variability of CT interpretation were not assessed.

CONCLUSION

In this prospective cohort of 60 patients, acute appendicitis was associated with significantly higher CRP levels and Alvarado scores than recurrent/chronic appendicitis. CT findings, particularly higher CT grades, were

significantly associated with acute appendicitis on histopathology. The findings support a multimodal diagnostic approach combining clinical scoring, CRP and CT, especially in patients with equivocal presentations. Larger multicentre studies with standardized diagnostic thresholds and ROC-based analysis are warranted to validate the optimal combination of these parameters.

DECLARATIONS

Ethics approval: Institutional Ethics Committee approval was obtained according to the thesis. Approval number: [TO BE INSERTED].

Consent: Written informed consent was obtained from study participants.

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Conflict of interest: To be confirmed by all authors before submission.

Author contributions: To be finalized and approved by all authors according to their actual contributions.

Data availability: The underlying patient-level dataset is not intended for public release and should be handled according to institutional policy.

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