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Research Article

CORRELATION BETWEEN C-REACTIVE PROTEIN (CRP) LEVELS AND APPENDICULAR PERFORATION: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Acute appendicitis is one of the commonest surgical emergencies encountered in general surgical practice and remains an important cause of acute abdominal pain requiring urgent diagnosis and timely operative management.

Objective: To assess the correlation between pre-operative high-sensitivity C-reactive protein (hsCRP) levels and appendicular perforation among patients diagnosed with acute appendicitis.

Methods: This prospective observational study was conducted in the Department of General Surgery among patients presenting with clinical features suggestive of acute appendicitis and scheduled for appendicectomy were evaluated for eligibility and enrolled after obtaining written informed consent. A total of 90 patients fulfilling the eligibility criteria were included in the final analysis. Duration of study was 18 months, from 1st April 2024 to 31st October 2025. The study was initiated only after approval from the Institutional Ethics Committee.

Result: Most patients presented with classical symptoms and signs of appendicitis, including nausea, vomiting, anorexia, fever, McBurney's tenderness, rebound tenderness, and local rigidity. The majority of patients had a high Alvarado score, supporting the clinical diagnosis of acute appendicitis.

Appendicular perforation was confirmed in a large proportion of patients, with 82 out of 90 cases (91.1%) showing final confirmed perforation. Despite this high rate of perforation, hsCRP did not demonstrate a statistically significant difference between perforated and non-perforated appendicitis. The mean hsCRP level was 87.90 ± 64.58 mg/L in perforated cases and 100.65 ± 74.83 mg/L in non-perforated cases, with a non-significant p value of 0.904.

Although hsCRP at a cut-off value of 67.0 mg/L showed moderate sensitivity of 73.2%, its specificity was only 50.0%, and the ROC curve showed an AUC of 0.514, indicating poor overall discriminatory ability. The high positive predictive value of 93.8% appears to be influenced by the very high prevalence of perforation in the study cohort rather than strong independent predictive accuracy of hsCRP.

Conclusion: Although hsCRP was elevated in the overall study population with acute appendicitis, it was not a reliable independent marker for predicting appendicular perforation in this cohort. hsCRP may still be used as a supportive inflammatory marker in the clinical evaluation of acute appendicitis

Keywords: *C-Reactive Protein (CRP) Levels, Appendicular Perforation, McBurney's tenderness, rebound tenderness.*

INTRODUCTION

A substantial number of patients presenting to emergency departments with abdominal pain are eventually evaluated for acute appendicitis, particularly when pain localizes to the right iliac fossa. Some patients present with the classical sequence of migratory abdominal pain, anorexia, nausea, vomiting, fever, and localized tenderness, whereas others show atypical, subtle, or overlapping features. Consequently, the surgeon is required not only to diagnose acute appendicitis, but also to identify those patients in whom the disease has already progressed to a complicated stage.[1-3]

The distinction between uncomplicated and complicated appendicitis is clinically crucial. Uncomplicated appendicitis generally refers to an inflamed appendix without gangrene, perforation, abscess, or generalized contamination, whereas complicated appendicitis includes gangrene, perforation, appendicular lump, peri-appendiceal abscess, and peritonitis. Among these complications, appendicular perforation is the most important because it is closely related to increased morbidity. Once perforation occurs, the inflammatory process is no longer confined to the appendix; the risk of local collection, diffuse peritonitis, sepsis, longer hospital stay, wound infection, postoperative complications, and delayed recovery rises considerably. Early recognition of perforation therefore has practical implications for the urgency of surgery, the choice and escalation of antibiotics, intra-operative preparedness, the need for drain placement, and the intensity of postoperative monitoring.[1-5]

The diagnosis of acute appendicitis has traditionally depended on careful history taking and physical examination, supported by laboratory investigations and imaging. Clinical scoring systems and radiological tools have improved diagnostic precision, yet no single modality is infallible. Ultrasonography is commonly used because it is inexpensive, easily available, and noninvasive, while computed tomography offers higher anatomical detail and greater overall diagnostic accuracy. However, even with imaging, the diagnosis of appendicular perforation may remain uncertain before surgery.

In this setting, inflammatory biomarkers assume special importance. C-reactive protein is among the most widely studied acute-phase reactants in surgical inflammation. The pathophysiological progression of acute appendicitis provides a strong rationale for the use of CRP as a marker of severity. CRP may reflect not only the presence of inflammation, but also the severity and progression of appendiceal disease.[3,5-6]

A number of published studies support the possible relationship between elevated CRP and appendicular perforation. Further evidence from recent literature strengthens this view. [7-9] Taken together, these studies indicate that CRP has promising diagnostic value, but they also show that the optimal cut-off and predictive accuracy may differ according to population characteristics, age group, disease spectrum, and study design.

Despite these encouraging results, the role of CRP in predicting appendicular perforation has not been adequately established in many Indian centers. This is an important gap because locally relevant factors such as delay in presentation, prior empirical treatment, nutritional status, referral bias, coexistence of other inflammatory conditions, and institutional variations in diagnostic work-up may influence both CRP levels and the incidence of perforation. A biomarker that performs well in one clinical setting may not demonstrate the same sensitivity, specificity, positive predictive value, or negative predictive value in another. Therefore, validation in the local population is essential before CRP can be confidently used as a reliable predictive tool in routine surgical practice.

MATERIAL AND METHODS

This prospective observational study was conducted in the Department of General Surgery among patients presenting with clinical features suggestive of acute appendicitis and scheduled for appendicectomy were evaluated for eligibility and enrolled after obtaining written informed consent. A total of 90 patients fulfilling the eligibility criteria were included in the final analysis. Duration of study was 18 months, from 1st April 2024 to 31st October 2025. The study was initiated only after approval from the Institutional Ethics Committee.

Inclusion Criteria

- Patients aged more than 18 years.
- Patients diagnosed with acute appendicitis on the basis of clinical evaluation supported by laboratory and/or radiological findings.
- Patients scheduled to undergo appendicectomy by either open or laparoscopic approach.

Exclusion Criteria

- Patients undergoing interval appendicectomy were excluded from the study.

Sample Size

The sample size was calculated for diagnostic accuracy assessment using the expected sensitivity of CRP for predicting appendicular perforation. The expected sensitivity was taken as 88.2%, based on previously published data. The maximal allowable distance from sensitivity was taken as 10%, with type I error of 5% and type II error of 20%. Based on this calculation, the minimum required sample size was 90 patients. During the study period, 90 consecutive eligible patients were enrolled.

The sample size calculation was based on the following principle:

n = required sample size; π = expected sensitivity of the diagnostic test; δ = maximal allowable distance from expected sensitivity; α = type I error; β = type II error.

Sampling Technique
A consecutive sampling technique was used.

Study Variables
The main exposure variable was the pre-operative hsCRP level measured in mg/L. The primary outcome variable was final confirmed appendicular perforation status. Final confirmed perforation was determined on the basis of intra-operative findings and histopathological confirmation. Other variables included demographic characteristics, presenting complaints, duration of symptoms, admission-to-surgery interval, clinical signs, Alvarado score, hematological and biochemical parameters, ultrasonography findings, surgical approach, duration of surgery, drain placement, post-operative complications, and length of hospital stay.

Data Collection Tools and Technique
Data were collected using a pre-designed semi-structured study proforma. After enrolment, demographic details, clinical history, examination findings, laboratory investigations, radiological findings, operative findings, histopathology findings, and post-operative outcomes were recorded systematically.

Primary Outcome
The primary outcome was the diagnostic ability of pre-operative hsCRP level to predict final confirmed appendicular perforation among patients with acute appendicitis.

Secondary Outcomes
- To determine the incidence of appendicular perforation among patients with acute appendicitis.
- To compare pre-operative hsCRP levels between perforated and non-perforated appendicitis groups.
- To determine the optimal hsCRP cut-off value for prediction of appendicular perforation using receiver operating characteristic curve analysis.
- To calculate sensitivity, specificity, positive predictive value, negative predictive value, overall diagnostic accuracy, and area under the ROC curve for hsCRP.
- To compare selected demographic, clinical, laboratory, operative, and post-operative variables according to final perforation status.

Statistical Analysis
The collected data were checked for completeness, numerically coded, and entered into Microsoft Excel. Statistical analysis was performed using IBM Statistical Package for Social Sciences (SPSS), version 25. Qualitative variables were expressed as frequency and percentage, whereas quantitative variables were expressed as mean ± standard deviation.

Patients were divided into two groups according to final confirmed perforation status: perforation present and perforation absent. Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. Quantitative variables were compared between groups using appropriate tests based on data distribution; the Mann-Whitney U test was used for non-parametric intergroup comparison.

Receiver operating characteristic curve analysis was performed to assess the diagnostic performance of hsCRP for predicting appendicular perforation. The optimal hsCRP cut-off value was identified, and sensitivity, specificity, positive predictive value, negative predictive value, overall accuracy, and area under the curve were calculated. A p value of less than 0.05 was considered statistically significant.

RESULTS
Among the 90 patients included in the study, 51 (56.7%) were male and 39 (43.3%) were female. Nausea, vomiting, and anorexia were present in 87 (96.7%) patients each, while fever was present in 86 (95.6%) patients. McBurney's test, rebound tenderness, and local rigidity were recorded in all 90 patients. The mean onset to admission time was 34.64 ± 20.51 hours and the mean admission to surgery time was 12.93 ± 6.59 hours. The mean Alvarado score was 7.59 ± 1.36.

Male patients constituted the larger proportion of the study cohort, accounting for 56.7% of all cases.

Nausea, vomiting, and anorexia were each reported by 96.7% of patients, whereas fever was present in 95.6% of the cohort.

McBurney's test, rebound tenderness, and local rigidity were documented in all patients included in the study.

Table 1. Timing variables, baseline vital parameters, and Alvarado score

Variable	Mean ± SD
Onset to admission time (hours)	34.64 ± 20.51
Admission to surgery time (hours)	12.93 ± 6.59
Pulse rate (per min)	89.10 ± 15.58

Systolic blood pressure (mmHg)	118.93 ± 11.01
Diastolic blood pressure (mmHg)	78.09 ± 9.61
Respiratory rate (per min)	23.06 ± 5.17
Temperature (°F)	99.15 ± 1.16
Alvarado score	7.59 ± 1.36

The mean onset to admission time was 34.64 hours, while surgery was performed after a mean interval of 12.93 hours from admission. The mean pulse rate was 89.10/min, and the mean temperature was 99.15°F.

Table 2. Laboratory profile of the study population

Laboratory parameter	Mean ± SD
Hemoglobin (g/dL)	11.88 ± 1.83
Total leukocyte count	13.12 ± 13.26
Platelet count (lakh/mm³)	2.11 ± 0.68
INR*	1.24 ± 0.10
hsCRP (mg/L)	89.03 ± 65.19
Total bilirubin (mg/dL)	0.99 ± 1.19
Albumin (g/dL)	3.60 ± 0.56
AST (U/L)	29.00 ± 14.88
ALT (U/L)	23.25 ± 24.29
ALP (U/L)	73.19 ± 28.11
Creatinine (mg/dL)	1.09 ± 1.08
BUN (mg/dL)	24.74 ± 15.53

** INR was available for 16 patients only.*

The mean hemoglobin level was 11.88 ± 1.83 g/dL and the mean total leukocyte count was 13.12 ± 13.26. The mean hsCRP level of the cohort was 89.03 ± 65.19 mg/L.

Table 3. Operative profile and postoperative outcomes

Variable	Value
Past medical history present	2 (2.2%)
Personal history present	11 (12.2%)
Laparoscopic appendicectomy	68 (75.6%)
Open appendicectomy	22 (24.4%)
Duration of surgery (hours)	1.46 ± 0.24
SSI	0 (0.0%)
Intra-abdominal abscess	0 (0.0%)
Anatomical leakage	0 (0.0%)
GI injury	0 (0.0%)

Ileus	0 (0.0%)

Laparoscopic appendicectomy was the commoner surgical approach and was performed in 75.6% of patients. No postoperative surgical site infection, abscess, anatomical leakage, gastrointestinal injury, or ileus was recorded in the uploaded master chart.

Table 4. Perforation confirmation status in the study cohort

Perforation variable	n (%)
Intra-operative perforation: Yes	82 (91.1%)
Intra-operative perforation: No	8 (8.9%)
Histopathology-confirmed perforation: Yes	82 (91.1%)
Histopathology-confirmed perforation: No	8 (8.9%)
Final confirmed perforation: Yes	82 (91.1%)
Final confirmed perforation: No	8 (8.9%)

As recorded in the updated master chart, final confirmed perforation was marked as present in 82 (91.1%) patients and absent in 8 (8.9%) patients.

Comparative analysis according to final confirmed perforation status. Selected clinical and operative variables were compared between patients with and without final confirmed perforation.

Table 5. Comparison of categorical variables according to final confirmed perforation status

Variable	Perforation Yes (n=82)	Perforation No (n=8)	p value
Male sex	48 (58.5%)	3 (37.5%)	0.286
Nausea present	79 (96.3%)	8 (100.0%)	1.000
Vomiting present	79 (96.3%)	8 (100.0%)	1.000
Fever present	78 (95.1%)	8 (100.0%)	1.000
Anorexia present	79 (96.3%)	8 (100.0%)	1.000
Past medical history present	2 (2.4%)	0 (0.0%)	1.000
Personal history present	10 (12.2%)	1 (12.5%)	1.000
Laparoscopic surgery	64 (78.0%)	4 (50.0%)	0.096

p values were calculated using Fisher's exact test/chi-square test as appropriate.

There was no statistically significant difference between the perforation and non-perforation groups with respect to sex, presenting complaints, past medical history, personal history, or surgical approach.

Table 6. Comparison of quantitative variables according to final confirmed perforation status

Variable	Perforation Yes (n=82)	Perforation No (n=8)	p value
Onset to admission time (hours)	35.41 ± 21.08	26.75 ± 11.21	0.334
Admission to surgery time (hours)	13.21 ± 6.58	10.12 ± 6.47	0.119
Alvarado score	7.61 ± 1.31	7.38 ± 1.92	0.982
Hemoglobin (g/dL)	11.92 ± 1.87	11.51 ± 1.45	0.609

Total leukocyte count	12.08 ± 11.20	23.50 ± 25.16	0.204
hsCRP (mg/L)	87.90 ± 64.58	100.65 ± 74.83	0.904
Total bilirubin (mg/dL)	0.95 ± 1.21	1.43 ± 0.93	0.034
Duration of surgery (hours)	1.45 ± 0.24	1.56 ± 0.18	0.238

Values are expressed as mean ± SD. p values were calculated using the Mann–Whitney U test.

The mean hsCRP value was 87.90 ± 64.58 mg/L in the perforation group and 100.65 ± 74.83 mg/L in the non-perforation group, and this difference was not statistically significant (p = 0.904). Total bilirubin showed a statistically significant difference between the two groups (0.95 ± 1.21 mg/dL versus 1.43 ± 0.93 mg/dL; p = 0.034). No statistically significant intergroup difference was observed for onset to admission time, admission to surgery time, Alvarado score, hemoglobin, total leukocyte count, or duration of surgery.

Table 7. Diagnostic performance of hsCRP for prediction of appendicular perforation

Diagnostic measure	Value
Optimal hsCRP cut-off (mg/L)	67.0
Area under ROC curve (AUC)	0.514
Sensitivity	73.2%
Specificity	50.0%
Positive predictive value	93.8%
Negative predictive value	15.4%
Overall accuracy	71.1%

Receiver operating characteristic analysis of hsCRP for predicting appendicular perforation yielded an area under the curve of 0.514. At an optimal cut-off of 67.0 mg/L, hsCRP showed a sensitivity of 73.2% and a specificity of 50.0%.

DISCUSSION

In the present study, males constituted the larger proportion of cases, with 51 (56.7%) males and 39 (43.3%) females. This finding is consistent with the commonly reported male predominance in acute appendicitis. Kumar R et al., (2020) [10], in a cross-sectional study of 50 patients undergoing emergency appendicectomy in North India, reported 29 (58%) males and 21 (42%) females, which is almost identical to the present study distribution.

The male predominance in appendicitis may be related to demographic distribution of surgical admissions, biological susceptibility, health-seeking behaviour, or referral patterns. while male predominance is common in acute appendicitis cohorts, sex by itself appears to be a weak predictor of perforation in both the present study and other published work.

In the present study, nausea, vomiting, and anorexia were each present in 87 (96.7%) patients, while fever was present in 86 (95.6%) patients. This indicates that the majority of patients presented with a typical clinical symptom complex of acute appendicitis, including gastrointestinal symptoms and systemic inflammatory response. Kumar R et al., (2020) [10] reported nausea and vomiting in 41 (82%) patients and anorexia in 40 (80%) patients among 50 clinically diagnosed appendicitis cases. Fever was present in only 11 (22%) patients in their cohort. Compared with their study, nausea, vomiting, anorexia, and fever were all more frequent in the present study.

The higher frequency of fever in the present study is clinically meaningful. Fever may be absent or low-grade in early uncomplicated appendicitis, but it becomes more frequent when inflammation progresses, especially when gangrene, perforation, abscess, or peritoneal irritation develops. Akai M et al., (2019) [11] found fever >37.3°C in 75 (56.0%) complicated cases compared with 58 (31.5%) simple cases, and fever remained an independent risk factor for complicated appendicitis on multivariate analysis (OR 2.43, 95% CI 1.449-4.057).

In the present study, McBurney's test, rebound tenderness, and local rigidity were documented in all 90 patients (100%). Kumar R et al., (2020) [10] reported right iliac fossa tenderness in 50 (100%) patients, but rebound tenderness in 35 (70%), guarding in 32 (64%), and rigidity in only 3 (6%). Compared with their study, the present study showed a much higher frequency of rebound tenderness and rigidity.

Akai M et al., (2019) [11] reported positive peritoneal irritation signs in 92 (68.7%) complicated appendicitis cases compared with 102 (55.4%) simple cases (p = 0.017). This supports the concept that peritoneal signs increase with disease severity. In the present study, the universal presence of rebound tenderness and local rigidity may reflect delayed presentation, strict clinical inclusion, or a perforation-enriched cohort.

In the present study, the mean onset-to-admission time was 34.64 ± 20.51 hours and the mean admission-to-surgery time was 12.93 ± 6.59 hours. The mean pulse rate was 89.10 ± 15.58/min, systolic blood pressure was 118.93 ± 11.01 mmHg, diastolic blood pressure was 78.09 ± 9.61 mmHg, respiratory rate was 23.06 ± 5.17/min, temperature was 99.15 ± 1.16°F, and mean Alvarado score was 7.59 ± 1.36. The mean Alvarado score suggests a high clinical probability of acute appendicitis.

Delay from symptom onset is one of the most clinically important contributors to perforation. Patmano M et al., (2022) [12] noted that perforation rates in appendicitis may vary between 12% and 25%, with some publications reporting rates over 35%, and emphasized the importance of early identification of perforation.

The Alvarado score in the present study was comparable with studies where most operated patients had clinically probable appendicitis. In one study evaluating clinical diagnosis and Alvarado score [13], 105 (70.0%) of 150 suspected appendicitis patients had an Alvarado score >7, supporting its utility as a triage and diagnostic aid. However, the Alvarado score is not primarily designed to predict perforation. This was reflected in the present study, where the Alvarado score was similar in perforated and non-perforated cases. Therefore, the Alvarado score is valuable for identifying likely appendicitis but should be combined with duration of symptoms, peritoneal signs, CRP, bilirubin, and imaging when perforation is suspected.

Akai M et al., (2019) [11] found that CRP was substantially higher in complicated appendicitis than in simple appendicitis, with mean CRP 9.87 mg/dL in complicated cases compared with 3.04 mg/dL in simple cases (p < 0.001). High CRP was also independently associated with complicated appendicitis on multivariate analysis (OR 7.61, 95% CI 3.257-17.757). The present study's mean hsCRP of 89.03 mg/L is approximately equivalent to 8.9 mg/dL, which is very close to the complicated appendicitis CRP level reported by Akai M et al.

Patmano M et al., (2022) [12] also found CRP to be a strong marker for perforation. Their ROC analysis showed a CRP cut-off of 25.5 with AUC 0.909, sensitivity 92%, and specificity 72.5% for perforated appendicitis. Raja MH et al., (2017) [14] reported that very high CRP levels were more often associated with necrotizing, gangrenous, or perforated appendicitis, and suggested that CRP values above 100 and below 150 mg/L may indicate possible perforated or gangrenous appendicitis. These studies support the biological plausibility of raised CRP as a marker of advanced inflammation.

The mean total bilirubin in the present study was 0.99 ± 1.19 mg/dL. In comparison, Alfehaid MS et al., (2023) [15] reported higher total bilirubin in complicated appendicitis than uncomplicated appendicitis, with median total bilirubin 15.3 [10-29.1] µmol/L versus 9.7 [7.1-15.2] µmol/L (p < 0.001).

The predominance of laparoscopic appendicectomy in the present study is consistent with contemporary surgical practice. Markides G et al., (2010) [16], in a systematic review and meta-analysis of complicated appendicitis, reported that laparoscopic appendicectomy was associated with lower surgical site infection compared with open appendicectomy (OR 0.43, 95% CI 0.34-0.55). The same review also reported shorter time to oral intake and shorter hospital stay after laparoscopic surgery, although operating time was longer by a mean difference of 12.80 minutes. The absence of postoperative complications in the present study is clinically favourable, but it must be interpreted carefully. In perforated appendicitis, published studies usually report some risk of wound infection or intra-abdominal abscess. The zero-complication finding in the present dataset may reflect effective perioperative antibiotic coverage, adequate source control, short follow-up duration, exclusion of minor complications, or under-recording in the master chart. Therefore, this result should be described as favourable in the present dataset rather than as proof that complications do not occur after perforated appendicitis.

The perforation proportion in the present study is much higher than most general appendicitis cohorts. Yamazaki S et al., (2021) [17] reported perforated appendicitis in 40 (29%) of 150 patients undergoing appendectomy. Alfehaid MS et al., (2023) [15] reported complicated appendicitis in 33 (20.9%) of 158 patients. Long J et al., (2024) [18], in a pediatric study of 313 patients, found perforation in 106 (33.87%; 95% CI 28.59-39.14%). Patmano M et al., (2022) [12] also summarized that perforation rates commonly vary between 12% and 25%, with some reports exceeding 35%.
Compared with these studies, the present study's perforation rate of 91.1% is exceptionally high. This difference is important for interpretation of all diagnostic statistics in the study.

In the present study, none of the categorical variables showed a statistically significant association with final confirmed perforation. Alfehaid MS et al., (2023) [15] similarly found that gender was not associated with complicated appendicitis (p = 0.896), and diabetes mellitus was also not significant (p = 0.839). This supports the present finding that baseline categorical variables such as sex and comorbidity may not reliably identify perforation.

Kumar R et al., (2020) [10] showed that symptoms and signs vary widely in general appendicitis: nausea/vomiting 82%, anorexia 80%, fever 22%, rebound tenderness 70%, guarding 64%, and rigidity 6%. In the present study, these symptoms and signs were much more frequent and nearly saturated across the cohort. Therefore, once most patients have already reached a clinically obvious stage of disease, categorical symptoms are more useful for diagnosing appendicitis than for distinguishing perforation.

Patmano M et al., (2022) [12] emphasized that identifying perforation before surgery is important because complicated appendicitis is associated with greater morbidity and may require different antibiotic and operative planning. Moon HM et al., (2011) [19] noted that CRP becomes more discriminatory as inflammatory duration increases. The present finding of numerically longer onset-to-admission and admission-to-surgery intervals in perforated patients is clinically consistent with delayed progression, even though statistical significance was not reached.

In the present study, total leukocyte count was 12.08 ± 11.20 in perforated cases and 23.50 ± 25.16 in non-perforated cases ($p = 0.204$), while hsCRP was 87.90 ± 64.58 mg/L in perforated cases and 100.65 ± 74.83 mg/L in non-perforated cases ($p = 0.904$). This is contrary to many published studies. Akai M et al., (2019) [11] reported significantly higher CRP in complicated appendicitis than simple appendicitis, 9.87 mg/dL versus 3.04 mg/dL ($p < 0.001$).

Total bilirubin showed a statistically significant difference in the present study, with 0.95 ± 1.21 mg/dL in perforated cases and 1.43 ± 0.93 mg/dL in non-perforated cases ($p = 0.034$). Although statistically significant, the direction of difference is opposite to most literature. Alfehaid MS et al., (2023) [15] found higher bilirubin in complicated appendicitis, and D'Souza N et al., (2013) [20] found hyperbilirubinemia significantly associated with perforated appendicitis ($p < 0.0001$). Therefore, the present bilirubin finding should be interpreted with caution. It may reflect outlier values in the very small non-perforated group, individual hepatobiliary variation, dehydration, or non-appendicular causes of bilirubin elevation rather than a true protective or inverse relationship.

This finding differs from several published studies. Moon HM et al., (2011) [19] reported that a CRP cut-off of 7.05 mg/dL had sensitivity 57.6%, specificity 98.3%, PPV 97.4%, and NPV 68.5% for complicated appendicitis. Patmano M et al., (2022) [12] reported stronger performance, with CRP cut-off 25.5, AUC 0.909, sensitivity 92%, and specificity 72.5%. Yamazaki S et al., (2021) [13] reported that a CRP cut-off of 3.0×10^4 µg/L, equivalent to approximately 30 mg/L, had AUROC 0.862, sensitivity 95.5%, and specificity 64.7% for perforated appendicitis.

The weaker ROC performance of hsCRP in the present study is best explained by the structure of the dataset. The non-perforated group was very small, and hsCRP values were elevated in both groups. When inflammatory marker values overlap between groups, even a biologically plausible marker loses statistical discrimination. The very high PPV of 93.8% should also not be overinterpreted because PPV increases when the prevalence of the outcome is high. Since the present study had 91.1% final perforation, a positive hsCRP result would naturally have a high probability of coinciding with perforation, even if the test's true discriminatory capacity is weak.

Long J et al., (2024) [18] demonstrated that combining CRP with another nutritional/inflammatory marker may improve risk stratification. Their pediatric study reported perforation in 106 (33.87%) of 313 children and found that the CRP/prealbumin ratio differed significantly between perforated and non-perforated groups. This supports the broader principle that CRP alone may be insufficient and that composite markers may perform better than isolated laboratory tests.

The present study supports the role of hsCRP as a marker of inflammatory burden in acute appendicitis, but it does not support hsCRP as a strong standalone discriminator of appendicular perforation in this dataset. The overall clinical profile was typical of acute appendicitis and showed male predominance, frequent gastrointestinal symptoms, frequent fever, universal localizing signs, elevated inflammatory markers, and high Alvarado scores. However, the most important methodological feature affecting interpretation was the very high perforation proportion and the very small non-perforated comparison group.

CONCLUSION

The study concludes that although hsCRP was elevated in the overall study population with acute appendicitis, it was not a reliable independent marker for predicting appendicular perforation in this cohort. hsCRP may still be used as a supportive inflammatory marker in the clinical evaluation of acute appendicitis, but it should not be used alone for determining perforation status. Clinical assessment, operative findings, histopathological confirmation, and other laboratory parameters should be considered together for accurate diagnosis and management.

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