



DIAGNOSTIC ROLE OF C-REACTIVE PROTEIN (CRP) IN ACUTE APPENDICITIS – A DOUBLE BLIND STUDY

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ABSTRACT

Background: Acute appendicitis is one of the most common causes of right iliac fossa pain and the most common surgical emergencies. Appendicectomy is the most commonly performed emergency surgery, still its diagnosis remains a challenge, with high rate of negative appendicectomy performed every year.

Objective: The objective of the study was to evaluate the role of accuracy of serum CRP estimation in the diagnosis of acute appendicitis and to reduce the morbidity by avoiding negative appendicectomy.

Methods: The study was conducted in Venkateshwara Institute of Medical Science, Gajraula, Uttar Pradesh. The study included 100 patients who were clinically diagnosed in emergency by a general surgeon as having acute appendicitis and posted for emergency appendicectomy. Preoperatively serum CRP estimation was done, and after the surgical intervention, all specimens were subjected to Histopathological Examination (HPE). Results of preoperative serum CRP level and postoperative HPE reports were correlated to evaluate the role of CRP in diagnosis of acute appendicitis.

Results: In present study, CRP has sensitivity and specificity of 91.8% and 86.7% respectively with positive predictive value of 97.5%. Hence it proves that CRP estimation can be used as a diagnostic tool to rule out appendicitis, so that surgery can be deferred in those subjects and can finally help to reduce rate of negative appendicectomies.

Conclusion: It is evident that history and clinical examination by a skilled surgeon still remain mainstay in diagnosing acute appendicitis. CRP being a cheap and easy diagnostic test should be included in the work up of acute appendicitis to lower negative appendicectomy rate.

Keywords: C-reactive protein, CRP, negative appendicectomy, acute appendicitis, HPE-Histopathological co-relation.

INTRODUCTION

Acute appendicitis is one of the most common causes of right iliac fossa pain and one of the most common surgical emergencies¹. Its diagnosis can be established depending on presenting history, clinical evaluation by surgeon and laboratory tests. Atypical presentations are quite common as many inflammatory and non-inflammatory conditions may present as acute appendicitis. The classic triad of history suggestive of acute appendicitis includes pain at the McBurney's point, fever and nausea/

vomiting have diagnostic accuracy of less than 80 percent. Even with radiological investigations such as USG abdomen and computed tomography the accuracy does not reach 90%². The presentation is common in females because of presence of pelvic inflammatory disease (PID) and other common obstetrical and gynaecological disorders which mimic acute appendicitis. These factors result in high rate of about 15-30% of negative appendicectomy³ and post-operative morbidity in 5- 15% of cases⁴. The goal of surgical treatment is removal of inflamed appendix before perforation, with minimal number of negative appendicectomy. A normal appendix during surgery represents a misdiagnosis while a delayed diagnosis of appendicitis may lead to abscess, gangrene, perforation and peritonitis. So higher incidence of unnecessary appendicectomies is actually to decrease the morbidity associated with gangrene and perforations⁵. In today's era of evidence-based medicine with higher emphasis on radiological investigations, the high rate of negative explorations for appendicitis is a burden faced not only by the surgeons, but also by the patients in developing nations like ours, in terms of financial burden and substandard quality of life. In our study we aim to correlate the serum levels of CRP with the histopathology of the removed appendix. This study emphasizes the impact of raised serum C-reactive protein in reducing the rate of negative explorations. C-reactive protein is an acute phase reactant, which increases rapidly in response to inflammation and can be measured in serum 6-12 hours after the onset of the inflammatory process. It is produced in liver, controlled by interleukin-6. Its concentration is increased in infection, autoimmune disorders, neoplasia and ageing. Its normal value of serum CRP is 0.1 to 0.8 mg^{6,7}. The evaluation of this protein is easy and its quantitative analysis can help in complementing the diagnosis of acute appendicitis.

Materials and Methods

In our prospective study patients coming to Emergency and Department of general surgery, Venkateshwara institute of medical sciences from Jan 2020 to Dec 2023, who were clinically diagnosed as having acute appendicitis were the source of study. They were included in the study after explaining about CRP test and after taking written consent by them in a prescribed format.

Inclusion and Exclusion Criteria of the study-

Inclusion criteria

All the patients who were admitted to the Emergency with a clinical diagnosis of acute appendicitis who underwent surgery during the study period are included in the present study.

Exclusion criteria

1. Children less than 11 years and elderly more than 80 years were excluded as the CRP response is not optimal in the extremes of age.
2. Patients managed conservatively because of appendicular lump or not willing to undergo surgery were excluded from this study.
3. Patients having history of jaundice, signs and symptoms suggestive of liver disease and chronic alcohol intake.
4. Females with history of taking oral contraceptive pill or pregnancy.

Method of collection of data

All Patients with pain abdomen reporting to Emergency or Department of surgery were examined by a surgeon. First a detailed history was obtained which was followed by Physical examination. Alvarado scoring system was also used. All suspected cases of acute appendicitis were subjected to routine laboratory tests, CRP, chest radiographs, ECG and USG Abdomen. All suspected cases of appendicitis were sent for USG abdomen to rule out other causes of RIF pain. Additional test (if any) was done for Pre-Anaesthetic Checkup (PAC) fitness purpose as advised by the anaesthetist. Few elderly patients underwent 2D Echo and Dobutamine Stress Echo also before surgery.

Serum CRP levels of all the patients were sent with routine laboratory tests before surgery which was done by latex agglutination method. Normal value of serum CRP is 0.1 to 0.8 mg/dl, value above 2.5mg/dl, suggest an ongoing inflammatory process and were considered as positive. The test

specimen (serum) is mixed with CRP latex reagent and allowed to react. If CRP concentration is greater than 0.8mg/dl visible agglutination is observed. If CRP concentration is less than 0.8mg/dl, then no agglutination is observed. The latex slide test has the advantage of rapid performance in comparison to other tests for detection of CRP. After surgical procedure appendix specimen were sent for HPE, to establish final and exact diagnosis. Accordingly, confusion matrix table was prepared considering HPE report as gold standard and serum CRP level (test to be evaluated).

Results

A total of 100 patients were evaluated for suspected appendicitis using serum C-reactive protein (CRP) levels, with histopathological examination (HPE) serving as the gold standard. The performance of CRP in predicting histologically confirmed appendicitis was assessed by comparing elevated CRP levels (predicted positive) with HPE findings (actual positive).

In our prospective study involving 100 patients undergoing appendectomy, the majority were male (74%), with the peak incidence observed in the second decade of life (11–21 years). This demographic trend (Table 1) is consistent with existing literature and supports the known epidemiological pattern of acute appendicitis predominantly affecting young males.

Table 1: Demographic profile of the patients

DEMOGRAPHY	Value
Total Patients	100
Male	74 (74%)
Female	26 (26%)
Age Range	11–78 years
Most Affected Group	11–21 years

Abdominal pain was the universal presenting symptom (Table 2), with right iliac fossa (RIF) tenderness observed in 86.66% of cases, highlighting the classical clinical profile of appendicitis. Other significant clinical signs included rebound tenderness (81%), fever (85%), and vomiting (83%), all of which are key elements in the clinical diagnosis. Shifting dullness was noted in 24% of cases, likely indicative of localized peritonitis or pelvic fluid collection, often associated with pelvic or retrocecal appendices.

Table 2: Presenting Symptoms

Clinical Feature	Number of Patients	Percentage
Abdominal Pain	100	100%
Pain in Right Iliac Fossa	87	87%
Rebound Tenderness	81	81%
Shifting Dullness	24	24%
Fever	85	85%
Vomiting	83	83%

Intraoperatively, the appendix was most commonly located in the retrocaecal position (70%), followed by the pelvic position (24%). These findings (Figure 1) mirror known anatomical distributions and reinforce the importance of anticipating positional variations, especially when diagnostic clarity is compromised by atypical presentations.

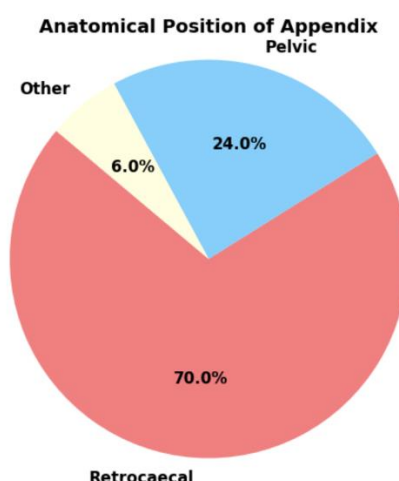


Figure 1: Representation of anatomical position of appendix

Out of 100 patients evaluated for suspected acute appendicitis, histopathological examination confirmed appendicitis in 85 cases and ruled it out in 15 cases. Serum C-reactive protein (CRP) levels were used as a diagnostic marker, with elevated CRP considered a positive test (Table 3)

Table 3: Confusion Matrix of the study results. (TP- True Positive; FP- False Positive; TN- True Negative; FN- False Negative)

HPE REPORT		POSITIVE FOR APPENDICITIS	NEGATIVE FOR APPENDICITIS
CRP LEV	ELEVATED	78 (TP)	2 (FP)
	NORMAL	7 (FN)	13 (TN)

A raised serum CRP level correctly identified 78 out of 85 patients with Histo-Pathologically confirmed appendicitis, yielding a **sensitivity of 91.8%**. Seven patients with confirmed appendicitis had normal CRP levels (false negatives). Among the 15 patients without appendicitis, 13 had normal CRP levels (true negatives), while 2 showed elevated CRP despite having no histopathological evidence of appendicitis (false positives), resulting in a **specificity of 86.7%**.

The **positive predictive value (PPV)** was 97.5%, indicating a high probability of true appendicitis in patients with elevated CRP. The **negative predictive value (NPV)** was 65.0%, and the overall **diagnostic accuracy** of serum CRP in predicting acute appendicitis was **91.0%**. The **F1 score**, which balances precision and recall, was calculated to be **94.6%**.

These findings support the utility of serum CRP as a supportive diagnostic tool in suspected appendicitis, particularly in ruling in the diagnosis when CRP is elevated.

The diagnostic performance of serum CRP is as shown in (Table 4).

Table 4: The diagnostic performance of serum CRP

Metric	Formula	Value
Sensitivity	$TP / (TP + FN)$	91.8%
Specificity	$TN / (TN + FP)$	86.7%
Positive Predictive Value	$TP / (TP + FP)$	97.5%
Negative Predictive Value	$TN / (TN + FN)$	65%
Accuracy	$(TP + TN) / (TP + TN + FP + FN)$	91%

Based on the results, our **Negative Appendectomy Rate** is **15%** which is consistent with the existing literature. (Table 5)

Table 5: Comparison of Negative Appendectomy rate with the existing literature

Study Groups	Negative Appendectomy Rate
Sanjay et al ¹¹	14%
Al-Saigh et al ¹⁴	14.30%
Albu E et al ¹⁵	10%
Thompson MM et al ¹⁶	8%
Chaitra s et al ¹³	14%
Our study	15%

Discussion

Acute appendicitis remains one of the most common surgical emergencies worldwide. The present study evaluated the diagnostic utility of serum C-reactive protein (CRP) levels in patients with suspected acute appendicitis, using histopathological findings as the gold standard. The results demonstrated that raised serum CRP levels are significantly associated with Histo-Pathologically confirmed appendicitis, with a sensitivity of 91.8% and specificity of 86.7%. These findings are consistent with previous literature suggesting that CRP is a valuable inflammatory marker in the diagnosis of acute appendicitis, particularly when combined with clinical evaluation and other laboratory findings.

The high positive predictive value (97.5%) observed in this study suggests that elevated CRP is a strong indicator of true appendicitis, supporting its role in affirming the diagnosis. However, the moderate negative predictive value (65.0%) indicates that a normal CRP level does not reliably exclude the condition, as demonstrated by the 7 false-negative cases in which patients had appendicitis despite normal CRP levels. This highlights the limitation of relying solely on CRP for diagnostic decisions, especially in early or atypical presentations where inflammatory markers may not yet be elevated.

The F1 score of 94.6% reflects a strong balance between precision and recall, reinforcing the reliability of CRP in positively identifying true cases. Moreover, the overall diagnostic accuracy of 91.0% underscores the value of CRP as a supportive diagnostic tool in the clinical assessment of suspected appendicitis.

Multiple studies have examined the sensitivity of CRP level alone for the diagnosis of appendicitis in patients selected to undergo appendectomy. Gurleyik et al noted a CRP sensitivity of 96.6% in 87 of 90 patients with histologically proven disease⁸. Similarly, Shakhathreh found a CRP sensitivity of 95.5% in 85 of 89 patients with histologically proven appendicitis⁹. Asfar et al reported a CRP sensitivity of 93.6% in 78 patients undergoing appendectomy¹⁰ which is in accordance to the results of our study. (Table 6)

Table 6: Comparison of Sensitivity and Specificity of serum CRP with the existing literature

Study Groups	Sample Size	Sensitivity (%)	Specificity (%)
Shakhathreh et al ⁹	98	95.5	88.9
Gurleyik et al ⁸	108	93.5	80
Asfar et al ¹⁰	78	93.6	86.6
Sanjay et al ¹¹	40	97.5	85
Naqvi R et al ¹²	100	90.6	50
Chaitra s et al ¹³	50	97.7	85.7
Our Study	100	91.8	86.7

Despite these strengths, certain limitations should be acknowledged. The sample size was relatively small and derived from a single centre, which may limit the generalizability of the findings. Additionally, variations in CRP cut-off values and the timing of presentation relative to symptom onset could influence diagnostic performance.

Conclusion

Serum CRP is a valuable adjunct in the diagnostic workup of acute appendicitis, demonstrating high sensitivity, specificity, and overall diagnostic accuracy. An elevated CRP level is strongly predictive of Histo-Pathologically confirmed appendicitis, supporting its use in reinforcing clinical suspicion. However, a normal CRP does not reliably exclude appendicitis, and should not be used in isolation to rule out the condition. Incorporating CRP with clinical assessment, imaging, and other laboratory parameters enhances diagnostic confidence and may contribute to more informed decision-making regarding surgical intervention.

Future studies with larger, multicentre populations and standardized CRP thresholds are recommended to further validate these findings and optimize diagnostic protocols.

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