

# Accuracy of Leukocyte Count and C-Reactive Protein in the Diagnosis of Acute Appendicitis –A Prospective Study

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## ABSTRACT

**Introduction:** Acute appendicitis is the most common abdominal surgical emergency. Misdiagnosis has a major impact in health care systems, as well as important legal consequences. The diagnosis of Appendicitis still remains a clinical dilemma. Even with the advances in medical field, there is no definitive method or tool to diagnose acute appendicitis.

**Aim:** To evaluate the accuracy of Total Leukocyte Count and C - reactive protein (CRP) in the diagnosis of acute appendicitis.

**Materials and Methods:** A prospective observational study was conducted and 50 patients who underwent emergency appendectomy were considered for the study. The sensitivity and specificity of TLC, CRP and HPE

reports of the resected specimens were tabulated. of 50 cases which underwent emergency appendectomy. Chi-square/ Fisher exact test has been used to find the significance of study parameters.

**Results:** Increased Total leucocyte count was seen in 88% cases and CRP in 80%. These values were also correlated with the histopathology reports to aid in the diagnosis.

**Conclusion:** This study aims at taking into account TLC and CRP in the diagnosis of acute appendicitis, it also helps in analyzing how specific and sensitive an indicator it is in the prediction of acute appendicitis. The values of TLC and CRP will be compared with the histopathology reports of the resected appendix specimen.

**Keywords:** Appendectomy, Diagnosis, Histopathology

## INTRODUCTION

Acute appendicitis is the most common abdominal surgical emergency. Misdiagnosis has a major impact in health care systems, as well as important legal consequences. Nowadays, the negative appendectomy rate is still about 15 percent and the perforation rate can be as high as 35 percent

The diagnosis of Appendicitis still remains a clinical dilemma. Even with the advances in medical field, there is no definitive method or tool to diagnose acute appendicitis. Many studies have taken into account Hematological and Radiological investigations which help in diagnosing acute appendicitis. The total leukocyte count (TLC) and C - reactive protein (CRP) are often used to aid in clinical assessment in patients with right iliac fossa pain. Acute appendicitis is usually associated with increased TLC. Additional tests that would improve diagnostic accuracy and hence reduce the number of unnecessary operations have to be identified. This is very important in these days when health system is driven by cost

parameters. CRP is a non-specific inflammatory marker that is used routinely in many hospitals as an aid in the diagnosis of patients with an acute abdomen. An acute phase protein is produced in the liver. Normal serum concentration is less than 10mg/l 8–12 hours after infection or trauma the increase of acute phase protein in liver the CRP is more important in clinical practice.

## AIM

This study aims at comparing few known and proven investigations for appendicitis like CRP and leukocyte count; comparing how specific and sensitive each one is, which is the best and has maximum positive predictive value. This would be done by comparing it with histopathology report.

## MATERIALS AND METHODS

A prospective clinical study was conducted in the Department of General Surgery at M.S.Ramaiah Medical College and Hospitals, Bangalore, for a period of 2 years from January

2013 to December 2014, to evaluate the accuracy of total leukocyte count and C - reactive protein (CRP) in the diagnosis of acute appendicitis.

In this study, all patients who came to the General surgery Outpatient Department and to the Emergency Department who presented with right iliac fossa pain and were diagnosed as acute appendicitis were considered for the study. They underwent routine blood investigations which included total leucocyte count and CRP. Histopathological reports of the resected appendix specimen of the patients who underwent emergency appendicectomy were also considered in the study. Total 50 cases of acute appendicitis were considered in the study after patients consent was sought and obtained. Finally an analysis was done to correlate the sensitivity and specificity of total leukocyte count and CRP in diagnosing acute appendicitis. The histopathological report was used to confirm the diagnosis of acute appendicitis. Ethical clearance for the study was sought and obtained from the concern institution.

### Inclusion criteria

All patients above the age of 15 years diagnosed clinically to have acute appendicitis and subjected to appendicectomy in M.S.Ramaiah Hospitals, Bangalore [Table/Fig-1 & 2].

### Exclusion criteria

1. Patients with history of recurrent pain in right iliac fossa.
2. Patients with appendicular mass or peritonitis.
3. Concomitant conditions where CRP or Leukocyte Count is elevated.

## RESULTS

Out of 50 patients who underwent appendicectomy, 48% came with chief complaints of pain in the periumbilical region migrating to the right iliac fossa. The mean age of presentation was 29.84 years. Increased leucocyte count was seen in 88% cases [Table/Fig-3], and CRP in 80% [Table/Fig-4]. Among the clinical symptoms, abdominal pain was present in all patients (100%), anorexia in 45(90%) patients, migration of the pain in right iliac fossa 24(48%), vomiting in 21(42%), fever in 25

Age in years	No. of patients	Percentage (%)
16-20	6	12.0
21-30	27	54.0
31-40	10	20.0
41-50	4	8.0
>50	3	6.0
Total	50	100.0

[Table/Fig-1]: Distribution of age groups among the patients studied.

patients (50%). Acute appendicitis was more commonly seen in male patients (40 patients).

The most common per operative finding was acutely inflamed appendix (80%), gangrenous appendix (6%), normal appendix (10%) and followed by perforated appendix (4%). The entire resected appendix specimen was sent for HPE examination. However, histopathological changes suggestive of acute appendicitis was seen in 90% of the cases and Normal histology was seen in 10% of the cases [Table/Fig-5]. Correlation of the increased TLC (total leukocyte count) and increased CRP (C - reactive protein) with histopathological changes suggestive of acute appendicitis was done and tabulated. In our study, we observed that TLC has highest sensitivity and specificity (95.56%, 80.0%) followed by USG (95.56%, 60%) and CRP count (88.89%, 80.0%)

Clinical features	Gender		Total (n=50)
	Female (n=10)	Male (n=40)	
Guarding	5(50%)	22(55%)	27(54%)
Pulse rate	5(50%)	20(50%)	25(50%)
Temperature	5(50%)	20(50%)	25(50%)
Rovsing's sign	0(0%)	3(7.5%)	3(6%)
Tachycardia	6(60%)	14(35%)	20(40%)
TLC	10(100%)	34(85%)	44(88%)
Differential leucocyte count	7(70%)	34(85%)	41(82%)
C-Reactive Protein	8(80%)	32(80%)	40(80%)
Rebound tenderness	7(70%)	28(70%)	35(70%)
PSOAS test	1(10.0%)	0	1(2.0%)

[Table/Fig-2]: Signs and symptoms of the presenting patients.

TLC	Histopathological Examination Report		Total
	Acute appendicitis	Normal appendix	
Positive	43(95.6%)	1(20.0%)	44(88.0%)
Negative	2(4.4%)	4(80.0%)	6(12.0%)
Total	45(100.0%)	5(100.0%)	50(100.0%)

[Table/Fig-3]: TLC values among the patients studied.

CRP	Histopathological Examination Report		Total
	Acute appendicitis	Normal appendix	
Positive	39(86.7%)	1(20.0%)	40(80.0%)
Negative	6(13.3%)	4(80.0%)	10(20.0%)
Total	45(100.0%)	5(100.0%)	50(100.0%)

[Table/Fig-4]: CRP values among the patients studied.

Histopathological Examination Report	Gender		Total
	Female	Male	
Acute appendicitis	9(90%)	36(90%)	45(90%)
Normal appendix	1(10%)	4(10%)	5(10%)
Total	10(100%)	40(100%)	50(100%)

**[Table/Fig-5]: Histopathological reports of the resected specimen.**

When all the three tests are combined (either/all) the sensitivity, specificity, positive predictive value and predictive value of negative test increases significantly ( $p\text{-value} = 0.0052$ ). It was observed that when all the three tests were negative, appendicitis could be safely ruled out and surgery can be deferred in these patients.

## DISCUSSION

Although the incidence of Acute appendicitis appears to have been waning slightly over the past few decades, it remains a frequent cause of acute abdominal pain and urgent operative intervention. The analysis of a patient with possible appendicitis can be divided into 3 parts: history, physical examination, and routine laboratory and radiological tests. Almost one-third of patients have atypical clinical features. The wide use of ultra sonography and computer tomography scan has not effectively decreased the rate of perforated appendicitis or number of negative appendectomies in large population studies.

In acute appendicitis, TLC and neutrophil counts are the most frequently used laboratory tests. Most of the studies conclude that 60-90 % of all patients with acute appendicitis have total and differential leucocyte counts suggestive of the diagnosis [1]. CRP is an acute phase reactant, synthesized by liver which exhibits an exponential rise in serum concentration within eight hours in bacterial infection [2,3]. It also appears in the sera of individuals in response to a variety of inflammatory conditions and tissue necrosis.

Many reports have investigated the value of CRP in improving the diagnostic accuracy of acute appendicitis with conflicting results [4,5]. CRP was identified in 1930 by Tillet and Francis and is regarded as the acute-phase protein. It has been studied as a screening device for inflammation, a marker for disease activity and as a diagnostic adjunct. Physiologically, CRP enhances cell-mediated immunity by promoting phagocytosis, accelerating chemotaxis and activating platelets. CRP is a reliable early indicator of inflammation or injury [6,7]. C-reactive protein (CRP) was first found in the serum of patients suffering from pneumonia caused by *Streptococcus pneumoniae*. Together with other acute phase-proteins, the serum level of CRP (C - reactive protein) rises in response to any tissue injury [8]. It also increases in response to infections (bacterial

and viral) and in non-infectious conditions like myocardial infarction, malignancies and rheumatic disorders. The levels of CRP (C-reactive protein) usually increase around 8 hours after the onset of injury and usually reach their peak levels around 2-4 days and are found to be elevated as long as there is persisting infection or injury [9]. Due to its short half-life (4-7 hours) serum CRP (C-reactive protein) concentration rapidly declines as the acute inflammatory process subsides. There have been many studies which have evaluated the association of raised CRP (C-reactive protein) levels in acute appendicitis, but with conflicting results [10].

Acute uncomplicated appendicitis is associated with total Leukocyte Count ranging around 10,000-18,000 cells and usually remains in this range. Complicated appendicitis involving perforation or gangrenous changes is associated with counts more than 18,000 cells [11].

In a study conducted by Khurana Siddeque et al., [12], it was found that total leucocyte count had a higher diagnostic accuracy and higher sensitivity than CRP in diagnosing simple acute appendicitis. The combined sensitivity of WCC and CRP increased to 95% and 100% for the diagnosis of simple acute appendicitis and a perforated appendix, respectively.

In a study conducted by Shefki Xharra, et al., [13]. The raised value of the CRP was directly related to the severity of inflammation ( $p\text{-value} < 0.05$ ). The WBC was altered in 77.5% of the cases, C-reactive protein in 76.9% cases. CRP monitoring enhances the diagnostic accuracy of acute appendicitis. The diagnostic accuracy of CRP is not significantly greater than WBC and a combination of these three tests significantly increases the accuracy. We found that elevated serum CRP levels support the surgeon's clinical diagnosis. But there were conflicting studies. Sengupta et al., noticed that, no patients with WCC and CRP both in the normal range had acute appendicitis. They concluded that raised WCC and CRP were poor positive predictors of appendicitis, both alone and in combination, and correlated poorly with the development of complications [14]. Amalesh et al., in their study found out specificity and sensitivity of serum CRP was 42% and 91% respectively. The predictive value of a positive (raised CRP) and negative (normal CRP) test was 88% and 48% respectively. They concluded that neither raised nor normal CRP value is helpful in the diagnosis of acute appendicitis [15].

In our study, serum CRP estimation in diagnosis of acute appendicitis yielded a sensitivity of 86.67%, specificity of 80%, positive predictive value of 97.50%, predictive value of negative test was 40%.

## LIMITATION

There is no information regarding the time duration of right iliac fossa pain present in our patient.

-No information regarding patients who underwent negative appendectomy.

## CONCLUSION

Even though there are many investigative modalities, good history and thorough clinical examination by the treating Clinician is the most important aspect in diagnosing Acute Appendicitis.

From our study, we can conclude that the patients who are clinically diagnosed to have acute appendicitis in right iliac fossa pain should undergo TLC and CRP blood tests as it reduces the rate of negative appendectomy.

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