# Role of C-reactive Protein, Leucocyte and Neutrophil Count in Diagnosis of Acute Appendicitis

Iqbal MF[1], Chowdhury AI[2], Aziz SR[3]

**DOI:** https://doi.org/10.3329/jafmc.v17i1.56717


## Abstract

***Introduction:*** Acute appendicitis is the most common cause of surgical acute abdomen and appendicectomy is the most commonly done surgery. Accurate preoperative diagnosis can reduce negative appendicectomy rate.

***Objective:*** To evaluate the diagnostic accuracy of C-reactive protein (CRP), total leucocyte count (TLC) and neutrophil count in patients operated after clinical diagnosis of acute appendicitis.

***Materials and Methods:*** This cross-sectional observational study was conducted among 100 patients at Combined Military Hospital, Dhaka from August 2012 to January 2013. Serum CRP level was measured by latex agglutination method which is a qualitative test and level of 6 mg / L was considered positive. TLC and neutrophil count were estimated by processing blood sample through automated haematology analyzer. TLC level of 10.5 x 109/L and differential count of neutrophil more than 75% were considered elevated.

***Results:*** Out of 100 cases the mean age of the patients was 21.7 years and 65 patients were male and 35 patients were female with male to female ratio 1.85:1. Majority cases (54%) were in the age group of 11-20 years. Clinical diagnosis was correct in 93% cases and negative appendicectomy rate was 07% ($p<0.001$). Appendix was found mostly inflamed (83%) and gangrenous (10%). CRP was highly sensitive (84.9%) and specific (85.7%) with diagnostic accuracy of 85%. TLC was also found equally sensitive and specific with diagnostic accuracy of 83%. Overall diagnostic accuracy of neutrophil was 76%.

***Conclusion:*** Diagnosis of acute appendicitis is essentially clinical supported by simple laboratory investigations like TLC and neutrophill count. Elevated levels of CRP, TLC and neutrophill count are helpful in confirming a suspected diagnosis of acute appendicitis. Appendicitis is very unlikely if the CRP, TLC and neutrophill counts are normal.


***Key-words:*** Acute appendicitis, C-reactive protein, Total leucocyte count , Neutrophill count.

## Introduction

Acute appendicitis accounts for the commonest indication for emergency visits during daily surgical practice, and appendectomy is the most common emergent operative procedure performed worldwide[1]. Lifetime risk of having acute appendicitis is 8.6% and 6.7% for men and women respectively[2].

Acute appendicitis when presenting in a teenager with classical history poses little diagnostic challenge. However the disease is notorious for its ability to simulate other conditions. It is often and reasonably said that, to remove a normal appendix when some other condition, which does not require surgery is present is not blameworthy. In general this is true, because to do so guards against the other error of failing, on account of confusing the diagnosis with something else and then having to remove the appendix at a later stage in the face of greater risk of complications, morbidity and even death[3]. Advances have been made in diagnostic modalities, yet the surgeon's clinical acumen is put to test in almost 30-40 % of patient population[4]. This raises the rate of negative appendicectomies to around 20%.

The major part in diagnosis of acute appendicitis is made by the patient's history, physical examination along with few supportive investigations like the total leucocyte count (TLC). Different scoring systems like Alvarado and Ohmann score have been devised to achieve more accuracy in diagnosis[5,6]. A certain diagnosis can only be obtained at surgery and after histopathological examination of appendix[7]. Recently, interest has grown in other inflammatory markers which could be helpful in diagnosing acute appendicitis. C-reactive protein (CRP), produced by hepatocytes is an acute phase protein indicating acute inflammation. Although it is a non-specific test, yet many authors recognized CRP to play a significant role in diagnosis of acute appendicitis[8]. With clinically suggestive signs, if CRP can be added to already existing laboratory tests, the diagnosis of acute appendicitis can be made with fair degree of accuracy and as such unnecessary appendicectomies can be avoided[9]. It has been suggested that combination of CRP, TLC and differential count of neutrophil has 100% sensitivity and 50% specificity in the diagnosis of acute appendicitis[10].

## Materials and Methods

It is a cross-sectional observational study of 100 cases to evaluate role of CRP, TLC and neutrophil count in the diagnosis of acute

1. **Lt Col Mohammad Faruq Iqbal**, MBBS, FCPS, Classified Specialist in Surgery, CMH, Savar, (*E-mail*: faruqiqbal79@gmail.com) 2. **Maj Arif Imtiyaz Chowdhury**, MBBS, DA, Graded Specialist in Anesthesiology, CMH, Savar 3. **Maj Sharkar Rushdi Aziz**, MBBS, Medical Officer, CMH, Savar.

appendicitis in the Department of Surgery, CMH Dhaka from August 2012 to January 2013. The present study used non random purposive sampling method. All patients clinically diagnosed as acute appendicitis and underwent emergency appendicectomy was included in the study. Patients with appendicular mass/ abscess and not treated with appendicectomy were excluded from the study, Patients with known co-morbidity which increases serum CRP (Rheumatoid arthritis, SLE, Gout, Inflammatory bowel disease etc) also excluded from the study. Written informed consent was taken from each patient. Prior to consent they were explained the aim and purpose of the research. Confidentiality was assured and anonymity was maintained. No participant was identified in any report or publication under this study. Data was analyzed by computer based program SPSS 16.0 for windows. Means was compared by independent sample t-test for continuous data, "chi-square" test for categorical data and p value of less than 0.05 was considered significant.

## Results

Mean age of the patients was 20.7±6.7 years. Majority cases (54%) were in the age group of 11-20 years followed by the age group of 21-30 years (36%) and only one patient has the age of less than 10 years. Number of male patients were 65 and female were 35 (Table-I). Histopathological report of most of the cases (82%) was consistent with acute appendicitis. Acute appendicitis with perforation was found in 10% cases. Normal appendix was seen in 7% cases (Figure-1). Ratio of histopathological positivity and negativity in male and female patients were 15.3:1 and 10.3:1 respectively (Table-II).

For CRP; sensitivity= 84.9%, specificity= 85.7%, positive predictive value= 98.8%, negative predictive value= 30% and diagnostic accuracy= 85%. For TLC; sensitivity= 82.7%, specificity= 85.7%, positive predictive value= 98.8%, negative predictive value= 27.2% and Diagnostic accuracy= 83%. For neutrophil count; sensitivity= 74.9%, specificity= 100%, positive predictive value= 100%, negative predictive value= 22.4% and diagnostic accuracy= 76%. For CRP and TLC combined; sensitivity= 95.7%, specificity= 42.8%, Positive predictive value= 95.7%, negative predictive value= 42.8% and diagnostic accuracy = 92% (Table-III).

**Table-I:** Age and sex distribution of patients (n = 100)

| Age group (Years) | Male | Female |
|---|---|---|
| 0-10 | 00 | 01 |
| 11-20 | 31 | 23 |
| 21-30 | 26 | 10 |
| 31-40 | 08 | 01 |
| Total | 65 | 35 |

**Table-II:** Correlation of sex to histopathologically positive and negative cases (n = 100)

| | | Histopathology | | Ratio |
|---|---|---|---|---|
| | | Positive | Negative | |
| Sex | Male | 61 | 04 | 15.3:1 |
| | Female | 32 | 03 | 10.3:1 |
| Total | | 93 | 07 | 13.3:1 |

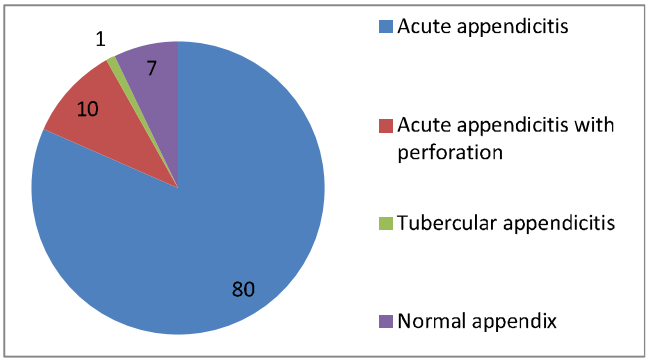


**Figure-1:** Histopathological findings of resected appendix (n = 100)

**Table-III:** Predictive value of CRP, TLC, neutrophil count and combined CRP & TLC in the diagnosis of acute appendicitis (n=100)

| | | Histopathology | | |
|---|---|---|---|---|
| | | Positive | Negative | Total |
| CRP | Positive | 79 (TP) | 01 (FP) | 80 |
| | Negative | 14 (FN) | 06 (TN) | 20 |
| | Total | 93 | 07 | 100 |
| TLC | Positive | 77 (TP) | 01 (FP) | 78 |
| | Negative | 16 (FN) | 06 (TN) | 22 |
| | Total | 93 | 07 | 100 |
| Neutrophil count | Positive | 69 (TP) | 00 (FP) | 69 |
| | Negative | 24 (FN) | 07 (TN) | 31 |
| | Total | 93 | 07 | 100 |
| Combined CRP & TLC | Positive | 89 (TP) | 04 (FP) | 93 |
| | Negative | 04 (FN) | 03 (TN) | 07 |
| | Total | 93 | 07 | 100 |

*Note: TP = true positive, FP = false positive, FN = false negative, TN = true negative*

## Discussion

Appendicitis is common in younger age group, though it can occur in any age. In our study mean age was 21.7 years. Patient age ranged from 09 to 39 years. The findings were similar to the study conducted by Ali N et al and Dholia KM et al in which mean age of the patients was 21.7 years and 26 years respectively[11,12]. The maximum number of patients was found in the age group of 11-20 years (54%) followed by the age group of 21-30 years (36%), total 90% in age group 11-30 years. These findings were supported by study conducted by Dholia KM et al (74%) and Agrawal CS et al (59.2%). The number of patients below 10 years and above 30 years was few[11-14]. Incident of acute appendicitis is variable in both sexes. In this study 65 patients were male and 35 patients were female with male female ratio of 1.9:1. The finding was similar to

the study conducted by Iqbal J et al in which male was 62 and female was 38 with male female ratio of 1.6:1[13]. But the finding was dissimilar to the study conducted by Dholia KM et al in which male female ratio was 3.1:1[12].

The negative appendicectomy rate was 07% in this study which was quite variable in different studies ranging from 8-30%. Similar results were reported by Ali N et al (08%) Dholia KM et al (10%) and but far variable to the finding of Agrawal CS et al (28%)[11,12,14]. Histopathological report revealed acute appendicitis in 93 (93%) cases. Among them 07 cases also had associated peritonitis and in one case, tuberculosis was the cause of appendicitis. Appendix was found inflamed in 83% cases, gangrenous in 10% cases, perforated in 04% cases and normal in 03% cases which was comparable with study conducted by Dholia KM et al (80%, 02%, 08% and 10%)[12]. Anatomical position of appendix was recorded in the study. Appendix was found retrocaecal in 68% cases followed by pelvic in 21% cases which were partially supported by study conducted by Dholia KM et al (87%, 02%)[12]. In this study, none of the cases with appendicular perforation had normal CRP. This observation is supported by the study done by Gronroo's M and Gronroo's P[15]. In this study, 14% of cases had normal CRP level even though histopathology was positive. In 01 patient, CRP was raised though histopathology was negative. CRP values were found to increase with an advancing stage of the appendicaecal inflammation found at operation.

In this study, all the cases which were histopathology negative had normal CRP level except one. In this study sensitivity and specificity of CRP were 84.9% and 85.7% respectively indicating high association between CRP and acute appendicitis ($p<0.0001$). Sensitivity and specificity of other studies, Ali N et al (84.6%, 90.9%). Dholia KM et al (93.4%, 79.1%)), Iqbal J et al (76.5%, 98.2%) Kyriadis AV et al (97.2%, 99.4%) and Shafi SM et al (97.8%, 55.5%) were similar to this study but sensitivity and specificity were found lower in studies conducted by Al Saigh AH et al (76.3%, 39.7%) and Agrawal CS et al (74.8%, 66.7%)[11-14, 16-18]. Positive predictive value, negative predictive value and diagnostic accuracy of CRP were 98.75%, 30% and 85% respectively which was comparable with the studies Conducted by Ali N et al (97.1%, 62.5%, 86%), Iqbal J et al (95.1%, 68.4%, 84%) and Agrawal CS et al (84.9%, 51.9%, 78.4%)[11,13,14].

On correlating TLC with histopathology positive and negative cases it was found that the Sensitivity and specificity of the TLC count was 83.3% and 85.7% respectively. It was comparable with the studies done by Ali N et al (74.4%, 72.7%) and Agrawal CS et al (78.6%, 54.8%) indicating high association between TLC count and acute appendicitis ($p<0.0001$)[11,14]. Positive predictive value, negative predictive value and diagnostic accuracy of TLC were 98.8%, 27.2% and 83% respectively which was comparable with the studies conducted by Ali N et al (90.6%, 44.4%, 74%), Iqbal J et al (95.8%, 48.3%, 82%) and Agrawal CS et al (81%,51.1%,71.7%)[11,13,14]. In this study, Neutrophilia of more than 75% was seen in 69% of cases. It is comparable with other studies done by, Marchand (81%), Verma (75%) and Yang (88%)[10,19,20]. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were 74.2%, 100%, 100%, 22.4% and 76%. None of the cases with histopathology negative report had raise in neutrophil count. This indicates that there was high association between raised nentrophil count and acute appendicitis ($p<0.001$).

In this study correlation between total leucocyte count and C-reactive protein in combination with histopathologically positive and negative cases was observed. The sensitivity and specificity were 90.4% and 100% respectively. Positive predictive value, negative predictive value and diagnostic accuracy were 100%, 28.5% and 90% respectively ($p<0.001$). The findings were comparable to study conducted by Ahmad QA et al in which study sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were 50% ,100%, 100%, 50%and 66% respectively[21]. Sensitivity and diagnostic accuracy of triple screening test (raised CRP, TLC and neutrophil count) were found 95.7% and 93% respectively. Yang HR et al found similar result with 99.2% sensitivity[20].

## Conclusion

Diagnosis of acute appendicitis is essentially clinical supported by simple laboratory investigations. CRP, TLC and neutrophil counts are useful in the diagnosis of acute appendicitis. CRP and TLC are almost equally sensitive in diagnosis of acute appendicitis. High CRP level is associated with complicated cases of appendicitis. This study suggests that negative appendicectomy rate can be decreased, if not completely avoided in cases where all three tests are negative.

## References

1. Ingraham AM, Cohen ME, Bilimoria KY et al. Comparison of outcomes after laparoscopic versus open appendectomy for acute appendicitis at 222 ACS NSQIP hospitals. Surgery. 2010; 148(4):625-35; discussion 635-7.
2. Flum DR, Koepsell TD. Evaluating diagnostic accuracy in appendicitis using administrative data. The Journal of surgical research 2005; 123(2):257-61.
3. Brown SP. Diagnosis. In: Ellis BW, Brown SP, editors. Hamilton Bailey's Emergency Surgery. 13th ed. New York: Arnold; 2000: 301, 399-400.
4. Anderson R, Hugander A, Ghazi S. Diagnostic value of disease history, clinical presentation and inflammatory parameters of appendicitis. World J Surg 1999; 23:133¬40.
5. Eryilmaz R, Sahin M, Alimoglu O et al. The value of C-reactive protein and leukocyte count in preventing negative appendicectomies. Ulus Travma Derg. 2001; 7:142-45.
6. 0' Connel PR. The Vermiform appendix. In: Russel RCG, williams NS, Bulstrode CJK, editors. Baily & Love's Short practice of surgery. 25th edn London: Arnold; 2008:1214.

7. Dado G, Anania G, Baccarani U et al. Application of a clinical score for the diagnosis of acute appendicitis in childhood. J Pediatr Surg. 2000; 35:1320-2.

8. Khan MN, Davie E, Irshad K. The role of white cell count and C-reactive protein in the diagnosis of acute appendicitis. J Ayub Med Coll. 2004; 16:17-9.

9. Bhopal SG, Ahmed BSG, Ahmed M et al. Role of TLC and C-reactive protein in the diagnosis of acute appendicitis. J Surg Pak. 2003; 8:14-7.

10. Marchand A, Van Lente F, Galen RS. The assessment of laboratory tests in the diagnosis of acute appendicitis. Am J Clin Pathol 1983; 80(3): 369-74.

11. Ali N, Rasul S, Mehmood Z et al. the value of total leucocyte count and C-reactive protein in the diagnosis of acute appendicitis. Journal of Surgery Pakistan (International) 2009; 14(4):153-6.

12. Dholia KM, Baloch I, Shaikh SA et al. Total and differential lencocyte count in cases of acute appendicitis. Medical Channel. 2010; 16(2):284-6.

13. lqbal J, Afzal M, Sami F, Rehan AG. C-reactive protein; A diagnostic tool for acute appendicitis. APMC Journal. 2007; 1(1):37-42.

14. Agrawal CS, Adhikari S , Kumar M . Role of serum C- reactive protein and leukocyte count in the diagnosis of acute appendicitis in Nepalese population. Nepal Med Coll. J 2008; 10(1): 11-5

15. Gronroos M and Gronroos P. leucocyte count and C-reactive protein in the diagnosis of acute appendicitis. BJS. 1999; 86: 501-4.

16. Kyriakidis AV, Alexandris I, Papoulia E et al. C-reactive protein: Diagnostic aid in right lower quadrant abdominal pain. Annals of Gastroenterology. 2010; 23(4):307-10.

17. Shafi SM, Afsheen M, Reshi FA. Total leucocyte count, C-reactive protein and neutrophil count: Diagnostic aid in acute appendicitis. Saudi J Gastroenterol. 2009; 15(2):117-20.

18. Al - Saigh AH. C-reactive protein in the differential diagnosis of the acute abdomen especially acute appendicitis. J R Coll Surg Edinb. 1992; 37(4): 238-40.

19. Verma A, Mehta FS, Vyas KC et al. C- reactive protein in acute appendicitis. Indian Journal of Surg. 1995:273-75.

20. Yang HR, Wang YC, Chung PK et al. Role of leucocyte count, neutrophil percentage and c-reactive count in the diagnosis of acute appendicitis in the elderly. Am Surg. 2005; 71(4):344-47.

21. Ahmad QA, Muneera MJ, Rasool MI. Predictive Value of TLC and CRP in the Diagnosis of Acute Appendicitis. ANNALS. 2010; 16(2):116-19.