

# Evaluation of C-reactive Protein as an Additional Marker in the Diagnosis of Acute Appendicitis in a Tertiary Care Hospital

Rakesh Fernando<sup>1</sup>, J Jason Sam Paul<sup>2</sup>, G Nirmal Kumar<sup>1</sup>, P Senthil Arumugam<sup>1</sup>, J A Jeyalal<sup>3</sup>

<sup>1</sup>Associate Professor, Department of General Surgery, Thoothukudi Government Medical College, Thoothukudi, Tamil Nadu, India, <sup>2</sup>Assistant Professor, Department of General Surgery, Thoothukudi Government Medical College, Thoothukudi, Tamil Nadu, India, <sup>3</sup>Professor, Department of General Surgery, Tirunelveli Government Medical College, Tirunelveli, Tamil Nadu, India

## Abstract

**Introduction:** Acute appendicitis is the most common abdominal surgical emergencies. A comprehensive history with detailed clinical examination, scoring systems, imaging modalities, and laboratory investigations aids in the early diagnosis of acute appendicitis. Recently, C-reactive protein (CRP) has been shown to be an emerging marker in predicting the severity of acute appendicitis.

**Aim:** This study aims to evaluate the CRP levels as a predictive tool in diagnosis of acute appendicitis and appendicular perforation.

**Methods:** One hundred patients of age above 13 years, who were diagnosed, admitted and operated as a case of acute appendicitis with histopathological evidence of either acute appendicitis or appendicular perforation. Cases were selected by purposive sampling. Correlation of CRP levels with Alvarado score, total counts, neutrophils, appendicular diameter, duration of hospital stay, and post-operative complications was done.

**Results:** The mean value of CRP in acute appendicitis was 13.06 mg/dl and in appendicular perforation was 36.95 mg/dl. There was a strong statistical correlation between CRP and Alvarado's score in diagnosing acute appendicitis and appendicular perforation. CRP values have been identified statistically using a 95% confidence value with the range of 9–17.12 mg/dl in acute appendicitis and 30.90–42.99 mg/dl in appendicular perforation. The surgical cutoff for appendicitis was >9 mg/dl. There was a very high statistically significant correlation between CRP and prolonged hospital stay by Pearson's correlation curve.

**Conclusion:** CRP levels can be considered for the diagnosis and choice of the treatment of appendicitis. Diagnostic precision of acute appendicitis has been increased significantly with the use of CRP. The current study suggests that CRP helps in the prediction of the severity of appendicitis for treatment and a high frequency of development of post-operative complications with high pre-operative CRP values.

**Key words:** Appendicitis, C-reactive protein, Inflammatory marker

## INTRODUCTION

Appendicitis is an inflammation of appendix vermiformis. Appendices vermiformis arises from the cecum on the posteromedial aspect at around 2 cm below the terminal

ileum. It is seen almost exclusively in humans and higher primates. Occasionally, it may be absent in humans.<sup>[1]</sup>

Acute appendicitis is one of the most common surgical emergencies encountered worldwide. In many instances, it causes a diagnostic dilemma among clinicians. Early and accurate diagnosis of acute appendicitis is often necessary which decreases the mortality and morbidity in the patients.<sup>[2]</sup> Recent advances in imaging and laboratory studies have helped clinicians to diagnose appendicitis at an earlier stage of presentation. However, there are instances where the diagnosis of acute appendicitis is inconclusive. Negative appendectomy rates have been reported to be as high as

Access this article online



www.ijss-sn.com

Month of Submission : 04-2021  
Month of Peer Review : 04-2021  
Month of Acceptance : 05-2021  
Month of Publishing : 06-2021

**Corresponding Author:** Dr. G Nirmal Kumar, Department of General Surgery, Thoothukudi Government Medical College, Thoothukudi, Tamil Nadu, India.

15–20% in the literature.<sup>[3]</sup> C-reactive protein (CRP) has been shown to be an emerging marker in predicting the severity of acute appendicitis.<sup>[4]</sup> A comprehensive history with detailed clinical examination, scoring systems such as Alvarado score, RIPASA score, appendicitis inflammation response score along with imaging modalities, and laboratory investigations such as total count, differential count, and CRP aids in the early diagnosis of acute appendicitis. It also decreases the rate of negative appendicectomies, thereby reducing unwarranted surgical intervention.<sup>[5]</sup>

### Aim

This study aims to evaluate the CRP levels as a predictive tool in diagnosis of acute appendicitis and appendicular perforation.

## MATERIALS AND METHODS

It is a prospective descriptive study done from November 2017 to August 2019 in the Department of General Surgery, Tirunelveli Medical College, Tirunelveli. Our study population was 100 patients who were diagnosed, admitted, and operated on as a case of acute appendicitis with histopathological evidence of either acute appendicitis or appendicular perforation. Cases were selected by purposive sampling. Inclusion criteria: Patients above the age of 13 years, who are clinically diagnosed as acute appendicitis in the emergency ward, operated with histopathological evidence of acute appendicitis or appendicular perforation. Exclusion criteria: Patients with age <13 years, appendicular mass, history of trauma to the right iliac fossa, pregnant females, and patients with any other comorbidities that may cause elevated CRP were excluded from the study.

After getting clearance from the Ethical Committee and informed written consent in the native language of the patient, details of the patients who are diagnosed as acute appendicitis and operated, with histopathological diagnosis of acute appendicitis or appendicular perforation were entered into the questionnaire. Ultrasound of the abdomen and blood samples was obtained from the patients for the measurement of complete hemogram and CRP before surgery. After surgery, the histopathological report of the patient was obtained from the pathology department to look for evidence of acute appendicitis or appendicular perforation.

Data collected from the questionnaire were entered using Numbers software. Statistics was derived using SPSS 21 software. Descriptive data were tabulated in frequency, mean, and standard deviation. A comparison of continuous variables was done by one-way ANOVA. Correlation of CRP levels with Alvarado score, total counts, neutrophils,

appendicular diameter, and duration of hospital stay was done using Pearson correlation curve.

## RESULTS

In the present study, of the total 100 patients, 45 were male and 55 were female. The most common age group of presentation is 19–30 years followed by 13–18 years [Table 1]. About 63% of patients were diagnosed with acute appendicitis [Figure 1], with mean value of CRP in acute appendicitis is 13.06 mg/dl and in appendicular perforation is 36.95 mg/dl. About 95% confidence value for CRP is in the range of 9 mg/dl–17.12 mg/dl in acute appendicitis and 30.90 mg/dl–42.99 mg/dl in appendicular perforation [Figure 2]. Pearson correlation was statistically significant for CRP values with Alvarado score, total count, neutrophils, and duration of hospital stay and insignificant correlation was noted for sonological appendicular diameter [Figures 3–6]. Independent Student's *t*-test showed a statistically significant correlation between the development of post-operative complications with high pre-operative CRP values [Table 2].

## DISCUSSION

The mainstay of the treatment of appendicitis is surgical management. Conservative management of appendicitis in selected cases has also been documented.<sup>[6,7]</sup> On diagnosing a patient with appendicitis, the severity of appendicitis has to be ascertained before selecting optimal treatment. White blood cell counts, CRP, and neutrophil percentage can be used as predictors of management. This study aimed to evaluate whether CRP predicts the severity of appendicitis. The most common age group diagnosed with appendicitis is 19–30 years which is similar to the

**Table 1: Patient characteristics**

Characteristics	Frequency	Percentage
Age group		
<18	34	34.0
19–30	38	38.0
31–40	12	12.0
41–50	9	9.0
>51	7	7.0%
Gender		
Male	45	45.0
Female	55	55.0

**Table 2: Complications**

Complication	<i>n</i>	Mean	SD	<i>P</i> -value
Yes	28	41.61	19.27	<0.0001
No	72	14.24	15.06	

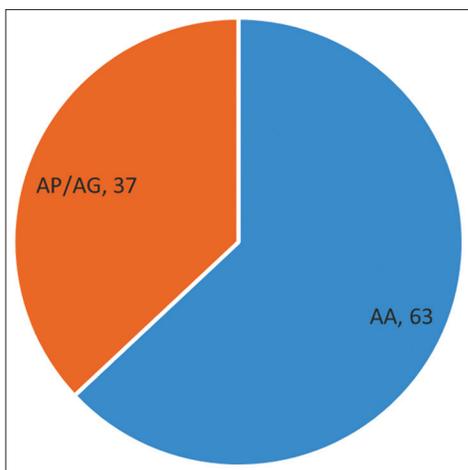


Figure 1: Diagnosis

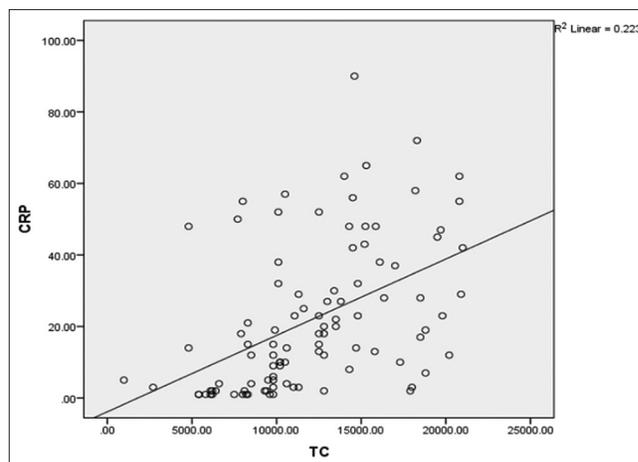


Figure 4: Correlation of C-reactive protein with total count

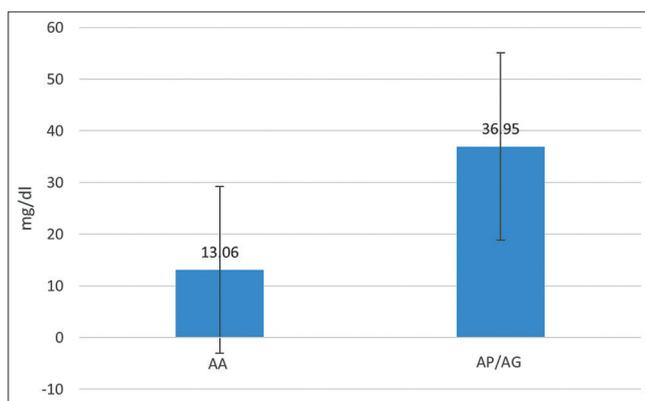


Figure 2: Diagnosis and C-reactive protein

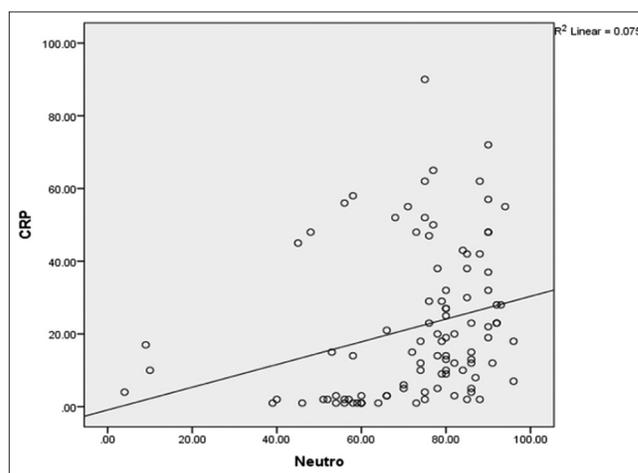


Figure 5: Correlation of C-reactive protein with neutrophil

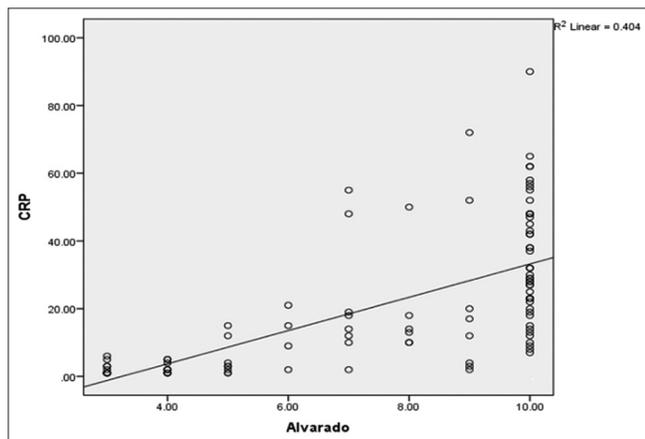


Figure 3: Correlation of C-reactive protein with Alvarado score

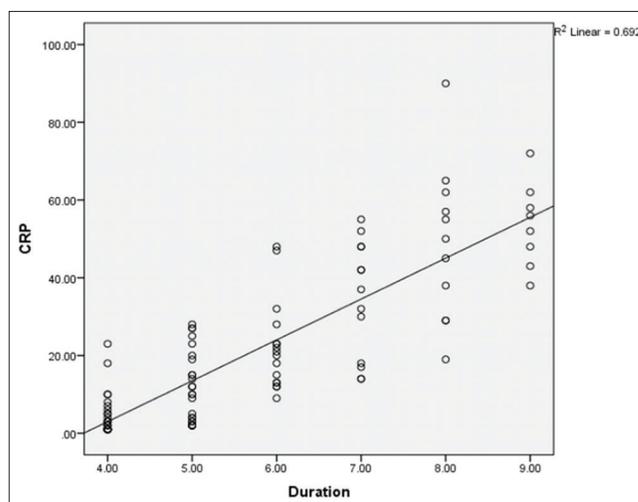


Figure 6: Correlation of C-reactive protein with duration of hospital stay

study done by Rathnam and Suggaiah.<sup>[6]</sup> The mean value of CRP in acute appendicitis was 13.06 mg/dl and in appendicular perforation was 36.95 mg/dl which was similar to the results by the study of Jangjoo *et al.*<sup>[7]</sup> and Wu *et al.*<sup>[8]</sup> As compared to the study by Dal *et al.*,<sup>[9]</sup> our study showed a strong statistical correlation between CRP and Alvarado score in diagnosing acute appendicitis and appendicular perforation. CRP values have been

identified statistically using a 95% confidence value with the range of 9–17.12 mg/dl in acute appendicitis and 30.90–42.99 mg/dl in appendicular perforation by our

study. Pearson correlation for CRP with Alvarado score, total counts, and neutrophils showed a strong correlation with Alvarado score, medium correlation with total count, and small correlation with neutrophil counts.

However, Pearson's for CRP with appendicular diameter in USG showed a statistically insignificant correlation. As per our study, the surgical cutoff for appendicitis is >9 mg/dl which is similar to the results of Yokoyama *et al.*<sup>[10]</sup> The results of this study also showed that there is a very high statistically significant correlation between CRP and prolonged hospital stay by Pearson's correlation curve. Further, independent Student's *t*-test compared CRP values with the development of complications and showed a statistical correlation of increased post-operative complications with increased pre-operative CRP values. This is similar to the results of the study done by Shelton *et al.*<sup>[11]</sup> These results suggest the consideration of the CRP level for the diagnosis and choice of the treatment of appendicitis. Diagnostic precision of acute appendicitis has been increased significantly with the use of CRP. CRP values are highly significant statistically in predicting acute appendicitis and appendicular perforation, at par with the time tested Alvarado score. The current study suggests that CRP helps in the prediction of the severity of appendicitis for treatment and the high frequency of development of post-operative complications with high pre-operative CRP values.

Hence, CRP can be a cost-effective investigation not only in predicting appendicular pathologies but also in anticipating post-operative complications.

## CONCLUSION

CRP could be a cost-effective easy method to aid clinicians in diagnosing appendicitis. A detailed history, clinical

examination, Alvarado scores to establish a diagnosis of appendicitis, along with CRP values will help in increasing the accuracy of diagnosing appendicitis and help in decreasing negative appendicectomy rates. Further, CRP can also be used as a predictor of morbidity and complications in patients undergoing appendicectomy. Grossly elevated CRP values warrant early referral to a tertiary center for expert management since complication rates are high in these patients.

## REFERENCES

1. Hodge BD, Kashyap S, Khorasani-Zadeh A. Anatomy, abdomen and pelvis, appendix. In: StatPearls. Treasure Island, FL: StatPearls Publishing; 2021. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK459205>. [Last accessed on 2020 Aug 10].
2. Humes DJ, Simpson J. Acute appendicitis. *BMJ* 2006;333:530-4.
3. Drake FT, Flum DR. Improvement in the diagnosis of appendicitis. *Adv Surg* 2013;47:299-328.
4. Sproston NR, Ashworth JJ. Role of C-reactive protein at sites of inflammation and infection. *Front Immunol* 2018;9:754.
5. de Castro SM, Ünlü C, Steller EP, van Wagenveld BA, Vrouwenraets BC. Evaluation of the appendicitis inflammatory response score for patients with acute appendicitis. *World J Surg* 2012;36:1540-5.
6. Rathnam U, Suggaiah L. C-reactive protein as a diagnostic tool in acute appendicitis. *Int Surg J* 2019;6:2386-9.
7. Jangjoo A, Varasteh AR, MehrabiBahar M, TayyebiMeibodi N, Aliakbarian M, Hoseinnejad M, *et al.* Is C-reactive protein helpful for early diagnosis of acute appendicitis? *Acta Chirurgica Belgica* 2011;111:219-22.
8. Wu HP, Lin CY, Chang CF, Chang YJ, Huang CY. Predictive value of C-reactive protein at different cutoff levels in acute appendicitis. *Am J Emerg Med* 2005;23:449-53.
9. Dal F, Cicek Y, Pekmezci S, Kocazeybek B, Tokman HB, Konukoglu D, *et al.* Role of alvarado score and biological indicators of C-reactive protein, procalcitonin and neopterin in diagnosis of acute appendicitis. *Turk J Trauma Emerg Surg* 2019;25:229-37.
10. Yokoyama S, Takifuji K, Hotta T, Matsuda K, Nasu T, Nakamori M, *et al.* C-Reactive protein is an independent surgical indication marker for appendicitis: A retrospective study. *World J Emerg Surg* 2009;4:1-5.
11. Shelton JA, Brown JJ, Young JA. Preoperative C-reactive protein predicts the severity and likelihood of complications following appendicectomy. *Ann R Coll Surg Engl* 2014;96:369-72.

**How to cite this article:** Fernando R, Paul JJS, Kumar GN, Arumugam PS, Jeyalal JA. Evaluation of C-reactive Protein as an Additional Marker in the Diagnosis of Acute Appendicitis in a Tertiary Care Hospital. *Int J Sci Stud* 2021;9(3):101-104.

**Source of Support:** Nil, **Conflicts of Interest:** None declared.