Original Article

Correlation of C-Reactive Protein to Alvarado Score and CT Scan in Diagnosing Acute Appendicitis

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ABSTRACT

Acute appendicitis is the most common cause of acute surgical abdomen. Early and accurate diagnosis is crucial to prevent complications. This study aimed to correlate C-reactive protein (CRP) levels with the Alvarado score and CT scan findings in diagnosing acute appendicitis.

This prospective observational study included 76 patients with suspected acute appendicitis. CRP levels, Alvarado scores, and CT scan findings were recorded. Statistical analysis was performed to assess the correlation between these parameters.

The results showed a strong positive correlation between CRP levels and Alvarado scores ($p < 0.0001$) and between CT scan findings and Alvarado scores ($p < 0.0001$). The mean CRP level was significantly higher in patients with acute appendicitis (24.47 ± 7.82 mg/L) compared to those with chronic appendicitis (7.38 ± 1.23 mg/L) ($p < 0.0001$). The study demonstrates that combining CRP levels with Alvarado scores and CT scan findings can enhance diagnostic accuracy, reducing negative appendectomies and ensuring timely treatment. The positive correlation between CRP levels and Alvarado scores suggests that CRP can be a valuable adjunct to clinical scoring systems.

This study demonstrates a positive correlation between CRP levels, the Alvarado score, and CT scan findings in diagnosing acute appendicitis. Combining these parameters may improve diagnostic accuracy and reduce unnecessary appendectomies. By integrating CRP levels with clinical scoring systems and CT scan findings, clinicians can make more informed decisions and improve patient outcomes. Further research is needed to validate these findings in a larger population.

INTRODUCTION

Acute appendicitis is the most common cause of acute surgical abdomen, with an estimated lifelong risk of 8.6% in men and 6.7% in women [1]. Appendectomy is generally accepted as a first-line treatment for non-complicated acute appendicitis. Reports have shown that preoperative radiographic evaluation has helped to decrease negative appendectomy rates from 20% to as low as 5% [2]. Computed tomography (CT) has been frequently used as an imaging modality in the evaluation of acute appendicitis and has improved the diagnostic ability leading to a significant reduction in the number of negative appendectomies. Computed tomography (CT) has been frequently used as an imaging modality in the evaluation of acute appendicitis and has improved the diagnostic ability leading to a significant reduction in the number of negative appendectomies [3].

In 1986, Alvarado presented a clinical scoring system on the basis of eight predictive clinical factors to improve the accuracy of physicians' clinical assessments in diagnosing acute appendicitis. This scoring system produces a maximum total score of 10 points and includes clinical symptoms (nausea and anorexia), signs (fever, shifting pain, right lower quadrant pain, and rebound tenderness), and laboratory findings (leukocytosis and neutrophilia). Right lower quadrant pain and leukocytosis contribute 2 points each while the rest contributes 1 point [4].

C – Reactive protein has been a measure of the acute phase reaction to inflammation for the last 20 years recently improved highly sensitive and standardised quantitative assay in serum and CSF have allowed a revaluation of its potential as a diagnostic laboratory test [5].

C-reactive protein is an abnormal serum glycoprotein produced by the liver during the acute inflammation. Because it disappears rapidly when the inflammation subsides its detection signifies the presence of a current inflammatory process.

In an age accustomed to early and accurate preoperative diagnosis acute appendicitis remains an enigmatic challenge. The goal of surgical treatment is removal of an inflamed appendix before perforation with a minimal number of negative appendectomies [6].

Many scoring system like Alvarado's score and Bayesian scoring have been used in diagnosing acute appendicitis [7].

Many studies have investigated the role of CRP in improving the diagnosis of acute appendicitis, with promising results [8-10].

There have only been a few limited studies correlating the diagnostic ability of Alvarado score, CT scan with C - reactive protein. This study aims to do just that.

METHODOLOGY

Acute Appendicitis was diagnosed by :

1. Presence of local inflammatory findings (McBurney's point tenderness, Rebound or Percussion tenderness, palpable mass and/or pain in right lower abdominal quadrant).

2. Systemic inflammatory findings (fever, Nausea and vomiting, tachycardia, tachypnoea and hypertension.)

3. Laboratory findings (Increased C-Reactive Protein, Neutrophilic Leucocytosis)

4. Specific finding for Acute Appendicitis on CT imaging (like dilated appendix with distended lumen of > 6mm, thickened and enhancing wall, thickening of the cecal apex, peri-appendiceal inflammation, extraluminal fluid, inflammatory phlegmon, abscess formation)

ALVARADO Score in these patients were calculated

Once diagnosis is confirmed with CT scan, the findings were correlated with CRP values and ALVARADO Score.

- **PRIMARY OUTCOME:** To assess the utility of serum CRP level as compared to ALVARADO Score and CT scan Findings in the diagnosis of acute appendicitis.

- **SECONDARY OUTCOME:** To utilize Serum C - reactive protein levels to reduce number of negative Appendicectomies.

Statistical Analysis:

Correlation was calculated by Pearson correlation analysis. The Pearson product-moment correlation coefficient was a measure of the linear dependence between two variables X and Y.

Explicit expressions that can be used to carry out various *t*-tests are given below. In each case, the formula for a test statistic that either exactly follows or closely approximates a *t*-distribution under the null hypothesis is given. Also, the appropriate degrees of freedom are given in each case. Each of these statistics can be used to carry out either a one-tailed test or a two-tailed test.

Once a *t* value is determined, a *p*-value can be found using a table of values from Student's t-distribution. If the calculated *p*-value is below the threshold chosen for statistical significance (usually the 0.10, the 0.05, or 0.01 level), then the null hypothesis is rejected in favour of the alternative hypothesis.

P-value $\leq$ 0.05 was considered for statistically significant.

RESULT

Difference of mean ALVARADO Score with CT scan Finding

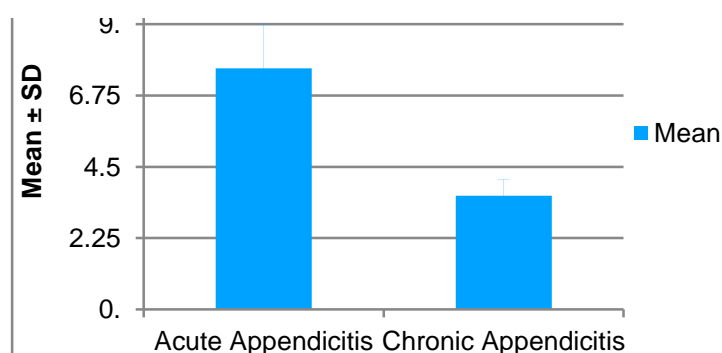*Table 1 Difference of mean ALVARADO Score with CT scan Finding*

	CT SCAN	Number	Mean	SD	Minimum	Maximum	Median	p-value
ALVARADO Score	Acute Appendicitis	64	7.6094	1.3641	3.0000	9.0000	8.0000	<0.0001
	Chronic Appendicitis	12	3.5833	.5149	3.0000	4.0000	4.0000	

In Acute Appendicitis on CT scan, the mean ALVARADO Score (mean ±s.d.) of patients was 7.6094 ±1.3641.

In Chronic Appendicitis on CT scan, the mean ALVARADO Score (mean ±s.d.) of patients was 3.5833 ±.5149.

Difference of mean ALVARADO Score with both CT Scan Findings was statistically significant (p<0.0001).

Table 2 Mean value of ALVARADO score in acute appendicitis and chronic appendicitis

Difference of mean CRP with CT scan Finding

Table 3 Difference of mean CRP with CT scan finding

|	CT SCAN	Number	Mean	SD	Minimum	Maximum	Median	p-value
CRP	Acute Appendicitis	64	24.4703	7.8169	8.2000	37.2000	25.0000	<0.0001
	Chronic Appendicitis	12	7.3833	1.2261	5.6000	9.6000	7.3500	

In Acute Appendicitis on CT Scan, the mean CRP (mean ±s.d.) of patients was 24.4703 ±7.8169.

In Chronic Appendicitis on CT Scan, the mean CRP (mean ±s.d.) of patients was 7.3833 ±1.2261.

Difference of mean CRP with both CT Scan Findings was statistically significant (p<0.0001).

Correlation of CRP: Alvarado Score

Table 4 Correlation of CRP with Alvarado score
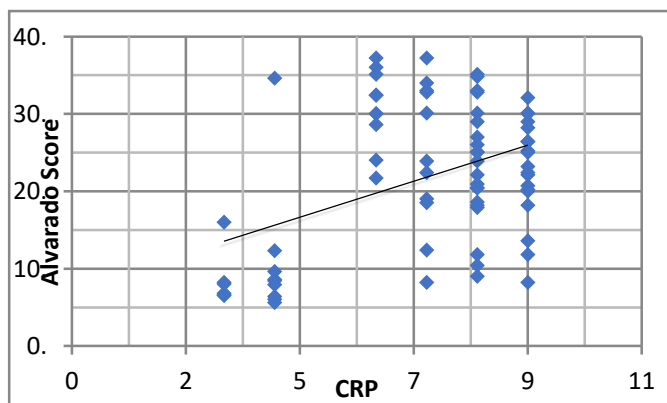
The value of R1 is 0.4217. The value of R2, the coefficient of determination, is 0.1778.

The P-Value is .000148. The result is significant at p < .05.

The Positive Correlation was found between CRP vs Alvarado Score.

DISCUSSION

In our study, most of the patients were present in age group 31-40years [24 (31.6%)]. Rest 19 (25.0%) patients were 21-30 years old; 8 (10.5%) patients were 41-50 years old; 17 (22.4%) patients were 51-60 years old and 8 (10.5%) patients were 61-70 years old. The mean Age (mean ± s.d.) of patients was41.5789 ± 13.5088years.

We found that in our study male population was higher [53 (69.7%)] than the female population [23 (30.3%)].

It was found that, most of the patients had Febrile Fever [63 (82.9%)] and only 13 (17.1%) patients had Afebrile Fever. 67 (88.2%) patients had Nausea and vomiting , 33 (43.4%) patients had Tachycardia, 30 (39.5%) patients had Tachypnoea & 49 (64.5%) patients had Neutrophilic Leucocytosis.

In our study, on CT scan most of the patients had Acute Appendicitis [49 (64.5%)] and only 12 (15.8%) patients had Chronic Appendicitis .

Our study showed that most of the patients had Acute (Superficial)Appendicitis in HPE [37 (48.7%)] , 17 (22.4%) patients had Acute (Phlegmonous, non-perforated) Appendicitis in HPE, 8 (10.5%) patients had Acute (Phlegmonous, perforated) Appendicitis in HPE, and 12 (15.8%) patients had Chronic Appendicitis in HPE.

Our study showed that in Acute Appendicitis, all patients [64 (100.0%)] had Acute Appendicitis as per CT scan Finding. In Chronic Appendicitis, all patients [12 (100.0%)] had Chronic Appendicitis as per CT scan Finding. It was statistically significant (p<0.0001).

We found that the mean CRP (mean ± s.d.) of Acute Appendicitis patients was significantly higher [24.4703± 7.8169] than the Chronic Appendicitis patients which was statistically significant (p<0.0001).

Table 3 Mean CRP in Acute Appendicitis and Chronic Appendicitis
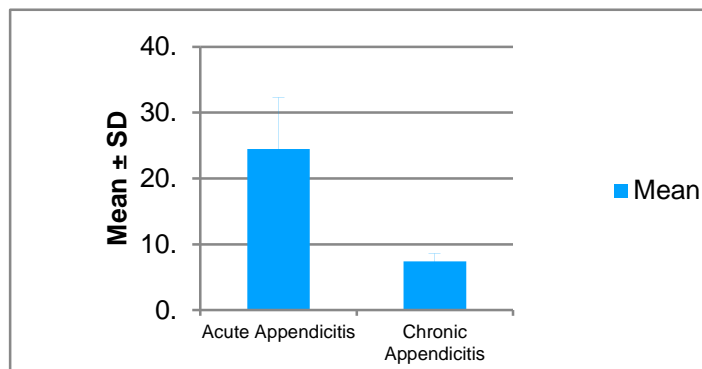
We also found that the mean TLC (mean ± s.d.) of Acute Appendicitis patients was higher [15403.1250± 4191.1459] than the Chronic Appendicitis patients [8037.5000± 1856.0864] and it was also statistically significant (p<0.0001).

Our findings were similar to other studies in literature [11-20].

This prospective, observational study was conducted in the department of General Surgery, Calcutta Medical Research Institute, Kolkata and Tata Motors Hospital, Jamshedpur, Jharkhand. This study was conducted for a period of 2 years. September 2019- August 2021. The source of data for study was 69 patients, admitting during period of 24 months commencing from September 2019, in the Department of general surgery, at Calcutta Medical Research Institute and Tata Motors Hospital. Adding 10% to make up for dropouts during the study, the sample size comes as 76.

All patients above the age of 18 years were included in this study with high clinical suspicion of an Acute attack of Appendicitis and patient with whole abdominal CECT as a part of protocol at CMRI HOSPITAL and TATA MOTORS HOSPITAL.

In our study a Positive Correlation was found between CRP vs. Alvarado Score in combination in diagnosing Acute Appendicitis with or without CT scan

The value of R is 0.4217. The P-Value is .000148. The result is significant at p < .05.

CONCLUSION

Acute appendicitis is a common gastrointestinal disease affecting individuals of all age groups each year with the highest incidence in children and adolescents. The variation of incidence is due to variations in ethnicity, sex, age, obesity and season of the year.

The aim of our study was to Correlate CRP to Alvarado Score and CT scan in Diagnosing Acute Appendicitis and to assess, on admission, whether C - reactive protein levels is a good predictor for Acute Appendicitis.

From our study we conclude that there was a Positive Correlation between CRP with Alvarado Score which was statistically significant

A positive correlation was found between CT scan findings and Alvarado score and between CRP and CT scan findings in favour of appendicitis which was statistically significant.

We concluded that using Alvarado score and CRP levels in combination with or without CT scan helps us to confirm or rule out acute appendicitis safely.

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