

To Determine the Diagnostic Accuracy of CRP and WCC in Non-Traumatic Acute Abdomen by Taking CT scan Findings as Gold Standard

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ABSTRACT

OBJECTIVE: To determine the diagnostic accuracy of C - Reactive Protein (CRP) and White Cell Count (WCC) in non-traumatic acute abdomen pathologies by taking CT scan findings as gold standard.

STUDY DESIGN: A retrospective analytic cross sectional study

PLACE AND DURATION: At Pinder fields Hospital Mid Yorkshire NHS Trust, over a period of 6 months from 1st January 2014 to 31st June 2014.

METHODOLOGY: All patients reporting to Emergency Department due to non-traumatic acute abdomen were included. Other than all basic demographic information, C- Reactive Proteins and White Cell Count within 24 hour of admission were recorded and its diagnostic value compared to the final diagnosis of all patients with CT scan. CRP > 5 mg/l and WCC <4 and >11 were taken as abnormal.

RESULTS: A total of 396 patients were studied, with mean age 59 years and male to female ratio was 1:1.5. Positive CT showing acute abdomen pathologies were 74.24% and 25.86% were negative. Abnormal WCC and Positive CT scan were found in 154 patients with Specificity of WCC 72% and Sensitivity of WCC 52%. The Pearson Chi-Square showing p-value < 0.001, which is highly significant i.e. there is a trend that abnormal WCC is associated with positive CT scan. The specificity and sensitivity of positive CT scan findings were 84% and 89-91% when CRP levels were more than 50 with normal or abnormal WCC. This reaches up to 97% with raised WCC and 100% with normal WCC.

CONCLUSION: C –reactive proteins more than 100 U/L has high diagnostic value and indication for CT scan or Surgery in diagnosing the exact cause of acute abdomen.

KEYWORDS: Non-Traumatic, Acute Abdomen, C- Reactive Proteins, White Cell Count, CT Scan, Diagnosis

HOW TO CITE THIS:

Ahmed S, Murtaza G, Aziz R, Ahmed I. To Determine the Diagnostic Accuracy of CRP and WCC in Non-Traumatic Acute Abdomen by Taking CT scan Findings as Gold Standard. *Isra Med J.* 2018; 10(6): 331-335.

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INTRODUCTION

The “acute abdomen “is defined as “sudden and severe

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Received for Publication: 05-03-18

1st Revision of Manuscript: 21-03-18

Accepted for Publication: 01-11-18

abdominal pain of unknown origin” and is a very common cause for presentation up to 10% in Emergency Departments all over the world^{1,2}. Variety of diseases can cause acute abdomen, ranging from mild and self-limiting to life-threatening pathologies or it can be classified into urgent or non-urgent causes. Urgent causes need prompt treatment (within 24 h) to minimize or prevent complications, whereas non-urgent causes does not require immediate treatment¹. The commonest urgent causes are acute appendicitis, acute diverticulitis, gut perforation, gut ischemia and bowel obstruction. Whereas the most common non-urgent causes of acute abdomen are nonspecific abdominal pain (NSAP) and gastro-intestinal diseases³. An early and precise diagnosis results in accurate management, which subsequently, leads to a better outcomes of the disease. Presentation of acute abdominal can be very non-specific at the beginning and with the time leads to more disease-specific symptoms in some cases. This leads to difficulty in accurate identification or diagnosis of the acute abdominal pain etiology. The initial step in the diagnostic workup is the clinical evaluation, which is based on medical history and physical examination. Based on this, a provisional diagnosis will be made. After clinical

evaluation, the further work up comprises of additional diagnostic investigations to reach the final diagnosis. A few decades ago, when imaging modalities were not available widely and their diagnostic accuracy was also low the patients were immediately sent to the operating theater for surgery. Whereas, the imaging modalities such as plain X-ray, ultrasound scan and computed tomography (CT) use has increased over the years which are helpful in more precise diagnosis. Due to this, many causes of acute abdomen does not require prompt treatment and can be treated conservatively^{2,3}. Despite this, in some case, the acute abdomen evaluation remains a diagnostic challenge because the underlying etiology can be in the area of other specialties such as internal medicine, gynecology, orthopedics and urology. This leads to a wide variation in choice of diagnostic modalities and treatment. Diagnostic practice varies within hospitals and within specialties, mostly lead by a doctor's preferences⁴. In this regards the hematological and serological markers such as white blood cell count (WBC), neutrophil count, hemoglobin, C-reactive protein (CRP), amylase, lipase, urea, creatinine are usually helpful to reach the diagnosis and helpful in guiding further analysis, including imaging modalities. Regarding imaging modalities, the Computerized tomography (CT) has significantly helped in reaching the correct diagnosis and is proved helpful in the evaluation of acute abdomen⁵. Many studies shows that with the use of CT in acute abdominal pain assessment has change the initial diagnosis and earlier planned treatment, decreased the hospitalization rate and length of hospital stay, provides ample time before surgery, helps to reach the alternative diagnoses by excluding potential diagnoses and moreover reduces the negative laparotomy rates. This has leads to the increase in use of CT scan by surgeons for patients with acute abdomen^{2,6-8}. In the United States, the use of CT scan performed for acute abdomen has increased up to 141% during 1996 to 2005. So, it's very important to assess that in which patients abdomino-pelvic CT would be useful and whether there is a need for laparotomy or not in the management of non-traumatic acute abdomen⁶. At the other end, the CRP, which is a non-specific inflammatory marker and an acute phase reactant, rises in parallel with severity of infection or inflammation and it falls rapidly in post-infectious or post-inflammatory phase because of 4-9 hours of elimination half-life. This rapid rise and fall of C-reactive Proteins are very helpful in monitoring an acute inflammatory processes⁹⁻¹². In previous studies, CRP and WBC levels were increase in diseases that causes acute abdomen and its reported that CRP is a measurable variable in evaluation of acute abdomen and can also be used to identify the serious situations such as hospitalization¹³. The rationale of the study was to establish whether the patients presenting with abdominal pain should undergo to contrast enhanced CT. For this purpose, we have investigated the possible relationship between CRP, WBC, neutrophil levels and the presence of pathological findings determined on abdominal pelvic CT images. This study was conducted with an objective to determine the diagnostic accuracy of C - reactive protein (CRP)

and White Cell Count (WCC) in non-traumatic acute abdomen pathologies by taking CT scan findings as gold standard.

METHODOLOGY

This retrospective analytic cross sectional study was conducted at Pinder fields Hospital Mid Yorkshire NHS Trust, over a period of 6 months from 1st January 2014 to 31st June 2014. All patients with non-traumatic acute abdomen presented first time in emergency department and admitted in surgical ward or transferred from other wards were included in the study. The patients having previous history of diagnosed acute abdominal condition or multiple visits to the emergency department or admission to hospital due to acute abdomen were excluded from the study. All basic demographic information of each patient (name, age, sex) was also be noted. All patients were evaluated by the senior registrar /consultant general surgery within 2-3 hrs of reporting to ER and all necessary investigations including blood CP, C-reactive proteins (CRP) were advised. All those patients who had CT scan abdo-pelvis for evaluation of acute abdomen were included in study. Among all investigations, CRP and WCC within 24 hour of admission were recorded and its diagnostic value compared to the final diagnosis of all patients on CT scan abdomen pelvis. CRP > 5 mg/l and White Cell Count of less than 4000 and more than 11000/cmm were taken as abnormal. Per-operative findings of all patients were also recorded for comparison and to confirm the clinical diagnosis with CT scan findings.

Data Analysis: Data entry and analysis was done by using SPSS 20. Specificity and sensitivity of the white cell count, CRP with positive or negative findings of acute abdomen on CT scan were measured. Number of positive or negative CT scan abnormal WCC and CRP were measured in percentages. Pearson Chi square calculated and p-value of less than 0.001 were considered as highly significant (considered as a trend that positive CT scan is associated with abnormal WCC).

RESULTS

A total of 396 patients were included in the study during study period. The mean age of patients were 59 years. Female were more (n=237, 59%) as compared to male (n=159, 41%) were noticed among our patients. All patients included in study had CT scan and positive CT scan was found in 294 (74.24%) and 102 (25.76%) patients have negative findings on CT scan. Abnormal WCC and Positive CT scan was found in 154 (52.38%) patients showing specificity of WCC 72% and sensitivity up to 52%. Pearson Chi-Square shows the p-value of < 0.001 which is highly significant i.e. there is a trend that positive CT scan is strongly associated with abnormal WCC.

Table – I, shows correlation of CRP level with positive CT scan in the patients in terms of specificity and sensitivity. P value of less than .001 was considered as statistically significant. Specificity and sensitivity of this correlation shows that as the value of CRP are increasing the CT scan abdomen is more likely to show positive findings among the patients. Data in table

shows that CRP level higher than 150 has more than 95% of specificity and sensitivity in the diagnosis of acute abdominal pathology with CT scan.

Table-I: Shows the correlation of C- reactive proteins with positive CT scan (N=396)

Category (CRP only)	Specificity	Sensitivity
=<5;	n/a [reference]	n/a [reference]
6 to 50;	64% (72/112)	53% (46/86)
51 to 100;	85% (53/62)	84% (46/55)
101 to 150;	92% (36/39)	94% (46/49)
151 to 200;	94% (34/36)	96% (46/48)
200 to 300;	98% (56/57)	98% (46/47)
>300	97% (33/34)	98% (46/47)

Fig -1, shows that only 5% of CT scan were unable to diagnose acute abdomen pathology when CRP levels are higher than 150 and if CRP levels are higher than 200, than only 2% of CT scans findings were inconclusive in reaching the diagnosis of acute abdomen. In contrary when CRP levels are less than 5 than only up to 45% of CT scans were helpful in reaching the pre-operative diagnosis of acute abdomen.

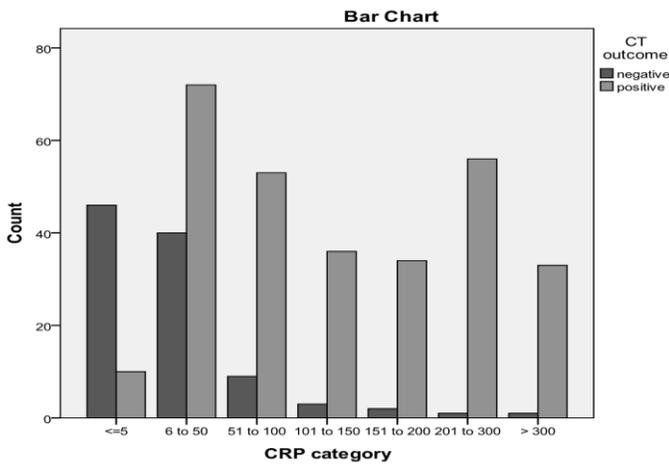


Fig-1: shows the comparison of CRP levels with positive and negative CT scan (N=396)

Table-II, shows the specificity and sensitivity of correlation between CRP, white cell count combined with CT scan findings in patients presenting with the acute abdomen. Data analysis shows that increasing CRP values are strongly associated with abnormal white cell count as its specificity and sensitivity is noticed to be increased as CRP values increasing. The specificity of CRP less than 5 which is 83% is increased up to 95% in patients when CRP has observed more than 200 among the patients. Similarly, the sensitivity of CRP with abnormal white cell count is also increased from 20% to 97% when CRP vale increased from 5 to 200 respectively. At the other end increasing CRP with normal white cell count also shows increasing specificity (from 58% to 100%) and sensitivity (from 62% to 100%) when CRP value increased from less than 5 to more than 200 respectively.

Table-II: The correlation between CRP, white cell count combined with CT scan findings in terms of specificity and sensitivity in patients presenting with the acute abdomen. (N=396)

Category *	Specificity	Sensitivity
CRP <5 and WCC normal (reference category)	n/a [reference]	n/a [reference]
CRP <5 and WCC abnormal	83% (38/46)	20% (2/10)
CRP > 5 to 50 and WCC normal	58% (38/66)	62% (45/73)
CRP >5 to 50 and WCC abnormal	76% (38/50)	69% (27/39)
CRP > 50 to 200 and WCC normal	84% (38/45)	89% (59/66)
CRP > 50 to 200 and WCC abnormal	84% (38/45)	91% (69/76)
CRP > 200 and WCC normal	100% (38/38)	100% (26/26)
CRP > 200 and WCC abnormal	95% (38/40)	97% (56/58)

In Fig-2, the correlation of increasing CRP, abnormal white cell count combined with positive or negative CT scan was given in patients with acute abdomen. As per data analysis CT scan were found to be inconclusive in reaching the pre-operative diagnosis when CRP level are low with normal or abnormal white cell count i.e. in CRP less than 5 with normal white cell count up to 38% of CT scans were negative and when CRP was up to 50 the negative CT scans were up to 30% in reaching pre-operative diagnosis. At the other end in patients with higher CRP levels (200 with normal or abnormal WCC) only up to 4% CT scans were found to be unhelpful in reaching the pre-operative diagnosis.

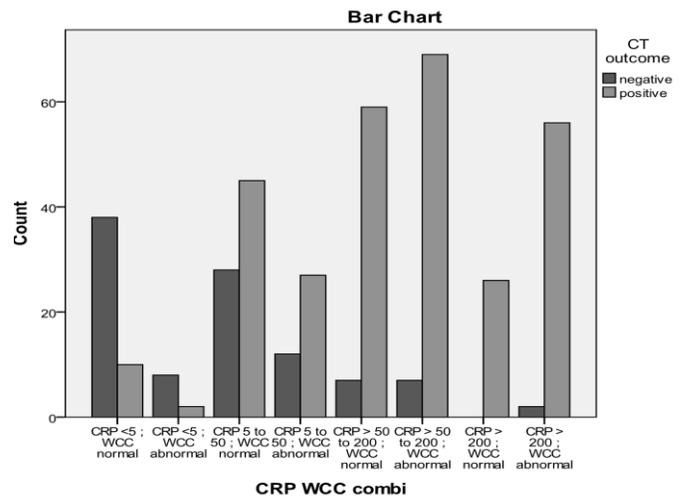


Fig 2: shows the correlation of increasing CRP, white cell count with positive or negative CT scan findings in patients with acute abdomen. (N=396)

DISCUSSION

Acute abdomen is described as severe abdominal pain occurring within a few hours. It is important to diagnose these patients accurately and quickly to reduce morbidity and mortality. But some time it is difficult to assess clinical status of these patients and conventional X-rays and laboratory studies are often not specific. Being accurate and reliable, the use of imaging methods, especially CT, by physicians in determining the diagnosis of acute abdomen, has greatly increased^{8,14,15}. C-Reactive Proteins, are acute phase reactant which starts increasing within 4-6 hours and reaches at peak levels within 2-3 days of inflammation. It rises up to 1000 times or more depending upon the severity of inflammation. Several studies has reported that the level of CRP and White Cell Count are increases among the patients having acute abdomen as the severity of inflammation increases^{8,10}. Similarly, the rise in CRP levels also depends upon the nature of inflammation for example, CRP levels are found to be higher in acute necrotizing pancreatitis as compared to acute interstitial pancreatitis⁷. In another study by Boermeester and colleagues has observed statistically significant difference between WCC and CRP levels while comparing simple ileus with strangulated ileus¹⁶. A Study conducted by Coyle et al to determine whether CRP is a reliable predictor of CT scan findings in acute abdomino-pelvic pathologies. They reported that overall up to 73% of CT scan shows positive imaging. In patients with low CRP (0-5 mg/L) level, shows an equal number of both CT scan findings (i.e. positive and negative) and the proportion of CT scan findings is increased as CRP level increased in blood. The likelihood ratio for positive CT scan with CRP value higher than 130 was 3.45 along with specificity and sensitivity of 90.9% and 31.4 %, respectively. Moreover, a low serum CRP value i.e. 0-5 mg/L) does not rule out the positive CT scan findings in acute abdomen⁶. In literature, many other studies also conclude that overall the higher levels of CRP correlates with increased likelihood of positive CT scan findings^{3,6,7,14,15}. In our study, the specificity and sensitivity of CRP is steadily increasing in proportion to the levels of CRP. The specificity and sensitivity is up to 98% when CRP levels were observed between 200-300 so it suggestive of high index of suspicion of acute abdomen among those patients. At this level only 2% of CT scan were found to be inconclusive in reaching the diagnosis of acute abdomen. In contrary the ratio of negative CT scan were found to be higher i.e. 40-45% when CRP levels were low (up to 50). In another study by Kozaci⁸ and colleagues in which they reviewed 130 patients with acute abdomen and reported a statistically significant correlation between the findings reported on CT scan images and CRP, WCC levels. The positive pathology were found on CT scans of patients with CRP level more than 0.8 mg/dl (i.e. 78.33% sensitivity and 98% specificity) and WCC of more than $12.91 \times 10^3 / \mu\text{L}$ (i.e. sensitivity 48.3% and specificity 86%). Same findings were also observed in our patients, when correlation of WCC and CRP were assessed with CT scan findings in patients with acute

abdomen. By analyzing the findings it's quite evident that the high level of CRP are associated more with abnormal CT scan findings as compared to normal WCC in patients. In the presence of normal WCC and elevated CRP(200-300), the percentage of negative CT scan were found to be less than 2% and 6% when CRP levels were found to be between 5-200 with or without normal WCC. Similarly, Kim et al are of the opinion that the severity of findings on CT scan images increases in parallel with an increase CRP levels. They studied patients with acute appendicitis and graded the CT scan findings from 0-4 depending upon the severity of inflammation and found it to be strongly associated with increasing CRP and WCC levels. They also reported a significant correlation among CT scan severity score and CRP and WCC in their study³. In another study by You et al on acute pancreatitis reported that the organ failure more likely to develop in patients with two or more intra-abdominal collections on CT scan and with high levels of CRP levels. They concluded that the CT-CRP are an important markers in predicting mortality in acute pancreatitis patients⁶. Similar observations were also made by Chi et al in their study⁵.

Calabro et al has reported that in acute abdomen the positive pathologic findings in acute abdomen were observed more likely in CT scan images of patients with CRP levels more than 5 (sensitivity 82.9% and specificity 47%), WCC of more than $11.3 \times 10^3 / \mu\text{L}$ (sensitivity 57.7% and specificity 71.2%). They also observed that the specificity of diagnosing positive pathologic findings on CT scan is up to 91% when CRP levels are higher than 130 mg/L⁹. The Xharra and colleagues has concluded that the raised levels of CRP alone are related directly to the severity of inflammatory process (p-value <0.05) in acute abdomen. The monitoring of CRP alone enhances the accuracy in the diagnosis of acute abdomen especially in acute appendicitis. And they conclude that the raised levels of serum CRP supports the surgeon in reaching the diagnosis in acute abdomen¹⁷. Different studies in literature supported this approach also but with limitations^{9,10,11} Gans and colleagues has reported that the CRP and WCC levels alone are not sufficient to discriminate between urgent and non-urgent cases in acute abdomen. CT scan has a highest sensitivity and specificity in making the preoperative diagnosis in patients with acute abdomen¹. Our study has concluded that the specificity and sensitivity of CT scan (95% and 97% respectively) helping in reaching the exact cause of acute abdomen is higher when CRP (>100) and WCC are high. Moreover, to be more precise by analyzing if CRP alone is more than 200 but WCC is normal, than the specificity and sensitivity of CT scan is also highest (reaching up to 100) which shows that even CRP levels alone are more superior as an indication of CT scan for the diagnosis of acute abdomen pathology. We tried to prove that WCC has a useful additional diagnostic value on top of CRP alone, but data showed CRP alone Superior. CRP above 200 some patients become neutropenic and WCC tend to go down.

CONCLUSION

C –reactive proteins more than 100 U/L has high diagnostic value and indication for CT scan or Surgery in diagnosing the exact cause of acute abdomen.

CONTRIBUTION OF AUTHORS

Ahmed S: Conceived idea, Designed methodology, Data collection, Data analysis

Dar GM: Data analysis, Literature search

Aziz R: Literature search, Manuscript writing

Ahmed I: Manuscript writing, Data analysis

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

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