

# THE ROLE OF WHITE CELL COUNT AND C-REACTIVE PROTEIN IN THE DIAGNOSIS OF ACUTE APPENDICITIS

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**Background:** Despite recent advances in diagnostic medicine, the diagnosis of appendicitis is still doubtful in a number of cases. Majority of the clinicians rely on their clinical examination strengthened by the laboratory tests. This study was carried out to find out the specificity and sensitivity of white cell count (WCC) and C-Reactive Protein (CRP) in diagnosing appendicitis in patients presenting with right iliac fossa pain. **Methods:** A total of 259 patients were included in this study that presented in the hospital with acute right iliac fossa pain and later on operated and had appendicectomy. The histopathology data was collected to find out the frequency of negative appendicectomy. According to the histopathology reports these patients were grouped into three sub-groups as normal appendix, inflamed appendix or perforated/gangrenous appendix. A record was kept of the WCC and CRP levels of these patients on admission. **Results:** A total of 259 patients were included in this study and out of them 37 had a normal appendix giving an over all negative appendicectomy rate of 14.3%. Out of these 11 were male and 26 were female, male to female ratio being 1:2.3. The age range was 12-73 with a median age of 24. Among the 222 patients who had appendicitis, 96 had a ruptured /perforated appendix and 126 had an inflamed appendix. Over all the WCC was elevated in 185 patients and CRP was elevated in 168 cases. The cut off value for white cell count was  $11 \times 10^6 / L$ . The C reactive protein levels were calculated by immunoturbidimetric test and the cut off value was taken as 1.7mg/dl. The sensitivity and specificity of WCC in this study was 83% and 62.1 % and that for CRP was 75.6% and 83.7 %. **Conclusion:** Both the inflammatory markers i.e. WCC and C-reactive protein can be helpful in the diagnosis, when measured together as this increases their positive predictive value.

**Key words:** appendicitis, white cell count, C reactive protein

## Introduction

Acute appendicitis is still one of the commonest surgical emergencies.<sup>1</sup> The diagnosis is primarily clinical.<sup>2</sup> A typical patient is one presenting with right lower abdominal pain, nausea and vomiting and has got tenderness and guarding in right iliac fossa on examination. However these sign & symptoms are not very specific for appendicitis and can mimic any other acute abdominal condition.<sup>3</sup> The picture is more confused by the variable position of the appendix.<sup>4</sup> Despite advances in diagnostic modalities the diagnosis is still doubtful in 30-40 % of cases.<sup>5</sup> And the definite diagnosis of appendicitis still remains a clinical decision, augmented by appropriate tests. A high degree of diagnostic accuracy is required to reduce the incidence of negative appendicectomies which still remains around 20 %.<sup>6</sup> One study has shown an incidence of 50% in women of reproductive age group.<sup>7</sup> Acute appendicitis is a disease of young adults.<sup>8</sup> It is rare below 3 years of age but people are vulnerable to it in extremes of their age and complication rate is higher in those groups. It is more common in males as compared to females. It used to be called as the disease of developed countries with an association of high protein intake, but the incidence is also increasing in developing countries. A study reported it to be around 1.9/1000 for males and 1.5/1000 for females.<sup>9</sup>

Apart from a careful history and clinical examination, total white cell count has remained an important factor in the definite diagnosis of appendicitis. Various studies have shown that this can be very non-specific at times.<sup>10</sup> Recently interest has grown in other inflammatory markers which could be helpful in diagnosing appendicitis. CRP is one of them. This study was conducted to check the sensitivity and specificity of the white cell count and CRP in patients presenting with right iliac fossa pain.

## MATERIAL and Methods

This study was carried out at Wishaw General Hospital, which is a modern district general hospital in the west of Scotland, serving a population of 160,000. This study included all the patients admitted with right iliac fossa pain and then had appendicectomy between September 2001-2002. The records of all such patients were accessed from the pathology department with the histopathology results. This was used to get the incidence of negative appendicectomy and then on these features patients were divided into 3 groups as

- 1- normal appendix
- 2- inflamed appendix
- 3- perforated/gangrenous appendix

Their blood results were reviewed and a note of WCC and CRP levels was made. The sensitivity and specificity of these tests were calculated according to the following formulas,

$$\text{Sensitivity} = \frac{\text{True Positives}}{\text{True Positives} + \text{False Negatives}}$$

$$\text{Specificity} = \frac{\text{True Negative}}{\text{True Negative} + \text{False Positive}}$$

The cut off value for white cell count was  $11 \times 10^6/L$ . This value was selected arbitrarily as it corresponds to the elevated WCC. The C reactive protein levels were calculated by immunoturbidimetric test and the cut off value was taken as 1.7mg/dl. This cut off value was taken in light of the previous research which showed it to be highly accurate.<sup>11</sup>

## Results

A total of 259 patients were included in this study and out of them 37 had a normal appendix giving an over all negative appendicectomy rate of 14.3%. Out of these 11 were male and 26 were female, male to female ratio being 1:2.3, again highlighting the fact that the diagnosis of appendicitis is straightforward in men but could be just a guess in females. The age range was 12-73 with a median age of 24. Among the 222 patients who had appendicitis, 96 had a ruptured /perforated appendix and 126 had an inflamed appendix. Over all the WCC was elevated in 185 patients and CRP was elevated in 168 cases. The sensitivity and specificity of WCC in this study was 83 % and 62.1 % and that for CRP was 75.6 and 83.7 %. The positive predictive values for WCC and CRP were 92% and 96% respectively ( $p < 0.001$ ).

**Table-1: Analysis of white cell count measurements in patients with RIF pain**

	Group I	Group II	Group III
	n = 37	n = 126	n = 96
White Cell Count Raised	14	96	89
White Cell Count Normal	23	30	07

Group I = patients with normal appendix

Group II = patients with inflamed appendix

Group III = patients with perforated/gangrenous appendix

Sensitivity = 83.3%, Specificity = 62.1%

Positive predictive value = 92%

Degree of freedom : 2, Chi Square = 45.23

P < 0.001 , hence the distribution is significant

## DISCUSSION

Majority of the patients with acute appendicitis present with right sided lower abdominal pain and nausea and vomiting, but these symptoms are very non-specific. In fact any acute abdominal condition can mimic appendicitis and hence the list of differential diagnosis is long and hence removal of a normal appendix is not unusual.

Table-2: Analysis of CRP measurements in patients with RIF pain

	Group I N = 37	Group II N = 126	Group III N = 96
CRP Raised	6	81	87
CRP Normal	31	45	09

Group I = patients with normal appendix

Group II = patients with inflamed appendix

Group III = patients with perforated/gangrenous appendix

Sensitivity = 75.6%, Specificity = 83.7%

Positive predictive value = 96%

Degree of freedom = 2, Chi Square = 67.99

P < 0.001 , hence distribution is significant.

A high degree of diagnostic accuracy is required to reduce the incidence of negative appendicectomies which still remain around 20 %. One study has shown the diagnostic accuracy of acute appendicitis of 60% in women of reproductive age group.<sup>12</sup> The implications can be two folds. Firstly although appendicectomy is considered to be a safe operation it still has got associated complications, most noticeable among them are wound infection, intra abdominal abscess, adhesions and bowel obstruction and pulmonary complications from general anaesthesia.<sup>13</sup> Secondly, the group of patients who have persistent symptoms after the operation are unsatisfied with the health care they received and are a burden on the hospital resources.

To improve the diagnostic accuracy surgeons have relied on a good history and sound clinical examination augmented by laboratory investigations ranging from simple blood tests looking at the white cell count, to modern sophisticated investigations including computerised tomography, ultrasonography, peritoneal aspirations, barium enema and laparoscopy.<sup>14-16</sup> But all these investigations have their demerits. They are invasive, time consuming, operator dependent and not very freely available everywhere. Among all these looking at the WCC has been very favourite test for the surgeons in deciding for probability of appendicitis although studies have shown it to have a low specificity.<sup>17</sup> The question of specificity and sensitivity of these tests remains open.

To improve the sensitivity and specificity surgeons have tried sequential leukocyte counts and neutrophil: lymphocytic ratio.<sup>18-19</sup> Recently attention has been focussed on other inflammatory markers which can be raised in appendicitis, CRP (C-reactive protein) being one of them. CRP was identified in 1930 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.<sup>20</sup> Several studies have addressed the accuracy of CRP in diagnosing appendicitis and it is agreed that its level increases in appendicitis and this increase is related to the severity of appendiceal inflammation.<sup>11</sup> However CRP levels may be elevated in patients with complications from pneumonia, pelvic inflammatory disease, and urinary tract infections.

This study showed that white cell count and CRP both are sensitive in diagnosing acute inflammation but they are not very specific. Combining the two tests together the specificity and positive predictive value increases. The measurement of CRP is useful in the diagnosis of acute appendicitis. In this study we have 37 patients in group I, where the appendix was found normal. In 23 of these patients both values were in the normal range. The accuracy of these tests increases with the increasing severity of inflammation. In group III where the appendix was found to be perforated or gangrenous, only 7 patients out of 87 had normal values of either CRP or WCC. In both groups II and III no patients were found with CRP or WCC with in normal range. We would recommend that if in a patient presenting with right iliac fossa pain, both CRP and WCC are normal the diagnosis of appendicitis is very unlikely.

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