

Original article

Value of C- Reactive Protein and White Blood Cells Count in Confirming the Diagnosis of Acute Appendicitis

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ABSTRACT

Acute appendicitis is one of the most frequent abdominal emergency operations in any surgical ward. The majority of professionals recommend early diagnosis and prompt surgical intervention (appendectomy) to decrease the morbidity and mortality which is associated with late diagnosis and appendicular perforation. A history and clinical examination are frequently utilized to facilitate early diagnosis, which is usually supported by laboratory tests and abdominal and pelvic ultrasound. The aim of our study is to investigate the diagnostic value of white blood cells (WBC) count and C-reactive protein (CRP) in confirming the diagnosis of acute appendicitis in suspected patients. A prospective study was conducted on 100 patients admitted to surgical ward in Alwahda teaching hospital (Derna, Libya) with abdominal pain and suspected to be acute appendicitis. Patients who operated for acute appendicitis (appendectomy) were divided according to their histopathology results into 80 cases with acute appendicitis and 20 with normal appendicitis. The results of histopathology were compared to the preoperative level of CRP & WBC count. A statistically significant increase in CRP and WBC was observed in acute appendicitis patients in comparison with normal appendicitis patients. CRP had a specificity of 65% and sensitivity of 70%, with significance for the prediction of acute appendicitis. WBC had a specificity of 55% and sensitivity of 83%, which is significant for predicting acute appendicitis. Overall, both CRP and WBC provide valuable diagnostic insights, with WBC showing a superior ability to detect true cases of acute appendicitis. However, the moderate specificity of both markers suggests that they have to be used in conjunction with other clinical assessments and diagnostic tools to improve diagnostic precision and reduce false positives.

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INTRODUCTION

Acute appendicitis is one of the most frequent reasons for abdominal operating emergencies in adolescents and kids [1]. The majority of professionals recommend early diagnosis and prompt operative intervention for decreasing the morbidity and mortality of acute appendicitis. A history and clinical investigation are frequently utilized to facilitate early diagnosis, which is occasionally supported by laboratory tests [2, 3].

This approach typically leads to an unacceptably relatively high negative appendectomy rate, as many acute abdominal conditions resemble acute appendicitis. Conversely, adolescent women and relatively younger kids frequently show atypical presentations. This can present an important diagnostic dilemma that may cause delayed intervention and, as a consequence, an elevated occurrence of complications. Prior research has demonstrated that the probability of a negative appendectomy ranges from fifteen percent to fifty-seven percent [4, 5].

Over the years, numerous investigations have investigated a variety of clinical criteria and simple blood tests in an effort to enhance diagnostic accuracy. Currently, C-reactive protein (CRP) and the white cell (WCC) count are frequently utilized to direct clinical evaluations. However, prior researches have shown that C-reactive protein measurements have sensitivities varying from forty percent to ninety-four percent and specificities of thirty-eight to eighty-seven percent [6,7, 8]. Numerous groups have stated more specific results, including perforation or appendicular abscess, that were demonstrated to be associated with elevated C-reactive protein levels [9].

CRP, an indicator of systemic inflammation, and elevated WBC levels, indicative of infection or inflammation, may provide valuable information when clinical symptoms are inconclusive [10].

We performed the current study to explore the diagnostic value of WBC count and CRP in enhancing the detection and confirmation of acute appendicitis.

METHODS

Study design and patients

This prospective research has been performed on 100 cases admitted to the surgical ward of Alwahda teaching hospital with suspicion of acute appendicitis. Patients who operated because of acute appendicitis were divided according to their histopathology results of appendectomy specimen into 80 patients had acute appendicitis and 20 had normal appendicitis. Patients of both sexes with clinical signs of acute appendicitis were included. While, we exclude cases with complication such as perforation, peritonitis and appendicular mass.

Data collection

All the cases have been exposed to a detailed clinical history, a full clinical examination, abdominal & pelvic ultrasound and relevant laboratory investigations like leukocyte count, hemoglobin, blood sugar and urine microscopic investigations. Other investigations have been performed only if required. The period of the clinical signs and the symptoms of acute appendicitis have been recorded at the time of admission. The clinical signs involved percussion and rebound tenderness, direct tenderness in the right lower quadrant, diffuse rigidity of the abdominal wall, and localized rigidity. The case was considered positive for clinical signs if a minimum one clinical sign was observed. The final diagnosis of acute appendicitis was clinically determined and established by the available laboratory examination results.

White blood cells were determined by the hematology analyzer. Concentrations greater than 11×10^9 per liter have been defined as being above normal. A Latex agglutination slide test was utilized to quantify the C-reactive protein level in non-diluted serum for semi-quantitative and qualitative analysis. Concentrations greater than 10.1 milligrams per liter were regarded as abnormal.

The specificity and sensitivity of these tests have been determined regarding the following formulas:

$$\text{Specificity} = \frac{\text{true negative}}{\text{true negative} + \text{false positive}}$$

$$\text{Sensitivity} = \frac{\text{true positives}}{\text{true positives} + \text{false negatives}}$$

The white cell count cutoff value was 10×10^9 cells pe. The cutoff value for C-reactive protein concentrations was 10.1 milligram per liter.

Statistical analysis

Data were analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp.). Qualitative data have been defined utilizing precents and numbers. The Kolmogorov-Smirnov test has been utilized to assess the normality of distribution. Quantitative data have been defined by range (maximum and minimum), standard deviation, mean, interquartile range (IQR) and median. The significance of the outcomes reported has been evaluated at the five percent level. We used the student's t-test for comparing two examined groups with normally distributed quantitative parameters. If more than twenty percent of the cells show an expected count of less than five, use Fisher's exact test or Monte Carlo correction for the chi-square test. Use the chi-square test for comparing variant groups depend on categorical variables.

RESULTS

According to demographic data, the mean age was 23 ± 6.1 , there were 32% males, 68% females, and 80% had acute appendicitis (Table 1).

Table 1. Distribution of general characteristic in the examined group.

Items	Studied group (n=100)
Age (Mean± SD)	23±6.1
Sex	
Male	32(32%)
Female	68(68%)
Acute appendicitis	
Yes	80(80%)
No	20(20%)

As shown in table 2, there was statistically significant increase in CRP and WBC in acute appendicitis patients compared with normal appendicitis patients.

Table 2. Distribution of CRP (mg/l) and WBC (x 10⁹ cells/l) between the studied groups.

Investigation	Acute appendicitis Number=80	Normal appendicitis Number =20	P-value
C-reactive protein (milligram per liter)	40.6±69.4	6.3±14.3	0.03
WBC (x10 ⁹ cells/l)	14.5±4.3	9.4±3.6	<0.001

P value <0.05 is statistically significant; P value >0.05: not significant; SD: standard deviation; p<0.001 is highly significant.

CRP had specificity of 65% and sensitivity of 70% with significance for prediction of acute appendicitis. WBC had specificity of 55% and sensitivity of 83% with significance for prediction of acute appendicitis.

Table 3. ROC curve of CRP (mg/l) and WBC (x 10⁹ cells/l) for predicting acute appendicitis.

Investigation	AUC	Cutoff value	Sensitivity	Specificity	Sig.	95% CI	
						Lower	Upper
CRP (mg/l)	.675	10.1	70%	65%	.01	.540	.810
WBC (x10 ⁹ cells/l)	.694	11	83%	55%	.008	.553	.835

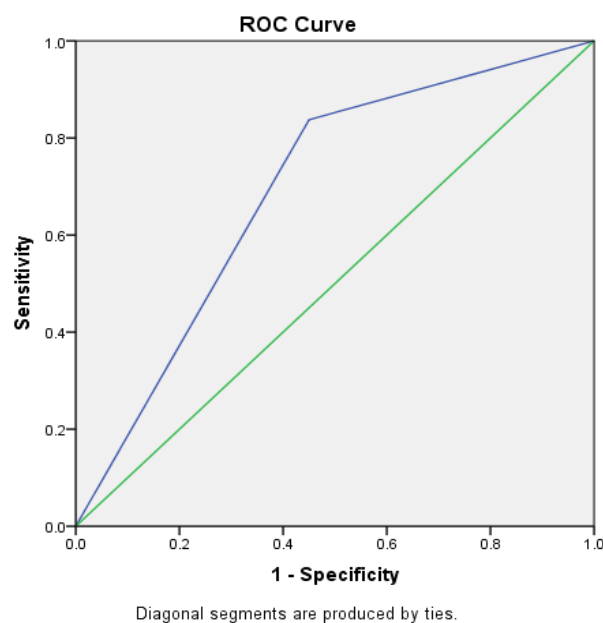


Figure 1. ROC curve of WBC for predicting acute appendicitis.

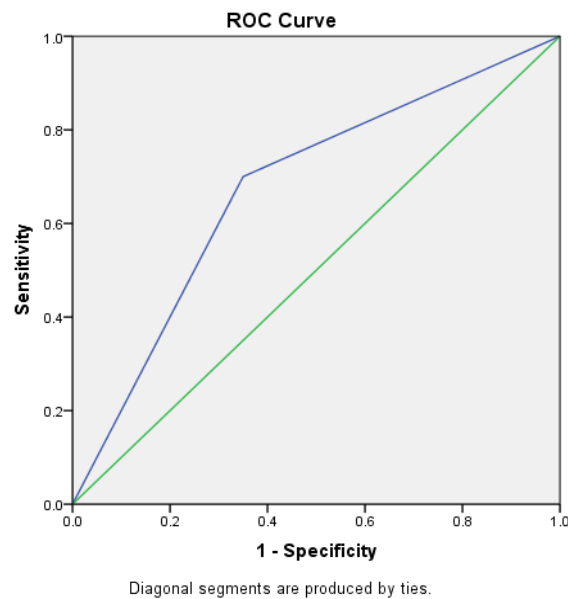


Figure 2. ROC curve of CRP for predicting acute appendicitis.

DISCUSSION

In the current study, we found that the mean age was 23 ± 6.1 , there were 32% males, 68% females, and 80% had acute appendicitis. Our study was consistent with Talabi AO et al.'s [11], who evaluated the diagnostic value of serum CRP and WBC count with acute appendicitis. They found that the specificity and sensitivity of CRP evaluation and total WBC count in diagnosing acute appendicitis were 98.8% and 36.8%, and 51.9% and 89.5%, respectively. Our results were aligned with Khan MN et al., [12] who aimed to discover the specificity and sensitivity of CRP and WBC count during diagnosing appendicitis within cases suffering from pain in right iliac fossa. They reported that a total of 259 cases participated, of which thirty-seven had a normal appendix, resulting in an overall negative appendectomy probability of 14.3%. Among these, eleven were men and 26 were women, resulting in a man-to-woman ratio of 1:2.3. The age ratio was twelve to seventy-three, with a median age of twenty-four. Of the 222 cases diagnosed with appendicitis, ninety-six presented with a perforated or ruptured appendix, while 126 showed an inflamed appendix. Similarly, Panagiotopoulou IG et al. [13] determined the diagnostic accuracy of the WCC and C-reactive protein indicators in perforated and acute appendicitis, in addition to their value in the disorder. They discovered that of the 1,169 cases investigated, 591 (50.6%) were women. The median age was twenty-five years (interquartile range]: seventeen to thirty-nine years). The cases have been classified into 3 groups based on their associated histology. There were 396 (33.9%) with normal appendix (NA), 732 (62.6%) with acute appendicitis, and forty-one cases (3.5%) with perforated appendicitis. Furthermore, our study was aligned with Xharra S et al. [14], who analyzed the role of C-reactive protein and white blood count in enhancing the precision of acute appendicitis diagnosis and compared it with the during surgery evaluation and histopathology results. They demonstrated that 148 (85.5%) cases had gangrenous perforated appendix, or acutely inflamed, whereas twenty-five (14.5%) cases had NA, according to the histopathology. The age distribution was as follows: 52% were men and 48% were women, with a median of 19.7 and a range of five to five-nine. The most common type observed is gangrenous (52.6%).

Our results revealed statistically significant variance among the examined groups according to CRP and WBC. Our results were supported by Khan MN et al., [12], who reported that in total, 185 cases had increased white blood count concentrations, whereas 168 cases had increased C-reactive protein concentrations. Moreover, our results align with Xharra S et al. [14], who found that the white blood count has been changed in 77.5% of the patients and the CRP has been changed in 76.9% of the patients. Of the 126 cases (72.8%) who had perforated appendix, the C-reactive protein and white blood count values have been elevated.

However, contrary to our results, Sengupta A et al. [15] assessed the efficacy of these indicators in cases who presented with acute lower abdominal pain. They found that insignificant variance has been observed in white blood count (P-value = 0.12), not in C-reactive protein concentration (P-value = 0.064), among patients diagnosed with simple acute appendicitis and cases with complications, for example, gangrene or perforation. This discrepancy suggests that the value of CRP and WBC count in diagnostic assessments can range based on the patient population and clinical context. With respect to the ROC curve of CRP (mg/l) and WBC ($\times 10^9$ cells/l) for predicting acute appendicitis, we demonstrated

that CRP had a specificity of 65% and a sensitivity of 70% with significance for acute appendicitis prediction. WBC had a specificity of 55% and sensitivity of 83%, which was significant for prediction.

The C-reactive protein area under the ROC curve analysis was 0.769, with a ninety-five percent confidence interval of 0.647 to 0.891, and the white blood cell count was 0.765, with a 95% confidence interval of 0.643 to 0.887. Both WBC count and CRP demonstrated greater discriminatory values among uncomplicated and complicated appendicitis (p-value less than 0.001). Additionally, our results were agreed with Khan MN et al. [12], who reported the cutoff value for white blood count was 11×10^9 per liter. The CRP concentrations have been determined by an immunoturbidimetric test, and the cutoff value has been obtained as 1.7 milligrams per deciliter. In the current research, the specificity and sensitivity of WBC count were 83% and 62.1%, respectively, and that for C-reactive protein was 75.6% and 83.7%. It was concluded that both inflammatory indicators, such as white blood cell count and CRP, may be beneficial in the diagnosis if estimated together, as this raises their PPV. Furthermore, our results were in concordance with Panagiotopoulou IG et al. [13], who revealed that CRP provides the greatest diagnostic precision for perforated appendix. Standard inflammatory indicators cannot rule out appendicitis, which is primarily a clinical diagnosis.

CONCLUSION

Overall, both CRP and WBC provide valuable diagnostic insights, with WBC showing a superior ability to detect true cases of acute appendicitis. However, the moderate specificity of both markers suggests that they should be used in conjunction with other clinical assessments and diagnostic tools to improve diagnostic precision and reduce false positives.

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Conflicts of Interest

The authors declare no conflicts of interest.

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قيمة بروتين سي التفاعلي وعدد خلايا الدم البيضاء في تأكيد تشخيص التهاب الزائدة الدودية الحاد

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المستخلص

التهاب الزائدة الدودية الحاد هو أحد أكثر العمليات الجراحية الطارئة شيوعاً في البطن في أي جناح جراحي. يوصى غالبية المهنيين بالتشخيص المبكر والتدخل الجراحي السريع (استئصال الزائدة الدودية) لتقليل معدل الإصابة والوفيات المرتبطة بالتشخيص المتأخر وثقب الزائدة الدودية. غالباً ما يتم استخدام التاريخ والفحص السريري لتسهيل التشخيص المبكر، والذي عادة ما يكون مدعوماً باختبارات معملية وموجات فوق صوتية للبطن والحوض. الهدف من دراستنا هو التحقيق في القيمة التشخيصية لعدد خلايا الدم البيضاء والبروتين التفاعلي سي في تأكيد تشخيص التهاب الزائدة الدودية الحاد لدى المرضى المشتبه بهم. أجريت دراسة مستقبلية على 100 مريض تم إدخالهم إلى جناح الجراحة في مستشفى الوحدة التعليمي (درنة، ليبيا) يعانون من آلام في البطن ويشتبّه في إصابتهم بالتهاب الزائدة الدودية الحاد. تم تقسيم المرضى الذين أجريت لهم عملية جراحية لالتهاب الزائدة الدودية الحاد (استئصال الزائدة الدودية) وفقاً لنتائج الفحص النسيجي إلى 80 حالة مصابة بالتهاب الزائدة الدودية الحاد و20 حالة مصابة بالتهاب الزائدة الدودية الطبيعي. تمت مقارنة نتائج الفحص النسيجي بمستوى ما قبل الجراحة لبروتين سي التفاعلي وعدد خلايا الدم البيضاء. لوحظت زيادة ذات دلالة إحصائية في بروتين سي التفاعلي وعدد خلايا الدم البيضاء لدى مرضى التهاب الزائدة الدودية الحاد مقارنة بمرضى التهاب الزائدة الدودية الطبيعي. كان لبروتين سي التفاعلي خصوصية 65% وحساسية 70%، مع أهمية للتنبؤ بالتهاب الزائدة الدودية الحاد. كان لبروتين سي التفاعلي خصوصية 55% وحساسية 83%، وهو أمر مهم للتنبؤ بالتهاب الزائدة الدودية الحاد. بشكل عام، يوفر كل من بروتين سي التفاعلي وعدد خلايا الدم البيضاء رؤى تشخيصية قيمة، حيث يُظهر كل من بروتين سي التفاعلي وعدد خلايا الدم البيضاء قدرة فائقة على اكتشاف الحالات الحقيقية لالتهاب الزائدة الدودية الحاد. ومع ذلك، فإن الخصوصية المعتدلة لكلا العلامتين تشير إلى أنه يجب استخدامهما جنباً إلى جنب مع التقنيات السريرية الأخرى وأدوات التشخيص لتحسين دقة التشخيص والحد من الإيجابيات الكاذبة.

الكلمات المفتاحية: بروتين سي التفاعلي، عدد خلايا الدم البيضاء، التهاب الزائدة الدودية الحاد.