eISSN:2708-888X
http://journals.khalijedental.com.ly/index.php/ojs/index

Original article

Values of White Blood Cell Count and C-Reactive Protein in Diagnosis of Acute Appendicitis

Khaled Elbaruni[1], Eman Abdulwahed[1*], Mona Elwafi[1], Maram Eljrew[1], Ahmed Atia[2]

[1]*Department of Medical Laboratories Sciences, Faculty of Medical Technology, University of Tripoli, Libya*
[2]*Department of Anesthesia and Intensive Care, Faculty of Medical Technology, University of Tripoli, Libya*
***Corresponding Email**: E.Abdulwahed@uot.edu.ly*

ABSTRACT

***Background and objectives**. Acute appendicitis is one of the most common surgical emergencies. Accurate diagnosis of acute appendicitis is based on careful history, physical examination, and laboratory investigation. The purpose of this study is to investigate the value of white blood cells (WBC) and C-reactive protein (CRP) in the diagnosis of acute appendicitis. **Methods**. A retrospective analysis of 350 files of patients who underwent appendectomy was conducted. Selected files were those patients who were admitted to ALmasara clinic Tripoli Libya between Aug 2011 to July 2023, ages of patients ranged from 18 to 80 years. Statistical analysis was performed using SPSS version 26 software. A statistical procedure was implemented to compare the hematologic parameters in two groups (Males and Females) to determine if there was any significant difference between them. Means of WBC, Neutrophil, Lymphocyte and CRP were compared between two groups by an independent one-way analysis of variance (ANOVA). **Results**. This study consisted of 350 participants who were diagnosed with appendicitis. The results showed that about (69.4%) of appendicitis patients exhibited a high white blood cell count (leukocytosis). Slightly over half (52.6%) of the participants had an elevated neutrophil percentage (neutrophilia). Approximately (64.3%) of the appendicitis patients had decreased lymphocyte percentage (lymphopenia). In relation to CRP values, the study showed that most participants (76.5%) had positive CRP results. **Conclusion**. Individuals with appendicitis have higher levels of leukocytes, neutrophils, and C-reactive protein, and decreased lymphocyte counts. Elevated WBC and CRP values together provide a better specificity and positive predictive value than individual markers.*

Keywords: Acute Appendicitis, Total Leucocyte Count, C-Reactive Protein.

Citation: Elbaruni K, Abdulwahed E, Elwafi M, Eljrew M, Atia A. Values of White Blood Cell Count and C-Reactive Protein in Diagnosis of Acute Appendicitis. Khalij-Libya J Dent Med Res. 2024;8(1):29–33. https://doi.org/10.47705/kjdmr.248105
Received: 11/01/24; **accepted**: 26/02/24; published: 01/03/24

الخلفية والأهداف. يعد التهاب الزائدة الدودية الحاد أحد أكثر حالات الطوارئ الجراحية شيوعًا. يعتمد التشخيص الدقيق لالتهاب الزائدة الدودية الحاد على التاريخ الدقيق والفحص البدني والفحوصات المخبرية. الغرض من هذه الدراسة هو دراسة قيمة خلايا الدم البيضاء (WBC) والبروتين التفاعلي (CRP) في تشخيص التهاب الزائدة الدودية الحاد. **طُرق الدراسة**. تم إجراء تحليل بأثر رجعي لملفات 350 من المرضى الذين خضعوا لعملية استئصال الزائدة الدودية. الملفات المختارة هي المرضى الذين تم إدخالهم إلى عيادة المسرة طرابلس ليبيا في الفترة ما بين أغسطس 2011 إلى يوليو 2023، وتراوحت أعمار المرضى من 18 إلى 80 عامًا. تم إجراء التحليل الإحصائي باستخدام برنامج SPSS الإصدار 26. تم تنفيذ إجراء إحصائي لمقارنة المتغيرات الدموية في مجموعتين (الذكور والإناث) لتحديد ما إذا كان هناك أي فرق كبير بينهما. وتمت مقارنة وسائلWBC ، العدلات، الخلايا الليمفاوية و CRPبين مجموعتين من خلال تحليل التباين المستقل في اتجاه واحد (ANOVA). **النتائج**. تكونت هذه الدراسة من 350 مشاركًا تم تشخيص إصابتهم بالتهاب الزائدة الدودية. أظهرت النتائج أن حوالي (69.4%) من مرضى التهاب الزائدة الدودية أظهروا ارتفاعاً في عدد خلايا الدم البيضاء (كثرة الكريات البيضاء). كان لدى ما يزيد قليلاً عن النصف (52.6%) من المشاركين نسبة مرتفعة من العدلات (العدلات). حوالي (64.3%) من مرضى التهاب الزائدة الدودية كان لديهم نقص في نسبة الخلايا الليمفاوية (قلة الليمفاويات). فيما يتعلق بقيمCRP ، أظهرت الدراسة أن معظم المشاركين (76.5٪) لديهم نتائج إيجابية لـ CRP. **الخاتمة**. الأفراد الذين يعانون من التهاب الزائدة الدودية لديهم مستويات أعلى من الكريات البيض، والعدلات، والبروتين التفاعلي سي، وانخفاض عدد الخلايا الليمفاوية. توفر قيم WBC و CRPالمرتفعة معًا خصوصية أفضل وقيمة تنبؤية إيجابية مقارنة بالعلامات الفردية.

eISSN:2708-888X
http://journals.khalijedental.com.ly/index.php/ojs/index

INTRODUCTION

Acute appendicitis (AA) is one of the most common reasons for urgent surgical intervention. It can affect any age group, but men are more prone to it than women [1]. The exact cause of appendicitis is unknown, but it's believed that luminal obstruction may be a contributing factor. This obstruction can lead to increased pressure, engorgement, and stasis, which can eventually cause necrosis and perforation. In addition, bacterial infection may also play a role in the development of appendicitis [2].

To diagnose AA, the first steps are a thorough medical history and a proper physical examination. After that, standard laboratory tests are performed which include a complete blood count (CBC), specifically a white blood cell count (WBC), and a C-reactive protein (CRP) test [3,4].

Recent studies indicate that using traditional inflammatory markers has limited value in predicting appendicitis. However, when combining the results of white blood cell count and C-reactive protein tests, the negative predictive value can be increased. If both the WBC and CRP values are normal, it is unlikely to be a case of appendicitis [5]. In recent years, radiological imaging methods have been increasingly used to improve diagnostic accuracy in suspected cases of appendicitis [6].

Various studies have been conducted in different countries to determine the relationship between blood count parameters and C-reactive protein values with acute appendicitis. In Turkey, a study focused on patients who underwent appendectomy between January 2012 and June 2019. It was found that WBC values were significantly higher in patients with acute appendicitis. However, CRP values did not helpful in predicting appendicitis [7]. In Dubai, a study conducted in 2021 found that a majority of the patients had elevated leukocyte and neutrophil counts, while an elevated CRP level was observed in 57.1% of the patients [8]. In Egypt, research conducted in 2017 involving 150 patients showed that high WBC and high CRP values were associated with complicated appendicitis. Of those, 16% of patients had complicated appendicitis, 65.3% had uncomplicated appendicitis, and 18.7% had normal appendices [9].

In Libya, a study was conducted in Benghazi Children's Hospital, between October 2001 and May 2002.The study included 216 patients who were admitted with suspected acute appendicitis. The results showed that 114 of these patients had CRP values of more than 8 micrograms/mL, and 109 patients had a total WBC count of more than 11,000/micro-L [10]. Another study was conducted in Zawia, Libya, between January 1, 2014, and May 31, 2015. The study included 307 patients with acute appendicitis, and it was found that 74.5% of the patients had leukocytosis [11].

It is important to diagnose and treat Acute appendicitis promptly to avoid complications such as ruptured appendicitis and systemic sepsis. To aid in diagnosis, laboratory tests, such as the measurement of biomarkers, are widely available and useful in most clinical settings [5]. Our study aims to investigate the diagnostic value of two commonly measured biomarkers, white blood cell count and C-reactive protein, in the diagnosis of acute appendicitis.

METHODS

Study subject and data collection

A retrospective analysis was conducted on 350 patient files who underwent appendectomy. The files were selected from patients admitted to the Almasara Clinic in Tripoli, Libya, between August 2011 and July 2023. The age range of patients was between 18 and 80 years old. The data collected from the files included patient age, sex, white blood cell count, and C-reactive protein pre-admission. Patients with any other conditions were excluded from the study.

Data analysis

The statistical analysis was conducted using SPSS version 26 software. A statistical procedure was implemented to compare hematologic parameters in two groups (males and females) to determine if there were any significant differences between them. The means of WBC, neutrophil, lymphocyte, and CRP were compared between the two groups by an independent one-way analysis of variance (ANOVA). Differences are expressed as the mean ±

standard deviation (SD). A P value greater than 0.05 was considered insignificant.

RESULTS

This study included 350 files that were diagnosed with appendicitis. The results revealed that (51.7%) of the participants were males, while the remaining 48.3% were females. Among the research participants, around 33.1% were in the age range of 21 to 30 years. On the other hand, the age group with the least representation was those over the age of 60 years, accounting for only 2% of the total sample. Table1 provides a clear overview of the demographic characteristics of the appendicitis cases included in the study.

Table 1. Displays the demographic features of the sampled appendicitis patients

Characteristic	Frequency (n)	Percentage (%)
Gender		
Male	181	51.7%
Female	169	48.3%
Age (in years) (Mean ± SD = 31.35±11.38)		
20 or less	73	20.9%
21 to 30	116	33.1%
31 to 40	86	24.6%
41 to 50	53	15.1%
51 to 60	15	4.3%
More than 60	7	2%

Table 2 presents the laboratory results of white blood cells, neutrophils, lymphocytes, and C-reactive protein values for patients diagnosed with appendicitis. The study found that 69.4% of appendicitis patients had a WBC count higher than 10,000/μL, which is considered high. Only 30.6% of patients had WBC counts within the normal range of 4-10×10^3/μL, and none of the patients had WBC counts below 4,000/μL. The average WBC count for these patients was 13.48×10^3/μL.

Concerning neutrophils, our study revealed that slightly more than half of the participants (52.6%) had an increased neutrophil percentage, known as neutrophilia. Only 17.7% of the participants had a neutrophil percentage within the normal range of 45-70%, while 11.4% exhibited a low neutrophil percentage, referred to as neutropenia, below 45%.

Moreover, the results indicated that 64.3% of the patients with appendicitis had lymphopenia, indicating a decreased lymphocyte percentage lower than 20%. A lymphocyte percentage within the normal range of 20-40% was present in about 29.4% of the patients. However, 6.3% of the cases had a high lymphocyte percentage, known as lymphocytosis, which was greater than 40%.

Regarding CRP values, the study found that the majority of participants (76.5%) had a positive CRP result exceeding 5 mg/dl. Conversely, 23.5% of the participants had a negative CRP result, measuring less than 5 mg/dl.

Table 2. Displays the WBC, neutrophils, lymphocytes, as well as CRP levels of the sampled appendicitis patients.

Parameter	Frequency (n)	Valid percentage (%)
White Blood Cells (× 10^3/μL) (Mean ± SD = 13481.4±9006.24)		
>10,000	234	69.4%
4,000-10,000	103	30.6%
<4,000	0	0%
Neutrophils (%) (Mean ± SD = 67.9±25.24)		
>70%	184	52.6%
45-70%	62	17.7%
<45%	40	11.4%
Lymphocytes (%) (Mean ± SD = 28.55±171.08)		
>40%	18	6.3%
20-40%	84	29.4%
<20%	184	64.3%
C-Reactive Protein (mg/dl) (Mean ± SD = 43.82±62.40)		
Positive (≥5)	205	76.5%
Negative (<5)	63	23.5%

Table 3 shows a comparison of WBC and CRP values between male and female appendicitis cases. The results indicate that there was no significant difference between the two genders in terms of WBCs, neutrophils, lymphocytes, and CRP values (p>0.05). Notably, although the mean percent of lymphocytes was higher in females (39.18%)

compared to males (18.2%), this difference did not reach statistical significance (p=0.297).

Table 3. Shows the difference in mean and standard deviation of WBCs, neutrophils, lymphocytes, and CRP values between males and females in appendicitis cases

Parameter	Males (n=181)		Females (n=169)		ANOVA (f-statistic)	P-value
	Mean	SD	Mean	SD		
WBC ($\times 10^3/\mu L$)	13.9	4.33	12.99	12.02	0.994	0.319
Neutrophils (%)	67.05	26.63	68.79	23.8	0.339	0.561
Lymphocytes (%)	18.20	17.67	39.18	242.9	1.091	0.297
CRP (mg/dl)	43.23	61.87	44.46	63.21	0.014	0.904

WBC (White Blood Cell), CRP (C-Reactive Protein), SD (Standard Deviation).

DISCUSSION

The accurate and timely diagnosis of acute appendicitis is essential to ensuring prompt medical intervention and minimizing potential complications [4]. Laboratory diagnostic tools like complete blood count (CBC) and C-reactive protein (CRP) values have emerged as valuable approaches. Both CBC and CRP are widely used blood tests that provide essential insights into the inflammatory and infectious processes occurring within the body. When used together, these tests offer clinicians a comprehensive perspective on the severity and presence of inflammation, which helps in diagnosing acute appendicitis [4,7]. Therefore, this research highlights the significance of WBC and CRP values in the diagnosis of acute appendicitis, emphasizing their role in enhancing diagnostic accuracy and guiding clinical decision-making.

According to the findings of this study, acute appendicitis occurred more frequently in males than females (51.7% vs 48.3%). This result is consistent with a study conducted by Ulukent *et al* in 2016 [12]. In this research, about (69.4%) of patients diagnosed with appendicitis displayed an increased white blood cell count, which is a sign of inflammation in the body. This finding is consistent with the results of studies conducted by Daldal and Dagmura, which also found that the average WBC count was higher among patients with acute appendicitis [7]. Additionally, Zarrouk and Amanollahi, *et al* observed that 74.5% to 80% of appendicitis patients experienced leukocytosis [11,13]. The rise in WBC count is mainly because of the body's immune response to fight against infection or inflammation.

The current study illustrated that over half of men diagnosed with appendicitis had a slightly higher than normal count of neutrophils, as shown in Table 3. This is in line with the results of earlier studies by Ulukent *et al* and Saleem *et al.*, who reported neutrophil counts of 73% and 82%, respectively [12,14]. The presence of neutrophilia indicates an active role of the immune system in fighting bacterial infections and inflammation in the inflamed appendix [15].

According to our research, approximately 64.3% of patients diagnosed with appendicitis showed a decrease in lymphocyte count, with an average of 28.5% lymphocyte percentage. A prior study conducted by Virmani *et al* reported a lower percentage of lymphocyte count (14.8%) than our study, which may be associated with cases of complicated appendicitis [16]. The decrease in lymphocyte count could be due to the immune system's response to the infection or a relative increase in neutrophil count [17].

Based on our recent study, we found that 76.5% of the patients diagnosed with appendicitis had a positive CRP result. This result is in line with the findings of previous studies [12-13, 18]. Appendicitis is an inflammatory condition that occurs because of bacterial infection of the appendix. When the body identifies the presence of pathogens or tissue damage, it triggers an immune response, which includes the release of signaling molecules such as cytokines. These molecules stimulate the liver to produce CRP. High levels of CRP are a sign that the body has activated its acute phase response to combat inflammation [19].

CONCLUSION

Our study found that individuals with appendicitis have higher levels of leukocytes, neutrophils, and C-reactive protein, and decreased lymphocyte counts. Elevated WBC and CRP values together provide a

better specificity and positive predictive value than individual markers. While these biomarkers alone are not definitive diagnostic tools, they can be used cautiously along with clinical assessment and other diagnostic methods to help accurately and quickly diagnose acute appendicitis. This approach may reduce the risk of complications and unnecessary surgeries.

Declaration of competing interest. None.

REFERENCES

1. Di Saverio S, Podda M, De Simone B, Ceresoli M, Augustin G, Gori A, et al. Diagnosis and treatment of acute appendicitis: 2020 update of the WSES Jerusalem guidelines. World J Emerg Surg. 2020 Apr 15;15(1):27. doi: 10.1186/s13017-020-00306-3 .
2. Hansson J, Khorram-Manesh A, Alwindawe A, Lundholm K. A model to select patients who may benefit from antibiotic therapy as the first line treatment of acute appendicitis at high probability. J Gastrointest Surg. 2014 May;18(5):961-7.
3. Boshnak N, Boshnaq M, Elgohary H. Evaluation of Platelet Indices and Red Cell Distribution Width as New Biomarkers for the Diagnosis of Acute Appendicitis. J Invest Surg. 2018 Apr;31(2):121-129.
4. Yang J, Liu C, He Y, Cai Z. Laboratory Markers in the Prediction of Acute Perforated Appendicitis in Children. Emerg Med Int. 2019 Sep 19;2019:4608053.
5. Yu CW, Juan LI, Wu MH, Shen CJ, Wu JY, Lee CC. Systematic review and meta-analysis of the diagnostic accuracy of procalcitonin, C-reactive protein and white blood cell count for suspected acute appendicitis. Br J Surg. 2013 Feb;100(3):322-9.
6. Yokoyama S, Takifuji K, Hotta T, Matsuda K, Nasu T, Nakamori M, Hirabayashi N, Kinoshita H, Yamaue H. C-Reactive protein is an independent surgical indication marker for appendicitis: a retrospective study. World J Emerg Surg. 2009 Oct 31;4:36.
7. Daldal E, Dagmura H. The Correlation between Complete Blood Count Parameters and Appendix Diameter for the Diagnosis of Acute Appendicitis. Healthcare (Basel). 2020 Feb 13;8(1):39.
8. Syed S, Naji H. A retrospective analysis of acute appendicitis in children treated with laparoscopic appendectomies at a single center in Dubai, UAE. Dubai Medical Journal. 2021;4(3):225-230.
9. Al-Abed YA, Alobaid N, Myint F. Diagnostic markers in acute appendicitis. Am J Surg. 2015 Jun;209(6):1043-7. doi: 10.1016/j.amjsurg.2014.05.024.
10. Mohammed AA, Daghman NA, Aboud SM, Oshibi HO. The diagnostic value of C-reactive protein, white blood cell count and neutrophil percentage in childhood appendicitis. Saudi Med J. 2004 Sep;25(9):1212-5.
11. Zarrouk, M. Acute Appendicitis A Study Carried out in Zawia Teaching Hospital. University Bulletin. 2016;18(4):24-34.
12. Anand S, Krishnan N, Jukić M, Križanac Z, Llorente Muñoz CM, Pogorelić Z. Utility of Red Cell Distribution Width (RDW) as a Noninvasive Biomarker for the Diagnosis of Acute Appendicitis: A Systematic Review and Meta-Analysis of 5222 Cases. Diagnostics (Basel). 2022 Apr 17;12(4):1011.
13. Amanollahi O, Salimi J, Diaz D. Diagnostic value of inflammatory markers (complete blood count, erythrocyte sedimentation rate, and C-reactive protein) in children with acute appendicitis. Annals of Pediatric Surgery. 2014;10(2):39-41.
14. Saleem M, Pervaiz M, Chaudhary I. Predictive Value of Leukocytosis for Diagnosing Acute Appendicitis. Pakistan Armed Forces Medical Journal. 2017;67(Suppl-3):S292-96.
15. Jones MW, Lopez RA, Deppen JG. Appendicitis. 2023 Apr 24. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan–. PMID: 29630245.
16. Virmani S, Prabhu PS, Sundeep PT, Kumar V. Role of laboratory markers in predicting severity of acute appendicitis. Afr J Paediatr Surg. 2018 Jan-Mar;15(1):1-4. doi: 10.4103/ajps.AJPS_47_16.
17. Delgado-Miguel C, Miguel-Ferrero M, García A, Delgado B, Camps J, Martínez L. Neutrophil-to-lymphocyte ratio as a predictor of postoperative complications and readmissions after appendectomy in children. Updates Surg. 2023 Dec;75(8):2273-2278.
18. Ghimire R, Sharma A, Bohara S. Role of C-reactive Protein in Acute Appendicitis. Kathmandu Univ Med J (KUMJ). 2016 Apr-Jun;14(54):130-133.
19. Raza A, Bilal H, Hadees M, Qudoos A, Shabbir G. Normal Total Leukocyte Count in Patients Despite Acute Appendicitis Clinically and Preoperatively. Pakistan Journal of Medical & Health Sciences, 2023;17(02):605-605.