Does Elevated White Blood Cell (WBC) Count Aid in the Diagnosis of Acute Appendicitis?

Ali Alhawaj, MBBCh, BAO*

Background: Acute appendicitis (AA) is one of the most common surgical emergencies worldwide.

Objective: To evaluate the clinical value of elevated white blood cell (WBC) count in the diagnosis of AA.

Design: A Retrospective Study.

Setting: Salmaniya Medical Complex, Bahrain.

Method: Two hundred twenty-eight patients who underwent appendectomy were included in this study. Histological results were reviewed and compared with the preoperative WBC counts and analyzed. Patients were divided according to their postoperative histological reports: normal appendix, uncomplicated inflamed appendicitis and complicated appendicitis.

Result: Fifteen (6.6%) had normal appendix, 175 (75.7%) had uncomplicated inflamed appendicitis and 38 (16.7%) had complicated appendicitis. The levels of WBC were higher in the appendicitis groups compared to the normal appendix group. The cut-off WBC value was found to be 9.995x103 with 65.67 sensitivity and 60% specificity. The Negative Predictive Value (NPV) was 11.54.

Conclusion: The WBC count as a single measure has not been found to be of clinical value in the diagnosis of AA. The sensitivity is not enough to rule out AA. Surgeons should not depend on elevated WBC as a single measure. Diagnosis of acute appendicitis is a clinical diagnosis.

Bahrain Med Bull 2020; 42 (1): 28 - 30

AA remains to be one of the most common surgical emergencies for a general surgeon. However, the diagnosis is still a dilemma for surgeons as no single measure is found to be effective in its diagnosis. The need for an objective measure in the management of AA is still under investigation. This is due to the frequent errors in diagnosis and the non-negligible rate of negative explorations (reaching up to 20%)[1]. In addition, even with the use of imaging, the diagnosis is still challenging in some cases[2].

In suspected patients with AA, the management is usually based on the clinical picture, associated with laboratory findings including the total white blood cells (WBCs), C-reactive protein, leukocyte elastase activity, granulocytes, and other parameters[3,4].

The diagnostic accuracy of WBC count has been questioned in several studies. However, studies still have shown a clear association between the diagnosis of AA and high WBC count, despite the variation in its significance[5]. Moreover, some studies focused on whether normal levels of WBCs can rule out AA. The high NPV found when the WBCs were within normal limits shows that it may be a reliable measure[3].

The aim of the study is to evaluate the clinical value of elevated white blood cell (WBC) count in the diagnosis of AA.

METHOD

Two hundred twenty-eight patients who underwent appendectomy were included in the study, 92 were females and were 136 males. The diagnosis was established based on clinical suspicion and laboratory findings. Personal characteristics, WBCs, neutrophil counts and the histopathology findings were documented. Patients who underwent incidental appendectomy and patients who were on immunosuppressive medications/ steroids were excluded from the study.

Patients were divided into three groups: normal appendix, uncomplicated inflamed appendicitis, and complicated appendicitis (perforated gangrenous appendix).

The data were expressed as means of +/− standard deviations [SD] or percentage. Statistical analysis was done using SPSS and MedCalc for Windows, version 5.0. The diagnostic properties of WBCs and neutrophils count were expressed as means of likelihood ration[6]. LR (+) describes the true-positive rate (in diseased patients) and the false-positive rate (in non-diseased patients). LR>10 usually indicated a true diagnostic test, while LR<0.1 signifies an exclusion test. Confidence intervals of 95% were used and a P-value of <0.05 was considered to be statistically significant.

RESULT

Two hundred and twenty-eight patients who underwent appendectomy were included in this study; 92 (40.4%) were females and 136 (59.6%) were males, P<0.0001.

Table 1 shows the personal characteristics of the patients, in addition to the type of operation performed. Two-hundred five (89.9%) patients underwent open appendectomies, and 23 (10.1%) patients underwent laparoscopic appendectomies.

* Senior Resident
Department of General Surgery
Salmaniya Medical Complex
Kingdom of Bahrain
E-mail: dr.ali.alhawaj@gmail.com

Table 1: Personal Characteristics

Parameters	All Patients (n=228)
Gender	
Male	136 (59.6%)
Female	92 (40.4%)
Significance (P< 0.0001)	
Age (Years)	24.25 +- 6.9 (15.00 – 56.00)
Type of Operation	
Open Appendectomy	203 (89%)
Laparoscopic Appendectomy	25 (10.9%)
Significance (P<0.0001)	

Data expressed as means of +/− SD range) or percentage (%) Significance between variables was made using nonparametric Chi-Square test

The mean of WBCs counts and neutrophils percentages are shown in table 2 and plotted against the 3 groups according to the final histopathological findings. Fifteen (6.6%) had normal appendix (group 1), 175 (75.7%) had uncomplicated inflamed appendicitis (group 2) and 38 (16.7%) had complicated appendicitis (perforated gangrenous appendix) (group 3). WBCs and neutrophils counts were higher in the complicated (P<0.001, P<0.001) and the inflamed (P<0.019, P<0.045) groups compared to the normal appendix group.

Table 2: Laboratory Characteristics of Patient Subgroups

Parameters	Normal Appendix N=15 (6.5%)	Appendicitis N=213 (101.3%)	
		Inflamed N=175 (76.7%)	Complicated N=38 (16.6%)
Laboratory Investigations			
WBC count (× 103/mm3)	7.912 +- 2.64 (4.60-10.6)	12.08 +- 8.47 (4.2-20.3)	17.64+-4.22 (13.12-22.01)
Significance		*P<0.019	*P<0.001, **P<0.045
Neutrophil Percentage	68.42 +-17.05 (52.2-88.1)	75.01+- 23.8 (43.5-93.7)	84.36 +- 9.02 (75.0-94.0)
Significance		*P<0.045	*P<0.001 **P<0.004

Data are expressed as means of +/− SD (range) or percentage (%). Significant between subgroups was made using Chi-Square test (P) for non-parametric parameters and *ANOVA test for parametric parameters, P significance between all groups, *P significance versus controls, **P significance versus inflamed appendix.

Patients with inflamed appendix compared to a normal appendix had a cut-off value for the WBCs count of 9.995x103 with 65.67% sensitivity and 60% specificity, see table 3. While a cut-off point of 71.715 % was seen in the neutrophil percentage test. However, in the normal compared to complicated appendix subgroups, the WBC cut-off was 12.775x103 with a sensitivity of 93.94 and a specificity of 93.33. The LR (+) was 14.09 and LR (-) was 0.06.

Table 3: Performance Characteristics Estimate of Normal versus Different Groups

Parameters	Cutoff point	Sensitivity	Specificity	PPV	NPV	LR(+)	LR(-)
Normal versus Inflamed Appendix (n=190)							
WBCs count 95% Cis	9.995x103	65.67 (58.66-72.21)	60 (32.29-83.66)	95.65 (92.15-97.63)	11.54 (7.64-17.06)	1.64 (0.88-3.08)	0.57 (0.36-0.9)
Neutrophil percentage 95% Cls	71.715%	68.66 (61.75-75)	66.67 (38.38-88.18)	96.5 (93.06-98.27)	13.7 (9.5-19.34)	2.06 (1-4.24)	0.47 (0.31-0.71)
Normal versus Complicated Appendix (n=53)							
WBCs count 95% Cis	12.775x103	93.94 (79.77-99.26)	93.33 (68.05-99.83)	96.88 (82.32-99.52)	87.50 (64.47-96.43)	14.09 (2.12-93.79)	0.06 (0.02-0.25)
Neutrophil Percentage 95% Cls	76.39%	90.91 (75.67-98.08)	60 (32.29-83.66)	83.3 (72.72-90.37)	75 (48.58-90.5)	2.27 (1.21-4.26)	0.15 (0.05-0.48)

WBCs white blood cells, 95% CIs 95% confidence intervals, NPV negative predictive value, PPV positive predictive value, LR likelihood ratio.

DISCUSSION

AA remains one of the most common surgical conditions presenting with acute abdominal pain. Appendectomy is the most common emergency surgical procedure. The diagnosis of AA is not only made based on a single radiological or laboratory measure. However, it is a sum of clinical presentations including history, physical examination and routine laboratory tests in addition to supportive imaging studies. Despite all that, the diagnosis remains to be challenging especially in atypical presentations.

Computed tomography (CT) and ultrasonography (US) have not been found to decrease the number of negative appendectomies[7]. Over the last few decades, several studies highlighted the use of certain inflammatory markers to increase the diagnostic accuracy of AA[3].

The elevated WBCs count was the earliest among other laboratory tests to indicate inflamed appendix[8]. Grönroos et al was the first to report that elevated WBCs count as early marker for AA in adults[3].

In our study, complicated appendix had significantly higher WBCs and neutrophil counts than normal. On the other hand, several other studies contradict this finding[9,10]. Yokoyama et al reported that WBCs count was not found to be useful for surgical indication in AA[11]. The use of sensitivity, specificity, PPV, and NPV can be difficult as both PPV and NPV are depending on disease prevalence. However, the use of likelihood-ratios LR (+) allows the surgeon to assess the likelihood that a patient with a given test, such as high WBCs, has the disease; it is independent of the disease prevalence. Gronroos et al had reported that the use of WBCs is a poor indicator of AA due to its low specificity[12]. Our study result was comparable to international studies with regard to the sensitivity and specificity of WBC counts[13].

Elevated total WBCs could lead to an earlier decision to operate on patients even when the clinical picture is not warranting so. On the other hand, normal WBCs count could also delay necessary intervention. Moreover, Guss et al have found an association between a higher rate of appendicular perforation and normal WBCs count patients[14].

CONCLUSION

WBCs and neutrophil counts should not be used as a diagnostic criterion in AA. The clinical picture is still superior in the diagnosis of AA. The sensitivity is not sufficient to rule out AA by WBCs. Moreover, WBCs alone is not preventive against negative appendectomies.

Author Contribution: All authors share equal effort contribution towards (1) substantial contributions to conception and design, acquisition, analysis and interpretation of data; (2) drafting the article and revising it critically for important intellectual content; and (3) final approval of the manuscript version to be published. Yes.

Potential Conflicts of Interest: None.

Competing Interest: None.

Sponsorship: None.

Acceptance Date: 19 August 2019.

Ethical Approval: Approved by Ethical and Training Committee of General Surgery Department, Salmaniya Medical Complex, Bahrain.

REFERENCES

1. Yang HR, Wang YC, Chung PK, et al. Laboratory Tests in Patients with Acute Appendicitis. ANZ J Surg 2006; 76(1–2):71–74.
2. Flum DR, McClure TD, Morris A, et al. Misdiagnosis of Appendicitis and the Use of Diagnostic Imaging. J Am Coll Surg 2005; 201(6):933–939.
3. Grönroos JM, Forsström JJ, Irjala K, et al. Phospholipase A2, C-Reactive Protein, and White Blood Cell Count in the Diagnosis of Acute Appendicitis. Clin Chem 1994; 40(9):1757–1760.
4. Cağlayan F, Cakmak M, Cağlayan O, et al. Plasma D-Lactate Levels in Diagnosis of Appendicitis. J Invest Surg 2003; 16(4):233–237.
5. Grönroos JM, Grönroos P. Leucocyte Count and C Reactive Protein in the Diagnosis of Acute Appendicitis. Br J Surg 1999; 86(4):501–504.
6. Zweig MH, Campbell G. Receiver-Operating Characteristic (ROC) Plots: A Fundamental Evaluation Tool in Clinical Medicine. Clin Chem Clin Chem 1993; 39(4):561–577.
7. Flum DR, McClure TD, Morris A, et al. Misdiagnosis of Appendicitis and the Use of Diagnostic Imaging. J Am Coll Surg 2005; 201(6):933–939.
8. Hallan S, Asberg A, Edna TH. Additional Value of Biochemical Tests in Suspected Acute Appendicitis. Eur J Surg 1997; 163(7):533–538.
9. Wolfe JM, Henneman PL. In: Rosen's Emergency Medicine: Concepts and Clinical Practice. 3. Marx JA, Hockberger RS, Walls RM, eds. Acute Appendicitis. St. Louis, MO: Mosby; 2002; 1293–1294.
10. Sarosi GA, Turnage RH. In: Sleisenger and Fortran's Gastrointestinal and Liver Disease. 7. Feldman M, Friedman LS, Sleisenger MH, eds. Appendicitis. Philadelphia, PA: Elsevier; 2002; 2092.
11. Yokoyama S, Takifuji K, Hotta T, et al. C-Reactive Protein is an Independent Surgical Indication Marker for Appendicitis: A Retrospective Study. World J Emerg Surg 2009; 4:36.
12. Gronroos JM. Do Normal Leucocyte Count and C-Reactive Protein Value Exclude Acute Appendicitis in Children? Acta Paediatr 2001; 90(6):649–651.
13. de Carvalho BR, Diogo-Filho A, Fernandes C, et al. Leukocyte Count, C-Reactive Protein, Alpha-1 Acid Glycoprotein and Erythrocytes Sedimentation Rate in Acute Appendicitis. Arq Gastroenterol 2003; 40(1):25–30.
14. Guss DA, Richards C. Normal Total WBC and Operative Delay in Appendicitis. Cal J Emerg Med 2000; 1(2):7–8.