

Original Article

Role of White Cell Count and Neutrophil Differential in Diagnosis of Acute Appendicitis

Jamal T. Hamdi

Department of Surgery, Umm Al-Qura University, Makkah, KSA.

Correspondence:

Jamal T. Hamdi

Associate Professor of Surgery

P.O.Box:8343, Faculty of Medicine, Umm Al-Qura University

Makkah

Mobile: 0509506820

e.mail: jthamdi@uqu.edu.sa

Received: April 11, 2011

Accepted: May 16, 2011

دور عدد كرات الدم البيضاء والعدلات التفاضلية في تشخيص التهاب الزائدة الدودية

د. جمال حمدي

قسم الجراحة، كلية الطب - جامعة أم القرى - ص. ب: 8343 - مكة المكرمة - المملكة العربية السعودية

الملخص العربي

التهاب الزائدة الدودية الحاد هو أكثر حالات جراحية حادة في اللشبطونص ال دقيق لالتهاب الزائدة الدودية صعب ، مما يؤدي إلى ارتفاع معدلات استكشاف البطن السلبية خاصة في الإناث ، وكذلك تأخر التشخيص وانفجار الزائدة الدودية عند أخريتاول هذه الورقة تقييم دقة التشخيص من مزيج من عدد كرات الدم البيضاء والنسبة المئوية للعدلات التفاضلية على تشخيص التهاب الزائدة الدودية الحاد.

المنهجية: دراسة استطلاعية أجريت على مائة مريض أزيلت منهم الزائدة الدودية. تم قياس عدد كرات الدم البيضاء والعدلات التفاضلية لكل مريض. تم حساب الحساسية والنوعية والقيمة التنبؤية الإيجابية والقيمة التنبؤية السلبية لكل اختبار بمفرده وبالاشتراك مع الاختبار الأخر على قيم مختلفة ومتنوعة.

النتائج: كان هناك 46 من الذكور و 54 من الإناث ، مع 80 ٪ من المرضى في نطاق 10 الي 30 عاما. وعثر على الزائدة الدودية ملتهبة في 80،4 ٪ من الذكور ، و 64،8 ٪ من المرضى من الإناث. وكان خصوصية كرات الدم البيضاء 100 ٪ إذا تم تعيين القيمة في ($16 < 10^9$ / لتر) ، والعدلات التفاضلية 93 ٪ إذا تم تعيين القيمة < 85 ٪ الحساسية والنوعية والقيمة التنبؤية الإيجابية والقيمة التنبؤية السلبية والكفاءة لاختبار كرات الدم البيضاء $< 10 \times 10^9$ / لتر ، والعدلات التفاضلية < 75 ٪ التي هي الحدود العليا من الاختبارات العادية تم قياسها علي حده، بالإضافة الي مزيج من الاختبارين.

مناقشة: في هذه الدراسة كرات الدم البيضاء $< 10 \times 10^9$ / لتر والعدلات التفاضلية < 75 ٪ أعطت أعلى كفاءة 75 ٪ لكل اختبار علي حده. الجمع بين الاختبارين أدى إلي كفاءة 83 ٪ ، وحساسية من 93،1 ٪ ، والقيمة التنبؤية الإيجابية من (84.8 ٪) ، وهو مستوي معقول لتشخيص التهاب الزائدة الدودية الحاد ، وتجنب عمليات الاستكشاف السلبية.

ABSTRACT

Acute appendicitis is the most common severe surgical condition of the abdomen. The accurate diagnosis of appendicitis is difficult, resulting in a higher incidence of negative laparotomies especially in females, as well as delayed diagnosis and rupture of appendix in others. The aim of the present work was to assess the diagnostic accuracy of the combination of white cell count (WCC) and neutrophil differential (ND) on the diagnosis of acute appendicitis.

Methodology: A prospective study was carried out on one hundred consecutive patients. The white cell count (WCC) and neutrophil differential (ND) tests were done for every patient. The sensitivity (SN), specificity (SP), positive predictive value (PPV), and negative predictive value (NPV) of the individual test were assessed at different values. The SN, SP, PPV, NPV, and efficiency of $WCC > 10 \times 10^9/L$, and $ND > 75\%$ which are the upper limits of normal tests, were measured, as well as the combination of the two tests.

Results: There were 46 males and 54 females with 80% of the patients in the range 10 to 30 years. The acutely inflamed appendix was found in 80.4% of male, and 64.8% of female patients. The specificity of the WCC was 100 if the value was set at $(> 16 \times 10^9/L)$, and of ND was 93 if the value was set as $> 85\%$.

Conclusion: In this study WCC at cut off $> 10 \times 10^9/L$ and $ND > 75\%$ gave the highest efficiency of 75% for each test on its own. The combination of the two tests gave an efficiency of 83%, a sensitivity of 93.1%, and positive predictive value of (84.8%), which is reasonably accurate to diagnose acute appendicitis, and avoid negative laparotomy.

Keywords: White cell count, neutrophil differential, specificity, sensitivity.

INTRODUCTION

Acute appendicitis is the most common severe surgical condition of the abdomen^[1]. The overall mortality rate for appendicitis is less than 1%, but it increases to 3% if the appendix is ruptured and approaches 15% in the elderly.² The diagnosis of appendicitis is more difficult in the extremely young and the elderly, resulting in a higher incidence of delayed diagnosis and rupture in these populations. Because a ruptured appendix can be associated with increased morbidity and mortality, it is felt that a certain number of negative laparotomies is acceptable (approximately 15% in the United States). However, negative laparotomies are twice as common in young women as in men (20% vs. 9%, respectively).^{3,4}

Combining various signs and symptoms into a scoring system may be more useful in predicting the presence or absence of appendicitis. The Alvarado score, originally described in 1986, is the most widely reported scoring system for acute appendicitis⁵ (Table 1). The Alvarado score combines patient symptoms, physical examination results, and laboratory values to assign a score from 0 to 10.

Table 1: Alvarado score in acute appendicitis.

		Value
Symptoms	Migration	1
	Anorexia-acetone (in the urine)	1
	Nausea-vomiting	1
Signs	Tenderness in right lower quadrant	2
	Rebound pain	1
	Elevation of temperature (>37.3°C measured orally)	1
Laboratory	Leukocytosis (>10,000/mm ³)	2
	Shift to the left (>75% neutrophils)	1
Total score		10

Wang⁶ reported a positive likelihood ratio of 9.8 for both elevated white blood cells (WBC) count and left shift, but the diagnostic value of the WBC count remains controversial⁷. Many authors found a relatively unimpressive positive likelihood ratio (LR) between 1.59 and 2.7 and a negative ratio between 0.25 and 0.50 for the WBC count in appendicitis.^{8, 9, 10, 11}

Nearly over 50% of all emergency appendectomies were performed on normal or mildly inflamed appendix. This figure rises to 60% if we consider females alone.^{12, 13} These patients would definitely benefit from conservative treatment with observation and antibiotics, if we can identify them preoperatively.^{14, 15} Hence the recent trend for more conservative treatment and more diagnostic accuracy of non inflamed appendix to avoid negative appendectomies. This paper tries to assess the diagnostic accuracy of the combination of white cell count (WCC) and neutrophil differential (ND) on the diagnosis of acute appendicitis.

MATERIAL AND METHODS

This was a prospective study which was carried on one hundred consecutive patients admitted with the diagnosis of acute appendicitis through the emergency room of a district hospital and subjected to surgery for that diagnosis. The white cell count (WCC) and neutrophil differential (ND) tests were done for every patient prior to surgery. The histopathology of the removed appendix was taken as the golden standard for the presence or the absence of acute appendicitis. Different values of WCC and ND were assessed against the presence or absence of acute appendicitis. The sensitivity (SN), specificity (SP), positive predictive value (PPV), and negative predictive value (NPV) of the individual test were assessed at different values including the upper normal limit of each test and for the combination of the two tests.

RESULTS

A total on one hundred patients were included in this study. There were 46 males and 54 females. The range of age was from 7 years to 45 years, with 43% between 10 to 20 years, and 37% between 20 to 30 years, accordingly, 80% of the patients were in the range 10 to 30 years. According to the histopathology records; acute appendicitis either perforated or non-perforated was found in 72% compared to normal appendix in 28%. The acutely inflamed appendix was found in 37 males (80.4% of all males), and 35 females (64.8% of all females).

Table (2) shows the mean values of WCC and ND in both acutely inflamed appendix and normal appendix groups. Using t-test there is a significant difference ($p < 0.05$) between the two groups in both WCC and ND.

Table 2: showing the mean values of WCC and ND in both appendicitis and non-appendicitis groups.

Test	Total	Appendicitis	Non-appendicitis
WCC($\times 10^9/L$)	10.8	11.7	8.5
ND (%)	72%	77%	59%

The specificity of the WCC was 100 if the value was set at ($>16 \times 10^9/L$), but the sensitivity was only 19.4 at that set value, which means that if you suspect acute appendicitis and $WCC > 16 \times 10^9/L$, then it is very likely that the appendix is inflamed, but only a small proportion of acute appendicitis present at that level.

The specificity of the ND was 93 if the value was set as $>85\%$, but the sensitivity at that value was only 33.3, which means that if you suspect acute appendicitis and $ND > 85\%$ then it is likely that the appendix is inflamed, but only a third of acute appendicitis can be detected at that level (Table 3).

Table 3: showing Sensitivity and Specificity to WCC ($>16 \times 10^9/L$) and ND ($>85\%$)

Test	Sensitivity	Specificity
WCC $> 16 \times 10^9/L$	19.4	100
ND $> 85\%$	33.3	93

Table(4) shows the sensitivity(SN), Specificity(SP), positive predictive value(PPV), negative predictive value(NPV), and efficiency of $WCC > 10 \times 10^9/L$ which is considered as the upper limit of normal WCC, and $ND > 75\%$ which is considered also as the upper limit of normal neutrophil percentage. The combination of these two upper normal limits of WCC and ND is also shown in the table. The relative efficiency of these two tests is 83, comparing with a figure of 75 for each test on its own.

Table 4: showing SN, SP, PPV, NPV and efficiency of WCC $> 10 \times 10^9/L$ and ND $> 75\%$ and the combination of the two tests

Test	SN	SP	PPV	NPV	Efficiency
WCC $> 10 \times 10^9/L$	76.4	71.4	87.3	54	75%
ND $> 75\%$	79.2	64.3	85	54.6	75%
WCC+ND	93.1	57	84.8	76.2	83%

DISCUSSION

This was a prospective clinical study on 100 consecutive patients with appendectomy operations. Appendiceal inflammation proved by histopathology in 72%, with negative laparotomy in 28% and perforation in 9%. These figures are compatible with other studies with laparotomy ranging from 11-76% and perforation rate ranging from 8-29%.^{3,15,16} The diagnostic accuracy was 80.4% for males, but only 64.8% for females, which is compatible with other studies.^{15,16,17}

The mean values for WCC and ND of the appendicitis group were $11.7 \times 10^9/L$ and 76.9%. In non-appendicitis group the values were $8.49 \times 10^9/L$ and 59.3% respectively. There was a significant difference between the mean values of the groups, which reflects clinical values of WCC and ND in the diagnosis of acute appendicitis.

The diagnostic accuracy of any test could be improved by changing the cut off values above which the test is considered positive. By lowering this level the sensitivity of the test increases, but at the expense of the specificity of the test. If the cut off is elevated then the sensitivity detected by the test decreases, while the specificity increases. The optimal discriminating point is that one which gives the highest efficiency.

In this study WCC at cut off $>10 \times 10^9/L$ and ND $>75\%$ gave the highest efficiency of 75% for each test on its own. The combination of the two tests gave an efficiency of 83%, which is reasonably good for any test or combination of tests. Also this combination has a sensitivity of 93.1%, which means that the false negatives are very low relative to the true positives. Also the positive predictive value is reasonably good (84.8%), which means that the false positives are reasonably low relative to true positives.

The clinical application of this data means that if you apply this combination of tests on clinically suspected cases of acute appendicitis, then you can pick up the vast majority of true acute appendicitis. Good clinical acumen would compensate for the low specificity and reduce the rate of negative appendectomy operations.

ACKNOWLEDGEMENT

Special thanks and gratitude to Dr Ala Hasan; my ex-resident for his great help in the conduction of the study.

REFERENCES

1. Liu CD, McFaden DW. Acute abdomen and appendix. In: Greenfield LJ, (ed.) *Surgery: Scientific Principles and Practice*, Philadelphia: Lippincott-Raven, 1997: 1246-1261.
2. Yeh B: Does this adult patient have appendicitis?. *Ann Emerg Med* 2008 ;52: 301-303.
3. Velanovich V, Satava R: Balancing the normal appendectomy rate with the perforated appendicitis rate. *Am Surg* 1991; 52: 264-269.
4. Colson M, Skinner KA, Dunnington G: High negative appendectomy rates are no longer acceptable. *Am J Surg* 1997; 174: 723-727.
5. Alvarado A.: A practical score for the early diagnosis of acute appendicitis. *Ann Emerg Med* 1986; 15: 557-564.
6. Wang LT, Prentiss KA, Simon JZ, et al: The use of white blood cell count and left shift in the diagnosis of appendicitis in children. *Pediatr Emerg Care* 2007; 23: 69-76.
7. Raftery AT: The value of the white blood cell count in the diagnosis of acute appendicitis. *Br J Surg* 1976; 63: 143-144.
8. Andersson RE: Meta-analysis of the clinical and laboratory diagnosis of appendicitis. *Br J Surg* 2004; 91: 28-37.
9. Cardall T, Glasser J, Guss DA: Clinical value of the total white blood cell count and temperature in the evaluation of patients with suspected appendicitis. *Acad Emerg Med* 2004; 11: 1021-1027.
10. Kessler N, Cyteval C, Gallix B, et al: Appendicitis: evaluation of sensitivity, specificity, and predictive values of US, Doppler US, and laboratory findings. *Radiology* 2004; 230: 472-478.
11. Birchley D.: Patients with clinical acute appendicitis should have pre-operative full blood count and C-reactive protein assays. *Ann R Coll Surg Engl* 2006; 88: 27-32.
12. Rao PM, Rhea JT, Novelline RA, Mostafavi AA, McCabe CJ. Effect of computed tomography of the appendix on treatment of patients and use of hospital resources. *N Engl J Med* 1998; 338(3): 141-146.
13. Bijnen C, van den Broek W, Bijnen A, Ruiter P, Gouma D. Implications of removing a normal appendix. *Digestive Surgery* 2003; 20(3): 215-221.
14. Liu K, Ahanchi S, Pisaneschi M, Lin I, Walter R. Can acute appendicitis be treated by antibiotics alone? *Am Surg* 2007; 73(11): 1161-1165.
15. Hamdi J. Is there a Place for Conservative Treatment of Acute Appendicitis? *JKAU: Medical Sciences* 2010; 17 (1) : 11-17.

16. Seetahal S, Bolorunduro O, Sookdeo T et al. Negative appendectomy: a 10-year review of a nationally representative sample *The American Journal of Surgery* 2011; 201: 433–437.
17. Sakorafas G, Mastoraki A, Lappas C, Sampanis D, Danias N, Smyrniotis V. Conservative treatment of acute appendicitis: heresy or an effective and acceptable alternative to surgery? *European Journal of Gastroenterology & Hepatology*.2011 23(2):121-127.