

Investigating cell blood counter and abdominal radiography accuracy in diagnosis of acute suppurative appendicitis among patients under surgery

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ABSTRACT

Background: Acute appendicitis is the most common surgical emergencies; while unusual symptoms have a differential diagnosis. This study aimed to determine the diagnostic accuracy of CBC and abdominal X-ray in acute suppurative appendicitis. **Methods:** This cross-sectional study was performed on 198 patients. For all patients, complete blood count and abdominal X-ray were recorded. The pathological report after surgery was the gold standard for diagnosis. Then indicators of the validity of tests CBC, X-ray and neutrophil to lymphocyte ratio, consisted of positive predictive value (PPV) and negative predictive value (NPV), sensitivity, specificity, were analyzed. **Results:** Out of patients, 133 of patients were male (67.2%), and 65 (32.8%) were female with mean age of 29.13 years. Acute appendicitis confirmed in 77.8% of pathological study, and 17.7% was the normal appendix. Leukocytosis, NLR and abdominal X-ray tests, each have a sensitivity of 89.5%, 78.5% and 100%, specificity of 31.4%, 31.4% and 31.8%, PPV 85.8%, 84.2% and 53.9%, NPV 39.2%, 23.9% and 100%, respectively. There was a significant relationship between appendicitis and WBC > 10,000 and abdominal radiography findings. **Conclusion:** Due to the sensitivity of performing CBC and leukocytosis and NLR is at an acceptable level, especially with a relatively high positive predictive value, could be concluded that the positivity of these tests for confirming the diagnosis in suspected cases might be helpful and can help to strengthen the clinical diagnosis. Our results in relation to the x-ray of the abdomen suggest its usefulness in the diagnosis of appendicitis.

Key words: Abdominal X-ray, Appendicitis, Leukocytosis, Sensitivity, Specificity

INTRODUCTION

Acute appendicitis (AA) is one of the most common causes of acute abdominal pain that leading to surgical interventions so that the prevalence of this disease in the general population of the world is estimated at 7-16%^{1,2}. In most cases, the reason of AA is unknown, but obstruction of the appendiceal lumen can be considered as one of the most important causes. The importance of AA is that, if delayed in diagnosis and surgery, due to the possibility of rupture of the appendix, it could lead to the patient's death¹. The clinical symptoms of AA are not the same in the different patients. After abdominal pain, which is early symptom nausea and vomiting, anorexia, diarrhea and urinary symptoms, fever and mild tachycardia can be seen¹⁻³.

Diagnosis of AA can be challenging due to ambiguous or similar symptoms to other diseases. However, the physical examination of the patient, a complete review of medical records, the consideration of the clinical symptoms, along with diagnostic tests and imaging

studies, will allow the correct diagnosis of AA⁴. The degree of white blood cell examination, the value of C-reactive protein and a history of fever have been studied widely for the diagnosis of patients with suspected appendicitis; however, absence adequate specificity and lack of these laboratory parameters may significantly reject the diagnosis of AA⁵. Imaging examinations due to having the high potential for initial diagnosis and the high sensitivities and specificities of these techniques are more effective when the diagnosis is doubted⁶⁻⁸. Since the wrong diagnosis of AA results in the unnecessary surgery which called "negative appendectomy" with rates up to 40%; also, postponement of surgery treatment could encourage the progress of complications and high mortality^{9,10}. Therefore, it is crucial that the surgeon relies on all clinical examination and experience to avoid these complications.

This study aims to evaluate the CBC diagnosis precision and abdominal radiography in acute appendicitis among patients under surgery at general hospitals of Lorestan Province, Iran.

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METHODS

Patients

This cross-sectional study was performed on 198 patients refereeing to general hospitals of Lorestan Province, Iran from January 2013 to February 2014; who satisfied the following inclusion criteria: suspected acute appendicitis, hospital admission, and signed informed consent by the parents. Moreover, patients with underlying disease and also immunodeficiency disorders were excluded from this study.

Ethics

Approval of the local ethics committee had been obtained from Lorestan University of Medical Sciences, Khorramabad, Iran; and patients were informed about the study, and written consents were taken.

Procedure

The study was done by the same trained surgical team at the Department of General Surgery of Ashayer Hospital of Lorestan Province, Iran. Due to the prevailing set-up, appendicectomies are usually performed as an emergency surgery, predominantly by general surgeons. Venous blood was routinely taken on admission and was sent to the emergency laboratory, and complete blood count and abdominal x-ray were requested for all patients before surgery. WBC count equal to or higher than $10 \times 10^3/\text{mm}^3$ was considered as leukocytosis. Neutrophil to lymphocyte ratio (NLR) higher than 3.5 was considered positive; the following radiographic findings, if there, for each patient were recorded and entered as positive or negative in the checklist.

- Appendicitis in the right lower quadrant
- Local ileus in the right lower quadrant
- Loss of psoas muscle shadow
- Free air in the abdomen
- Abnormal cecal overview
- Soft tissue density in the right lower quadrant

The gold standard of diagnosis was based on the histopathological examination by the existence of transmural acute inflammatory changes in the specimen. The determination of gangrenous and perforated appendices was made by the surgeon during the operation.

Data analysis

The collected data entered into a statistical software SPSS version 20. Descriptive statistics were reported in terms of percent (for categorical) and mean (SD) (for continuous) variables. We used the Chi-square

test to examine the univariate association between independent variables and outcome.

RESULTS

This study was performed on 198 patients that were eligible to participate in the study. Of these, 65 of them were female (32.8%), and 133 were male (67.2%). The mean age was 29.13 years, and a maximum and a minimum age of them was 15 and 50 years, respectively. When the patients were evaluated for leukocytes, 85.9% had higher than the 10,000 leukocytes (Table 1) and 76.8% of patients had more than 3.5 NLR.

Statistical analysis of the appendix pathology review showed that 17.7% of patients had a normal appendix and 77.8%, 3.5%, and 1% had acute, gangrenous and perforated appendicitis respectively. Study for the presence of abdominal radiographic findings in patients showed that in 55.6% of them there were no positive abdominal radiographic findings while the rest of them (44.4%) had at least one finding. Appendicolith in the right lower quadrant had the highest percentage (34.3%) of abdominal radiographic findings (Table 2). In addition, 85.8% of patients, had a positive pathology and leukocytes above 10,000. After Chi-square test analysis there was a statistical correlation among the type of pathology and leukocyte count ($P < 0.05$). Sensitivity, specificity, PPV and NPV values of leukocyte count were 89.5%, 31.4%, 85.8% and 39.2% respectively. Sensitivity, specificity, PPV and NPV values of NLR were 78.5%, 31.4%, 84.2% and 23.9% respectively. There was no statistically significant relationship among the type of pathology and NLR ($P > 0.05$). Sensitivity, specificity, PPV and NPV values of abdominal radiographic findings were 53.9%, 100%, 100% and 31.8% respectively. The result of the Chi-square test was a statistically significant relationship between the type of pathology and abdominal radiographic finding ($P < 0.05$) (Figure 1).

DISCUSSION

This study showed that white blood cell count is higher in acute appendicitis. In various studies, sensitivity and specificity of white blood cell count is 67-97% and 31.9-80% respectively is reported in the diagnosis of acute appendicitis¹¹. A recent study conducted sensitivity and specificity of leukocyte levels in acute appendicitis 91% and 74%¹². However, in our study, 85.9% of patients had leukocyte level higher than the 10,000, and 85.8% had a positive pathology and leukocytes above 10,000, and there was a statistical correlation between the type of pathology and leukocyte count ($P < 0.05$). Sensitivity, specificity,

Table 1: Leukocytosis and pathologic findings

			Pathology		Total
			Negative	Positive	
Leukocyte count	<10.000	Count	11	17	28
		% within leukocyte	39.3%	60.7%	100.0%
Total	>10.000	Count	24	146	170
		% within leukocyte	14.1%	85.9%	100.0%
		Count	35	163	198
		% within leukocyte	17.7%	82.3%	100.0%

Table 2: Frequency of abdominal radiographic findings in patients

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	110	55.6	55.6	55.6
	1	68	34.3	34.3	89.9
	2	12	6.1	6.1	96.0
	3	1	.5	.5	96.5
	4	2	1.0	1.0	97.5
	5	2	1.0	1.0	98.5
	6	3	1.5	1.5	100.0
	Total	198	100.0	100.0	

0: negative. 1: appendicitis in right lower quadrant, 2: Local ileus in right lower quadrant, 3: Loss of psoas muscle shadow, 4: Free air in the abdomen, 5: abnormal cecal overview, 6: Soft tissue density in right lower quadrant

PPV and NPV values of leukocyte count were 89.5%, 31.4%, 85.8% and 39.2% respectively. The level of sensitivity compared to other studies was similar, but the specificity was much less.

In a study by Berenji *et al.*, From 200 appendectomy patients, 124 (62%) were men, and 76 (38%) were female, and their average age was 29 years. Of these, the presence of acute appendicitis in 186 patients (93%) was confirmed in pathology. At the end of the study, the sensitivity and PPV of WBC test was high, but the NPV was low¹³.

Also in our study, with similar sample size, the frequency of men and women and their average age and also the results of the sensitivity, PPV and NPV of WBC test were similar with Berenji *et al.* study (and also in Baghi study). It was concluded that the positivity this test in patients with suspected appendicitis will help with clinical diagnosis. But by considering the low NPV of that test, it is suggested that the negative result (WBC<10.000) by no means cannot deny the existence of acute appendicitis.

In the Ishizuka *et al.* study the relationship between neutrophil to lymphocyte ratio (NLR) with

gangrenous appendicitis was evaluated. The specificity and sensitivity was 27% and 39%, respectively. NLR>8 with showed a significant relationship between gangrenous appendicitis in patients undergoing appendectomy¹⁴. But these values in our study were 89.5 and 31.4% respectively. And there was no statistically significant relationship between the type of pathology and neutrophil to lymphocyte ratio. Differences in values can be related to differences in the number of neutrophils to lymphocyte ratio in our study (3.5) to the study of Ishizuka (over 8) and a different type of appendicitis.

In the study of Baghi, on 158 patients with clinical diagnosis of acute appendicitis who underwent surgery, of these 146 cases (92.4%) acute appendicitis was confirmed in the pathology and the sensitivity, specificity, PPV and NPV of leukocyte count was 84.2%, 33.3%, 93.3%, and 14.8%, respectively¹⁵. While these values in our study were 85.5%, 39.2%, 31.4% and 89.5% respectively; which is almost similar to the study of is Baghi. Since in our study, 77.8% of patients in pathologic assessment has had acute appendicitis (lower than the study of Baghi) so the reason for the difference in values is the same. Horng-Ren *et al.* study

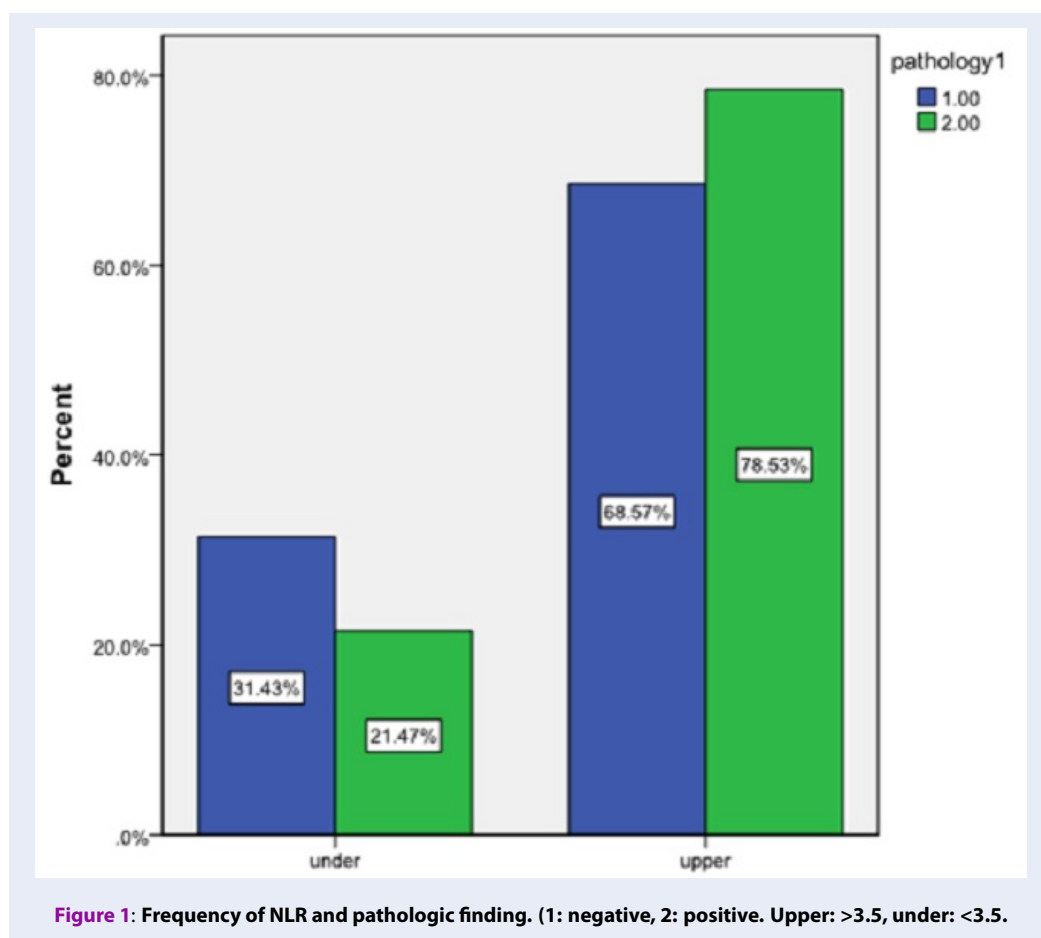


Figure 1: Frequency of NLR and pathologic finding. (1: negative, 2: positive. Upper: >3.5, under: <3.5.

are in line with these results¹⁶. However, the reported values of Sengupta *et al.* study were higher (85%, 72%, 44%, and 95%) and this could be due to low sample size (98 patients) in that study¹⁷.

Plain radiography is not specific, generally is not cost-effective, and can be misleading in this situation. In fewer than 5% of patients, an opaque fecalith may be apparent in the right lower quadrant. Plain films of the abdomen generally are not recommended unless other conditions (*e.g.*, perforation, intestinal obstruction, ureteral calculus) are suspected^{18,19}.

In a study by Steinert *et al.* in relation to the use of radiography in the diagnosis of appendicitis, 72% have two or more radiographic findings, in favor of appendicitis²⁰. But in our study, 44.4% of graphs had least one radiographic finding in favor of appendicitis. This difference could be related to the development of diagnostic tools or visiting patients at the beginning of the process of appendicitis. The study of Barnes *et al.*²¹ also, abdominal X-ray was less than 50% positive in appendicitis cases that are in line with our study.

CONCLUSION

The obtained findings revealed that due to the sensitivity of performing CBC and leukocytosis and NLR is at an acceptable level, especially with a relatively high positive predictive value, could be concluded that the positivity of these tests for confirming the diagnosis in suspected cases might be helpful and can help to strengthen the clinical diagnosis. But by considering the low NPV of these tests, it is suggested that the negative results cannot deny the existence of acute appendicitis. Our results in relation to the X-ray of the abdomen suggests its usefulness in the diagnosis of appendicitis. But even if the use of X-ray, compared to ultrasound and other methods in the diagnosis of appendicitis is defective and should be used to rule out differential diagnoses. However, it should be mentioned that the main limitation of this study was the sample size; whereas to obtain the accurate conclusion we need to study the higher sample size.

COMPETING INTERESTS

The authors declare no conflict of interest in this study.

AUTHORS' CONTRIBUTIONS

MKS: Study design, writing

HM: Data collection

SN: Data collection

MN: Critical reviews

MA: Data analysis

AR: Writing, supervisor

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