International Journal of Medical and Pharmaceutical Research
Website: https://ijmpr.in/| Print ISSN: 2958-3675 | Online ISSN: 2958-3683
NLM ID: 9918523075206676
Volume: 4 Issue:3 (May-June 2023); Page No: 14-19

Research Article

The Accuracy of Leucocyte Count in Diagnosing Acute Appendicitis

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ABSTRACT

Background: Acute appendicitis is a frequently encountered surgical disease. Detection is difficult even with imaging and blood investigations. Total leukocyte count is a promising investigation. Its role in the confirmation of acute appendicitis is investigated and analysed in the present study. **Methods**: Patients having acute appendicitis treated by surgical intervention (appendicectomy) were included in the study. The leukocyte count measured before surgery was compared with histopathology findings of the appendix. Parameters of diagnostic accuracy of leukocytosis were measured by standard formulae. **Results**: The majority of patients with acute appendicitis are below 25 years old, comprising 70% of the total patients, and males have a higher incidence of acute appendicitis at 56.67% compared to females at 43.33%. Physical findings suggest that pain in the right upper quadrant, rebound tenderness, anorexia, nausea/vomiting, and fever are common in patients with acute appendicitis.
The leukocyte count (TLC) test was found to have a sensitivity of 74.69% and specificity of 38.89% in identifying cases of inflamed appendix. The positive predictive value (PPV) was high at 91.67%, indicating that if the test identifies a case as inflamed appendix, there is a high likelihood that the case is truly inflamed. However, the negative predictive value (NPV) was low at 14.58%, indicating that if the test identifies a case as normal appendix, there is a low likelihood that the case is truly normal. **Conclusions**: Leukocytosis alone is not a helpful investigation to support the diagnosis of acute appendicitis.

Key Words: *Leukocytosis, Gangrene of Appendix, Negative Appendectomy*

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INTRODUCTION

Acute appendicitis is a prevalent cause of abdominal discomfort in people of all ages. It is responsible for around 10% of laparotomies and one-third of all acute abdominal pain in children. It is a challenging job for a professional to appropriately identify acute appendicitis. Numerous scores and examinations, such as C-reactive proteins (CRP), make the surgeon's job more difficult because they are not always accurate. TLC (Total Leucocyte Count) is a good test for acute appendicitis [1]. In patients with acute, uncomplicated appendicitis, leukocytosis is usually less than 18,000 cells per microliter. TLC is inexpensive and widely available in nearly all primary health care settings. There have been numerous research reported on the role of Leucocytosis in acute appendicitis.

TLC's diagnostic accuracy is boosted even more when paired with other markers of inflammation [2]. Acute appendicitis is a frequent surgical condition with a lifetime incidence of 6%. It is most common between the ages of 11 and 32, but it can occur at any age. Males are more likely to be afflicted than females. In America, the overall lifetime risk for males is 8.4 percent and 6.8 percent for females. Every year, around 3 lakh appendectomies are performed in the United States, and over 40,000 instances of acute appendicitis are hospitalised to the surgical department in the United Kingdom. While uncomplicated acute appendicitis has a fatality incidence of less than 1%, it rises to 5% or more in smaller children and the elderly due to the increased risk of perforation and complications due to late detection. Even now, appendectomy is the best treatment option for appendicitis. As early treatment of appendicitis is necessary to decrease morbidity and fatalities, some relaxations of making overdiagnosis is agreed by most of the surgical schools. A surgeon's vigorous treatment of questionable patients with acute appendicitis (i.e., overdiagnosis) increases the likelihood of a negative laparotomy, whereas a conservative treatment (i.e., underdiagnosis) increases the risk of perforation and other sequelae. As a result, the treating physician faces the challenging task of striking the proper balance between overdiagnosis and underdiagnosis. Diagnose supportive drugs can let the surgeon operate and remove the appendix earlier, lowering the negative laparotomy rate as well as the incidence of perforations and mortality. However, these diagnosis supporting drugs have a number of downsides, which are addressed below.

While diagnostic laparoscopy has been shown to reduce the chances of negative laparotomy by around 25% and may be useful in doubtful cases, particularly in women of reproductive age or with a high body mass index, it should be used

only after all other methods and investigations have been exhausted, as it is not a non-invasive intervention and has the potential for infection and complications. Diagnostic imaging has become more important in questionable cases of acute appendicitis in recent years. However, ultrasonography (USG) and computerised tomography (CT) cannot be utilised in all cases with right-sided abdominal discomfort since these procedures are expensive, not available in all hospitals, and have the drawback of ionising radiations (e.g., CT) and operator reliant diagnostic abilities (e.g., USG). Few studies suggested that USG and CT scanning in the diagnosis of acute appendicitis should be performed only in individuals who are unable to be diagnosed by clinical and laboratory tests. Because USG has the disadvantage of operator dependency and requires an experienced person, CT is preferable to USG because it offers higher diagnostic accuracy. Both a CT scan and an ultrasound are used to evaluate patients who have a dubious diagnosis of appendicitis. As previously said, CT scan has higher sensitivity and specificity when compared to USG with sensitivity and specificity. The worst thing is that neither imaging modality can minimise the negative appendectomy rate. Because rural Indian hospitals lack access to advanced imaging studies and manpower. Patients are frequently misdiagnosed or overdiagnosed, and they are referred to higher-level facilities for therapy based on educated guesses. This is costly, as patients spend a lot of:

i. Valuable time to reach higher centers and in waiting for the specialists and
ii. Money in traveling and maintenance [3].

If the histology specimen is normal, a negative appendectomy is regarded. Many strategies have been developed to assist in the reduction of negative appendectomy rates in questionable instances (NAR). Several grading systems have been developed to aid in the early detection and management of acute appendicitis. These scores are based on the clinical history, physical examination, and test results. Acute appendicitis is diagnosed based on a history, clinical examination, and a few laboratory tests. However, in all cases, a firm diagnosis may only be made following histological examination of the surgical specimen. Before surgery, the diagnostic accuracy of acute appendicitis remains poor, ranging from 25% to 80% and being more difficult in females than males. A NAR of 21-41 percent has also been confirmed, and many physicians believe that a rate of 30 percent is unpreventable. The removal of a normal appendix results in a financial loss for both the patient and the hospital. An attempt to avoid it may result in an inaccurate diagnosis and a delay in surgery, as well as the likelihood of consequences such as perforation and peritonitis [4].

Patients with acute appendicitis are easy to diagnose and treat, even if they are uncomplicated. However, in uncommon circumstances, even experienced clinicians have a challenging problem. Even with advancements in diagnostic and scanning procedures, negative appendicectomy rates have not decreased significantly. Clinical examination remains the most important guiding tool in the treatment of instances with suspected acute appendicitis. It is neither cost-effective or safe to do a CT scan or diagnostic laparoscopy on all patients suspected of having acute appendicitis. However, when employed in a small number of suspected patients, it can enhance diagnostic accuracy while also lowering the cost and rate of negative appendicectomy [5].

The diagnosis of acute appendicitis remains difficult and may be a common diagnostic quandary in the surgical community. The normal combination of three components, a credible history, pain at Mc Burney's point, and leukocytosis, yields an 80 percent diagnosis accuracy. If ultrasonography, computerised topography, or radionuclide scans are combined, it can enhance by up to 90%. Early surgery has been used for many years, however it may result in the removal of a significant number of normal appendices. Some surgeons indicated that "operate and diagnose" is preferable to "wait and observe," because a needless surgery is preferable to an unaccepted perforation. As a result of the procedure, there is a 10% to 15% chance of problems such as wound infection, deep vein thrombosis, chest infection, adhesion bowel obstruction, and so on. Increased Total leukocyte count (TLC) with clinical signs and symptoms suggests acute appendicitis, yet it is possible to have a perforated appendix with normal TLC and differential leukocyte count. C reactive protein is the archetypal acute phase reactant produced by the liver; its level rises within 8 hours of the commencement of tissue injury/inflammation, peaks within 24 -48 hours, and remains high as long as tissue inflammation or destruction continues. Regular TLC and CRP measurements in suspected appendicitis may increase the accuracy of diagnosing acute appendicitis [6].

Every year, new tests related to inflammatory markers to confirm the diagnosis of acute appendicitis are published in the medical literature, and in many of these studies, the investigators always mention the white blood cell count (WBC), indicating that this is an important reference test that has the added benefit of being available in all health facilities.

Apart from WBC, the most common biological markers studied in the diagnosis of acute appendicitis are: Differential Leukocyte Count (DLC), CReactive Protein (CRP), Erythrocyte Sedimentation Reaction (ESR), Tumour Necrosis Alpha (TNF-alpha), Alpha 1- Glycoprotein (Alpha 1gp), leukocyte elastase complex (Elastase), Interleukin-8 (IL-8), Procalcitonin and Leucine-Rich Alpha Glycoprotein-1 (LRG). None of these tests, however, have been shown to be beneficial in the early identification of acute appendicitis. Furthermore, because they are measuring the severity of an inflammatory response, all of these indicators are generic. According to Jangioo, the most often used inflammatory marker, C-reactive protein, is not an acceptable diagnostic tool for ruling out or confirming acute appendicitis. Pruekprasert et al. compared the surgeon's clinical diagnosis of acute appendicitis with the Alvarado Score and CRP measurement, and found that the surgeon's evaluation had a sensitivity of 96 percent vs 79 percent for the Alvarado score and 62 percent for the CRP.

In a patient with suspected appendicitis, a high total leukocyte count (TLC) plays a significant role in the Alvorado score.

The accuracy of the surgeon's assessment, the Alvarado score, and the CRP were 90%, 72%, and 61%, respectively. Atema discovered that none of these tests can safely and sufficiently confirm or reject the diagnosis of acute appendicitis in a study to examine the accuracy of the WBC and C-reactive protein in relation to the length of symptoms in patients suspected of having acute appendicitis. They concluded that, regardless of the duration of symptoms, normal inflammatory markers could not "rule out" acute appendicitis in patients suspected of having it. Based on these data, they could not support the use of these biomarkers to confirm or exclude a diagnosis of acute appendicitis, either alone or in combination [7].

According to the Birchley D8, 'individual history, clinical symptoms, and blood tests are poor predictors of acute appendicitis inflammation.' When they are coupled, however, they provide a superior diagnostic value. As a result, tests like TLC and CRP are more effective when used together.

A clinically decided appendectomy has a net negative laparotomy rate varies from 15 percent to 30 percent. As a result, reducing the removal of normal appendices should not result in an increase in the number of perforations[8]. Appendicectomy is not without risk of consequences, including wound infection (10- 15%), adhesive blockage, thrombosis, pulmonary infection, and so on. Although leukocytosis, in conjunction with clinical examination, can accurately diagnose acute appendicitis, it has been shown in a few studies that even perforated appendixes have normal TLC and differential leukocyte count [9].

AIM & OBJECTIVE

To determine the predictive value of leucocyte count in the diagnosis of acute appendicitis.

MATERIALS AND METHODS

This was a cross-sectional observational study conducted in the Department of Surgery, Srinivas institute of medical sciences and research center, from 1st March 2022 to 28th February 2023. The study included 180 patients aged >18 years with clinical features suggestive of acute appendicitis. Patients with previously treated appendicitis, appendicular lump/peritonitis, UTI with ureteric/renal calculi, pregnancy, hematological diseases, malignancies, and immune compromised patients were excluded. Written informed consent was obtained from all patients. Physical findings of pain in the right iliac fossa (RIF) presenting within three days, nausea/vomiting, anorexia, and fever were included in the study. Blood complete picture of the patients presenting with clinical findings showing suspicion of Acute Appendicitis was sent. Ultrasonography was done. Open appendectomies were done by consultant/senior registrar or by trainees under direct supervision. Preoperative findings were noted and recorded. The specimen was sent for histopathology examination. Patients were called for follow-up after one week with histopathology report.

RESULTS

Based on the analysis, the majority of patients with acute appendicitis are below 25 years old, comprising 70% of the total patients. The 26-45 age range had 12.78% of the patients, while those over 46 years old had 17.22%. In terms of gender, males had a higher incidence of acute appendicitis at 56.67% compared to females at 43.33%. (Table 1)

Physical findings revealed that pain in the right upper quadrant was present in all patients, while rebound tenderness and anorexia were present in 83.89% and 78.89% of the patients, respectively. Nausea/vomiting was seen in 73.89% of the patients, while fever was present in 63.89% of the cases. These findings suggest that pain in the right upper quadrant, rebound tenderness, anorexia, nausea/vomiting, and fever are common physical findings in patients with acute appendicitis. (Table 1)

Table 1: Baseline characteristics of the study population

	NUMBER	**PERCENTAGE**
AGE IN YEARS		
<25	126	70.00
26-45	23	12.78
>46	31	17.22
SEX		
MALE	102	56.67
FEMALE	78	43.33
PHYSICAL FINDING		
PAIN IN RIF	180	100.00
REBOUND TENDERNESS	151	83.89
ANOREXIA	142	78.89
NAUSEA/VOMITING	133	73.89
FEVER	115	63.89

Table 2: Leukocyte count and HPE/Operative diagnosis among the patients (n=180)

	HPE OF APPENDIX		TOTAL
	INFLAMED APPENDIX	**NORMAL APPENDIX**	
HIGH TLC	121	11	132
NORMAL TLC	41	7	48

There were 132 patients with elevated leukocyte counts and there were 48 patients with leukocyte counts in normal range. The diagnosis of acute appendicitis was made in 41 out of 48 (85.4%) patients with normal TLC and in 121 out of 132 (91.8%) patients with raised TLC suspicion of acute appendicitis on physical findings and ultrasound. (Table 2)

Table 3: Comparison of acute appendicitis across various subgroups of patients

		TOTAL CASES	ACUTE APPENDICITIS		p-value
			N	%	
AGE IN YEARS	<25	126	105	83.33	0.991
	26-45	23	19	82.6	
	>46	31	26	83.8	
SEX	MALE	102	84	82.3	0.862
	FEMALE	78	65	83.3	

The p-values provided in the Table 3 suggest that there is no significant difference in the distribution of acute appendicitis cases between different age groups or genders ($p > 0.05$ for both).

Table 4: Leukocyte count and HPE/Operative diagnosis among the patients (n=180)

	HPE OF APPENDIX		
	INFLAMED APPENDIX	**NORMAL APPENDIX**	**TOTAL**
HIGH TLC	121[TP]	11[FP]	132
NORMAL TLC	41[FN]	7[TN]	48

Sensitivity = 121/162 x 100 **= 74.69%**
Specificity = 7/18 x 100 = 38.89%
Positive predictive value (PPV) = 121/132 x 100 = **91.67%**
Negative predictive value (NPV) = 7/48 x 100 = **14.58%**

Based on the histopathological examination (HPE) of the appendix, there were a total of 180 cases, out of which 162 were inflamed and 18 were normal. In addition, the HPE results were compared with the total leukocyte count (TLC) of the patients. Out of 132 cases with a high TLC, 121 were identified as inflamed appendix (true positive), while 11 were identified as normal appendix (false positive). Out of 48 cases with normal TLC, 7 were identified as normal appendix (true negative), while 41 were identified as inflamed appendix (false negative).

The sensitivity of the TLC in identifying inflamed appendix was calculated as 121/162 x 100 = 74.69%, which indicates that the test correctly identified 74.69% of the cases with inflamed appendix. The specificity was calculated as 7/18 x 100 = 38.89%, which indicates that the test correctly identified 38.89% of the cases with normal appendix. The positive predictive value (PPV) was calculated as 121/132 x 100 = 91.67%, which indicates that the test correctly predicted 91.67% of the cases with inflamed appendix among all the cases identified as inflamed appendix by the test. The negative predictive value (NPV) was calculated as 7/48 x 100 = 14.58%, which indicates that the test correctly predicted 14.58% of the cases with normal appendix among all the cases identified as normal appendix by the test.

In summary, TLC was found to have moderate sensitivity and low specificity in identifying cases of inflamed appendix. The PPV of the test was high, indicating that if the test identifies a case as inflamed appendix, there is a high likelihood that the case is truly inflamed. However, the NPV of the test was low, indicating that if the test identifies a case as normal appendix, there is a low likelihood that the case is truly normal. These findings suggest that while the HPE of the appendix is a useful tool in diagnosing inflamed appendix, it should not be relied upon as the sole diagnostic method and should be used in conjunction with other clinical and diagnostic tools.

DISCUSSION

Dynanmonte et al [8] Acute appendicitis is the most common cause of the acute abdomen requiring surgery with lifetime risk of 7%, which is maximal in childhood and declines steadily with age. The sensitivity, specificity, predictive value of positive test and predictive value of negative test of TLC in their study was76.79%, 68.42%, 87.76% and 50% respectively. These results were in accordance with study by Yang et al indicating high association between TLC and acute appendicitis [9].

According to study done by Goonroos JM et al TLC was the test of choice in diagnosing uncomplicated acute appendicitis, however it's a poor predictor of protracted inflammation [10]. This supported in study by David and Berchley et al [11]. The TLC count when done individually distinguishes normal appendix from uncomplicated acute appendicitis. But does not distinguish uncomplicated from complicated appendicitis. Colemen C et al reported that TLC is a poor predictor of severity of disease [12]. Vermenum et al after evaluating 221 patients concluded that TLC count did not significantly influence the surgical decision making [13].

In the present study, the specificity of leukocyte count for acute appendicitis was found to be disappointingly low of 38.89.%, comparable with other studies.

Table 5: Comparison of Specificity of TLC for Acute Appendicitis, with other studies

	Specificity
My Study	**38.89 %**
De Carvalho et al [14]	28.33 %
Gulzar et al [15]	21.43 %
Al-Gaithy et al [6]	32.33 %
Kamran et al [16]	46.83 %

CONCLUSION

When it comes to managing patients who are suspected to have acute appendicitis, clinical judgment remains the most crucial factor. It is not advisable to use CT scans or diagnostic laparoscopy for all such patients as it is neither cost-effective nor safe. Leukocytic count is a useful criterion for diagnosing acute appendicitis, but it is not reliable to rule out the possibility of acute appendicitis due to its low negative predictive value and specificity. Therefore, clinical correlation is essential in such cases.

LIMITATION OF STUDY

One major limitation of the current study is that the inflammatory response that leads to an elevation of the total leukocyte count may take time to develop, which could explain cases of acute appendicitis with a normal TLC count. This implies that some patients with acute appendicitis may be missed by relying solely on TLC counts and emphasizes the importance of clinical judgment in making a proper diagnosis.

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