Diagnostic Value of Total and Differential Leukocyte Counts for the Diagnosis of Acute Appendicitis

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Abstract

Objective: To establish the predictive value of total and differential leukocyte counts for the acute appendicitis diagnosis.

Method: This cross-sectional study lasted for 6 months over 95 patients. In order to determine TLC and DLC, a blood sample was taken. The patients were categorized as TLC positive or negative & DLC positive or negative. Appendectomy was performed to determine whether the patient was positive or negative. TLC and DLC's sensitivity, specificity, PPV, NPV, and diagnostic accuracy were calculated & outcomes mentioned.

Results: Patients had mean age of 31.20±12.14 years. A total of 60 women (63.2%) and 35 men (36.8%). Patients' mean body mass index was 23.394.87kg/m2. We calculated a mean time to resolution of 6.603.53 hours. TLC averaged 13413.12 ±8142.58 per milliliter. Overall, the DLC averaged 76.33 ±12.56%. TLC had a Sensitivity of 90.7%, Specificity of 96.2%, PPV of 95.1%, NPV of 92.6%, and Diagnostic Accuracy of 93.7% to diagnose acute appendicitis. For DLC, Diagnostic accuracy was 88.4%, sensitivity 88.4%, specificity 76.9%, PPV 76%, NPV 88.9% & PPV of 76% for identifying acute appendicitis.

Conclusion: In an emergency setting both TLC and DLC were reliable enough allowing the patients to have some confirmation that they were experiencing the signs of acute appendicitis and avoiding an appendectomy or unneeded surgery in at least the negative cases.

Keywords: Appendectomy, Acute appendicitis, Differential leukocyte count, Total leukocyte count, Histopathology

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Introduction

Acute Appendicitis is one of the most common cause of sudden stomach pain. Patients presenting with typical symptoms may have a straightforward clinical diagnosis, but those with less common presentations may face diagnostic uncertainty and treatment delays.[1] Forty-eight percent of patients with classic symptoms of acute appendicitis were indeed suffering from the illness.[2]

When diagnosed with acute appendicitis, abdominal pain is typically the patient's first symptom. One may have mild to severe nausea, vomiting, and loss of appetite. Following localization of the discomfort to the right iliac fossa, an examination reveals localized tenderness of the abdomen and muscular rigidity.[3] Elevated leukocytosis with a left shift is typically seen in lab results upon initial presentation.[4,5]

The evaluation of a patient presenting to the emergency department with significant abdominal discomfort can be challenging. Poor patient outcomes can result from

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incorrect diagnosis, which can be delayed or prevented by a muddled presentation caused by a number of reasons. Clinicians need to take into account the possibility of multiple diagnoses, especially in the case of serious illnesses that call for immediate treatment to reduce the risk of serious complications or death.[6,7]

Diagnosing acute appendicitis can be aided by a total leukocyte count (TLC). Patients with acute, uncomplicated appendicitis typically have a white blood cell count (WBC) more than 11,000/ml and they also typically have a moderate polymorphonuclear predominance.[8,9] One further test that can aid in diagnosis is the differential leukocyte count (DLC). The neutrophil count is a primary indicator of DLC, and a value of > 80% indicates an issue.[10,11] To diagnose acute appendicitis sensitivity of TLC is reported to be 86.9% and a specificity of 81.25%, while the sensitivity of DLC is 82%, with a specificity of 68.75%.[10] That they can both be utilized to anticipate acute appendicitis is demonstrated. However, other research indicates sensitivity and specificity of TLC to be 64.8% and 89.4% for diagnosing acute appendicitis.[12] The aim of our study is to establish whether TLC or DLC is more accurate in predicting acute appendicitis when using appendicitis as the gold standard. TLC and DLC have been shown to be effective in determining whether a patient's stomach pain is actually related to acute appendicitis, hence preventing unnecessary operations. However, different findings have been reported in the literature.

There was some discrepancy between the studies on TLC's accuracy compared to DLC. As limited local data is available, this study was designed to determine that whether TLC is sufficient for diagnosis of acute appendicitis or if further interventions are required? In the future, we can adopt TLC/DLC count-based screening for patients complaining of stomach pain before deciding whether to send them to the operating room. The findings of this research will reduce the workload of surgeons and hospitals by reducing the number of unnecessary surgical procedures.

Material and Methods

The study's primary aim was to evaluate the predictive accuracy of total and differential leukocyte counts for diagnosing acute appendicitis using appendectomy itself as the gold standard. The information was collected using a cross-sectional validation study design in the West surgical ward, Mayo Hospital in Lahore. Six months were devoted to the investigation, beginning on November 26, 2018, and ending on May 26, 2019. The sample size of 95 cases is computed using a 95% confidence level, an expected percentage of acute appendicitis of 48%, the sensitivity of TLC of 86.9% with a 10% margin of error, and the specificity of TLC of 81.25% with a 12% margin of error, with appendectomy as the gold standard.

All those patients ranging in age from 16 to 60 years old, and exhibiting symptoms such as loss of appetite, nausea, or vomiting, as well as pain localizing to the right lower quadrant and increasing in intensity prior to appendectomy, make up the sample. Patients with a history of diabetes mellitus (BSR>186mg/dl), those who are taking non-steroidal anti-inflammatory or immuno-suppressive medicines within 2 weeks prior surgery, and patients with a perforated appendix (based on clinical examination and ultrasound) were not included in the sample. Patients included in this study were enrolled through the emergency room of surgery at Mayo Hospital in Lahore. The subject has given their informed consent in writing. Names, ages, genders, and symptom durations were collected as a means of establishing context. A 3cc disposable syringe was used to draw blood in CBC vial. Both TLC and DLC analysis were performed on all samples at the hospital's laboratory. Consulting surgeon, aided by a researcher, performed an appendectomy on all of the patients under General Anesthesia. Patient results were either favorable or negative. The data collection was followed by its entry into SPSS 21. Age, body mass index, symptoms' duration, symptom severity & TLC and DLC were just some of the quantitative factors that were shown as means and standard deviations. In this study, we used frequency and percentage displays to show gender differences in acute appendicitis (on TLC, DLC of appendectomy). Using appendectomy as the gold standard, 2×2 tables were created to determine the sensitivity, specificity, PPV, NPV, and diagnostic accuracy of TLC and DLC. The data was divided into groups based on age, gender, body mass index, and length of time they had been experiencing symptoms.

Results

In this cross sectional validation study, there were 35 (36.8%) males while 60 (63.2%) females.

With a mean age of 31.20±12.14 years, with a mean BMI of 23.39±4.87kg/m^2. The mean duration of symptoms was 6.60±3.53hours. The mean TLC was 13413.12±

8142.58 per ml. The mean DLC was 76.33±12.56%. Acute appendicitis was positive in 41 (43.2%) cases on TLC while 50 (52.6%) were positive on DLC and 50 (52.6%) were positive histopathology. For diagnosis of acute appendicitis, TLC showed Sensitivity of 90.7%, Specificity of 96.2%, PPV of 95.1%, NPV of 92.6% and diagnostic accuracy of 93.7%. Similarly, for diagnosis of acute appendicitis, DLC showed Sensitivity of 88.4%, Specificity of 76.9%, PPV of 76%, NPV of 88.9% and diagnostic accuracy of 82.1%. For the results of TLC, stratification of data done for the patients age. Patients aged 16-40 years, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of TLC were 88.9%, 97.5%, 97%, 90.7%, 93.4%, respectively. In patients aged 41-60 years, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of TLC were 100%, 91.7%, 87.5%, 100%, 94.7%, respectively. Stratification of data done for the patient's gender. In male patients, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of TLC were 80%, 93.3%, 94.1%, 77.8%, 85.7%, respectively. In female patients, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of TLC were 100%, 97.3%, 95.8%, 100%, 98.3%, respectively. Stratification of data done for the patients BMI. In underweight to normal BMI patients, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of TLC were 91.7%, 100%, 100%, 95.4%, 96.9%, respectively. In overweight and obese patients, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of TLC were 89.5%, 81.8%, 89.5%, 81.8%, 86.7%, respectively. Data was stratified for duration of symptoms. In patients presented within 1-6 hours of symptoms, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of TLC were 86.4%, 100%, 100%, 90%, 93.9%, respectively. In patients presented after 7-12hours of symptoms, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of TLC were 95.2%, 92%, 90.9%, 95.8%, 93.5%, respectively. For the results of DLC, Stratification of data done for the patients age. In patients aged 16-40years, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of DLC were 88.9%, 72.5%, 74.4%, 87.9%, 80.3%, respectively. In patients aged 41-60years, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of DLC were 85.7%, 91.7%, 85.7%, 91.7%, 89.5%, respectively. Stratification of data done for the patients' gender. In male patients, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of DLC were 90%, 86.7%, 90%, 86.7%, 88.6%, respectively. In female patients, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of DLC were 87%, 73%, 66.7%, 90%, 78.3%, respectively. Stratification of data done for the patients' BMI. In underweight to normal BMI patients, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of DLC were 95.8%, 82.9%, 76.7%, 97.1%, 87.7%, respectively. In overweight and obese patients, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of DLC were 79%, 54.6%, 75%, 60%, 70%, respectively. Data was stratified for duration of symptoms. In patients presented within 1-6 hours of symptoms, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of DLC were 86.4%, 74.1%, 73.1%, 87%, 79.6%, respectively. In patients presented after 7-12 hours of symptoms, the sensitivity, specificity, PPV,

Table 1: *Descriptive Statistics of age, BMI, duration of symptoms, TLC, DLC of patients (n=95)*

Age (years)	**n**	**95**
	Mean	31.20
	Standard deviation	12.14
	Minimum	16
	Maximum	60
BMI (kg/m^2)	n	95
	Mean	23.39
	Standard deviation	4.87
	Minimum	16.50
	Maximum	34.87
Duration (hours)	n	95
	Mean	6.60
	Standard deviation	3.53
	Minimum	1
	Maximum	12
TLC (per ml)	n	95
	Mean	13413.12
	Standard deviation	8142.58
	Minimum	4582
	Maximum	29891
DLC (%)	n	95
	Mean	76.33
	Standard deviation	12.56
	Minimum	51
	Maximum	95

Table 2: *Distribution of Acute Appendicitis on TLC, DLC and Histopathology (n=95)*

Acute appendicitis on		Frequency	Percentage
TLC	Positive	41	43.2
	Negative	54	56.8
DLC	Positive	50	52.6
	Negative	45	47.4
Histopathology	Positive	50	52.6
	Negative	45	47.4

Table 3: *Diagnostic Accuracy of TLC & DLC against histopathology*

A: Diagnostic Accuracy of TLC against histopathology				
		Histopathology		Total
		Positive	Negative	
TLC	Positive	39	2	41
	Negative	4	50	54
Total		43	52	95
Sensitivity = 90.7%; Specificity = 96.2%; PPV = 95.1%; NPV = 92.6%; Diagnostic accuracy = 93.7%				
B: Diagnostic accuracy of DLC against histopathology				
		Histopathology		Total
		Positive	Negative	
DLC	Positive	38	12	50
	Negative	5	40	45
Total		43	52	95
Sensitivity = 88.4%; Specificity = 76.9%; PPV = 76.0%; NPV = 88.9%; Diagnostic accuracy = 82.1%				

NPV and diagnostic accuracy of DLC were 90.5%, 80%, 79.2%, 90.9%, 84.8%, respectively.

Discussion

Despite advances in surgical technology, appendicitis remains a frequent surgical emergency. Although most instances will show with classic symptoms, appendicitis can be tricky to diagnose based on physical examination alone due to the appendix's movable location.[13,14] The definitive diagnosis of appendicitis continues to be a clinical judgment, supplemented by relevant diagnostics, despite advancements in imaging modalities.[14,15] A negative result from a test cannot rule out a diagnosis if the patient's detailed history & physical examination advocate a high likelihood of a condition. Even in the presence of a life-threatening infection, like appendicitis or cholecystitis, the TLC may be normal.[16] The mean age of 31.2±12.14 years was included in our study. Out of a total of 95 participants, 60 (63.2%) were women, and 35 (36.6%) were men. In our research, more women participated than men. Within 12 hours of experiencing symptoms, patients sought medical attention. TLC had a sensitivity of 90.7%, specificity of 96.2%, positive predictive value (PPV) of 95.1%, negative predictive value (NPV) of 92.6%, and diagnostic accuracy of 93.7% when used to diagnose acute appendicitis. The diagnostic accuracy of DLC was 82.1% for the identification of acute appendicitis, with a sensitivity of 88.4%, specificity of 76.9%, positive predictive value (PPV) of 76%, negative predictive value (NPV) of 88.9%, and Diagnostic accuracy of 82.1%. Our research showed that TLC was more reliable than previous studies, including a series that found an elevated TLC of more then 11,500/mm^3 was found in 49% of 354 individuals.[17] Although a rise in TLC is indicative of the disease but still not diagnostic due to its limited specificity, hence high TLC count does not contribute more in patient care when combined with other, more conclusive clinical findings.[18] The diagnostic accuracy of a total leucocyte count was 76.5% and 73.7% in a series of 20 acute appendicitis patients, respectively. Thus, while high white blood cells in the smear raise the sensitivity for diagnosing acute appendicitis but it is not very specific and offers little in the way of diagnostic utility. Another study stated that WBCs can be normal despite having a perforated appendicitis.[17] Many studies have demonstrated that DLC can improve diagnosis accuracy. However, DLC is not as specific as other tests despite its high sensitivity. TLC with a sensitivity of 86.9% and a specificity of 81.25 % for the diagnosis of acute appendicitis, while DLC scores just 82% and 68.75 % in these categories. In this way, it helps in demonstrating their usefulness in predicting the condition, acute appendicitis. However, research shows that TLC has 64.8% of sensitivity and 89.4% of specificity for diagnosing the acute appendicitis.[12]

Conclusion

Thus, TLC and DLC were found to be reliable enough to be used in an emergency setting, allowing patients to have some confirmation as to whether or not their symptoms are indicative of acute appendicitis and thereby reducing the likelihood that patients who do not have the condition will undergo an appendectomy or other unnecessary surgeries. In this regard, we have just discovered that TLC is more reliable than DLC. However, we urge larger-scale trials to corroborate the evidence.

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Authors Contribution

JA: Conceptualization of Project
HSA: Data Collection
HJAR, MKJ: Literature Search
HJAR: Statistical Analysis
HSA: Drafting, Revision
FH: Writing of Manuscript