Readers Insight
Publisher of open access books and journals
PJMLS
Print ISSN: 2707-4471. Online ISSN: 2707-448X

Research Article	Pak-Euro Journal of Medical and Life Sciences
DOI: 10.31580/pjmls.v6i3.2855	Copyright © All rights are reserved by Corresponding Author
Vol. 6 No. 3, 2023: 183-190	
www.readersinsight.net/pjmls	**Revised:** September 17, 2023 **Accepted:** September 25, 2023
Submission: June 30, 2023	**Published Online:** September 30, 2023

CORRELATION BETWEEN TOTAL LEUKOCYTE COUNT, NEUTROPHIL COUNT, AND APPENDIX DIAMETER ON ULTRASOUND OF ACUTE APPENDICITIS PATIENTS

Sadia Safi[1], Irum Jehan[2], Anwer Zeb Alam[3], Ashraf Ullah[4], Shah Faisal Jamal[5], Rizwan Ullah[6]*, Waqas Ahmad[7], Aqal Zaman[8]

[1]**Department of Radiology,** Taj College of Nursing and Allied Health Sciences, Bannu, Pakistan

[2]**Department of Radiology,** The Professional Institute of Health Sciences, Mardan, Pakistan

[3]**Department of Radiology,** Pakistan Institute of Medical and Management Sciences, Peshawar, Pakistan

[4]**Department of Radiology,** Tehsil Head Quarter Hospital, Mir Ali, North Waziristan, Pakistan

[5]**Medical Laboratory Technology,** Institute of Paramedical Sciences, Khyber Medical University, Peshawar, Pakistan

[6]**Department of Radiology,** Institute of Paramedical Sciences, Khyber Medical University, Peshawar, Pakistan

[7]**Department of Radiology**, Institute of Health Sciences Swabi, Pakistan

[8]**Department of Microbiology and Molecular Genetics**, Bahudin Zakarya University, Multan, Pakistan

***Corresponding Author:** Rizwan Ullah. Email: rizwan.ipms@kmu.edu.pk

Abstract

The study aimed to correlate total leukocyte count, neutrophil count, and appendix diameter measured on ultrasound of acute appendicitis patients, to find out whether it will help in the accurate and precise diagnosis of acute appendicitis and will decrease the rate of negative appendectomy. This study was a prospective analytical study. Patients who came to the Radiology department with suspected appendicitis and had physical examination and complete blood count done were included in the study and their reports were used for analysis after proper informed consent from the patients. Post-operative results were taken from surgeons. A total of 111 patients who were clinically diagnosed with acute appendicitis (AA) were analyzed. The study consisted of 68 male and 43 female patients. Acute appendicitis was found more at the age of 21 years. The diameter of the appendix was mentioned in the reports of 46, Total leukocyte count (TLC) and Neutrophil count (NC) were mostly high in those patients whose appendix diameter was mentioned on the Ultrasound reports. A significant correlation was present between TLC, NC, and appendix diameter. There was also a statistically significance correlation ($p<0.001$) between total leukocyte count, neutrophil count, appendix diameter, and post-operative results. It was concluded from the study that mentioning diameter on ultrasound will help the surgeon for better decisions about surgery. It was observed that if the diameter of the appendix was increased and or secondary signs were seen on ultrasound there are more possibilities of increased TLC and NC of patients having suspected appendicitis.

Keywords: *Acute appendicitis, appendix diameter, neutrophil count, postoperative results, total leukocyte count*

INTRODUCTION

Acute appendicitis is a very common abdominal disease in patients having abdominal pain. Acute appendicitis occurs most commonly in between 10 and 19 years of age. The risk ratio of acute appendicitis for male is 8.6% and for female is 6.7% (1). Acute appendicitis has a life time risk of 7% (2). There is no

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specific cause of appendicitis but in majority of cases it is caused by appendiceal lumen obstruction (3). Typical symptoms may be periumbilical pain, nausea, anorexia and vomiting. About 30% of patients are having atypical symptom (1).

Appendix is a part of the digestive system lying in the Right Lower Quadrant(RLQ) of abdomen originates from the postero-medial region of the caecum approximately 2cm below the ileocecal valve (4). Appendix length ranges from 2-20 cm (5). Diameter of the appendix is because of lymphoid tissue present in the mucous and sub mucosa layer2023/9/20. Diagnostically accepted parameter for acute appendicitis is non-compressible and thickened diameter greater than 6mm (6). Celik and his co-worker conducted a research project in 2019, most common diameter of appendix in their study was 6mm to 8mm and greater than 8mm (7). Its position differ from person to person (8). A category of six positions is: retrocecal, preileal, subcecal, retroileal, pelvic, and ectopic (4). Appendicular artery which arises from the ileocolic artery supplies the appendix (9). In early times human appendix was considered a vestigial element of intestinal tract. Yet, some years ago, different researches stated that it has immunological significance in growth and maintenance of the immune system of intestine (10).

Usually clinical and physical examination is done for diagnosis of acute appendicitis (11). Guarding, rebound tenderness and percussion tenderness are the most consistent medical findings indicative of AA (12). Ultrasound is the most frequent and the first diagnostic modality used for acute appendicitis diagnosis (13). Appendix without any abnormality cannot be seen on ultrasound but when inflammation occurs and its size increases it can be seen on ultrasound (5).

The most frequent laboratory test use for finding acute appendicitis is complete blood count (1).The value of white blood cell (WBC) generally exceeds 11,000/mm3 (5).Though the value of white blood cell (WBC) increases in acute appendicitis yet its specificity and sensitivity is not defined. In addition to white blood cell(WBC) values increase, neutrophil value may also aids in diagnosis of acute appendicitis (14). Akbulut and Sahin (2020) conducted a research that correlates complete blood count parameters and appendix diameter in acute appendicitis patients. Appendix of diameter greater than 6mm was considered pathological. The results of their study showed that complete blood count (CBC) parameters and appendix diameter both are essential in the diagnosis of acute appendicitis (1).The emergency surgery require for appendicitis called appendectomy (15).

The aim of this investigation was to assess whether ultrasound measurements of the appendix diameter, along with parameters from the complete blood count (CBC), including neutrophil count and total leukocyte count, could enhance the accuracy of diagnosing acute appendicitis.

MATERIALS AND METHODS

This study was approved by the Clinical Research Ethics Committee. The approval for data collection was obtained from Khyber Teaching Hospital, Peshawar. We conducted a prospective examination of 111 patients who had received a clinical diagnosis of acute appendicitis and subsequently underwent an appendectomy. Sample size was calculated by using formula having prevalence of about 7% (16). Clinical diagnosis was based on general comment of the physician/doctor. The comparative analytical study was conducted through a proforma containing information about Complete Blood Count (CBC) parameters (Total Leukocytes Count and Neutrophils Count) obtained from laboratory reports and appendix diameter obtained from ultrasound report. Post-operative result was collected from the surgeon on the basis of surgical observation.

Sample size was calculated by using formula:

$$N= Z^2p (1-p) /E^2 \text{ (16)}$$

$$N= (0.95)^2(0.07) (1-0.07)/ (0.05)^2$$

$$N= (3.84)(0.15) (0.85)/ (0.0025)$$

$$N= 101$$

(10% non-respondent 10/100 * 101 = 111)

(Where N is the calculated sample size, Z is the desired level of confidence (95%), E is the standard sampling error (5%) (0.05), and is the estimated prevalence 7%. Sample size in this study will be 111 P. Non Probability Convenient Sampling was applied for this study.)

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Written consent was also taken from the study participants and agreed participants were asked for ultrasound and CBC reports. We reviewed ultrasound reports for suggestive finding of acute appendicitis. Those patients whose ultrasound reports gave some indication of acute appendicitis were asked for lab results. The indicator for acute appendicitis on ultrasound was swollen appendix having diameter >6 mm, obstruction and distension of appendiceal lumen, an appendicolith, high echogenicity in periphery of appendix. Post-operative results were made on surgeon comment. The desired data consists of patient's age, gender, CBC parameters (TLC and NC) and ultrasound results (diameter mentioned or not mentioned). The limitation of our study is that confirmation of positive and negative appendectomy is based on surgical observations and is not performed histopathologically.

Data analysis was performed by using SPSS V.20 and MS Excel. Descriptive statistics were applied for mean, percentage and frequency of variables. Data was presented in the form of tables, charts, graphs and scatter plot diagram. Independent sample t test was used for mean comparison between two independent variables. To study the relationship between categorical variables (appendix visualization on ultrasound and post operative results) chi square test was applied. For correlation of variables (TLC, NC and appendix diameter) we used bivariate correlation.

INCLUSION AND EXCLUSION CRITERIA

All the patients diagnosed clinically with acute appendicitis were included in our study without any consideration of age or gender. Those patients who had any bacterial, viral, fungal or parasitic infection were excluded from our study. Those people who had history of any organ transplant or are on immune-suppressant were also excluded. Patients who had any sort of blood disorder like anemia, thalassemia, leukemia etc were also excluded from the study. The reason behind the excluded ones was that it may fluctuate the laboratory reports.

RESULTS

The current study was conducted on 111 patients who were clinically diagnosed with acute appendicitis. The study was distributed as having 68 male patients of age limit 8 years to 56 years (mean 22 y) and 43 female patients of age limit 7 years to 44 years (mean 19 y)(Table I).

Table I. Descriptive statistics of age, TLC, NC and appendix diameter

	Age of patients (year), n=111	Total leukocytes count (/cmm), n=111	Neutrophil count (%), n=111	Diameter of appendix (mm), n=46
Minimum	7	5600.00	32	7
Maximum	56	90000.00	90	13

According to the result it was clarified that the maximum chances of occurrence of acute appendicitis was present in the age group 19-36y.

ULTRASOUND FINDINGS

On the basis of ultrasound results the data were classified into three categories for clear understanding:

Category 1: Appendix visualized (diameter mentioned in 46 patients)

Category 2: Appendix visualized (diameter not mentioned in 41 patients)

Category 3: Appendix not visualized but the confirmation for acute appendicitis was done by secondary signs (increased vascular supply to the appendix and fluid collection surrounding the area) and CBC results.

In the study of 111 patients, the inflamed appendix was visualized in 87 patients while in 24 patients appendix was not visualized by sonologists and ultrasound-technologist. Diameter of 8mm and 12mm were found more frequently (Table II).We considered appendix of diameter greater than 6mm as abnormal.

LABORATORY FINDINGS

We established the normal TLC (Total Leukocyte Count) value as 11,000/cmm, in line with WHO criteria, where a TLC counts exceeding 11,000/cmm was deemed abnormal. Our findings revealed that out

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of the patients, 90 had a TLC exceeding 11,000/cmm, while 21 had a TLC below 11,000/cmm. Additionally, we examined the correlation between TLC and the mentioned appendix diameter, leading to the identification of 43 patients with a TLC exceeding 11,000/cmm, of which 3 had a TLC below 11,000/cmm.

For neutrophil count (NC), our study adopted the standard normal range of 40-75%. An NC exceeding 75% was considered abnormal. Our results showed that 46 patients fell within the normal NC range of 40-75%, 1 patient had an NC below 40%, and 64 patients had an NC exceeding 75%.

Table II: Diameter of appendix mentioned on ultrasound report

	Diameter of appendix(mm)							Total
	7	8	9	10	11	12	13	
Visualized Appendix on ultrasound	3	11	5	9	4	10	4	46

POST-OPERATIVE RESULTS

Out of 111 patients who had done appendectomy, 106 patients were positively operated which mean they were truly diagnosed with acute appendicitis. While negative results were observed in the remaining 5 patients. Thus the rate of negative appendectomy is 4.5%.

The ultrasound results of the negatively operated patients were having no visualization of appendix. The TLC of the 5 patients was as such that 3 of them had higher TLC than 11000 and 2 of them had normal TLC; same was the case with neutrophil count.

For correlating total leukocyte count with post operative result, we found that most of the positively operated patients had high TLC, which suggests the likelihood of acute appendicitis. Similarly neutrophil count was also observed and compared with post operative results which also showed high neutrophil count in post operated patients. These findings suggest that increase in TLC and neutrophil count strongly suggest the diagnosis of acute appendicitis.

Independent sample T test was applied for comparison between appendix diameter and post-operative results. A significance difference was found between these variables. The value of p is less than 0.001 which showed both variables, appendix diameter and post-operative results were statistically significant.

For two categorical variable such as appendix on ultrasound (visualized or not visualized) and post-operative results (positive and negative appendectomy) we applied chi square test. The result of this test showed strong significant association between post-operative results and appendix visualization on ultrasound, $x^2(1) = 18.980$ and $p<0.001$

By correlating each variable individually with post-operative results we then correlated WBC, neutrophil and appendix diameter with each other. Pearson correlation was applied to study the relationship between total leukocyte count, neutrophil count and appendix diameter because all variables are continuous.

Table III. Correlation between total leukocyte count, neutrophil count and diameter of appendix

	Total leukocytes count	Neutrophil count (%)	Diameter of appendix(mm)
Total leukocytes count	1		
Neutrophil count (%)	0.453**	1	
Diameter of appendix(mm)	0.279*	0.257*	1

* Correlation is significant at the 0.05 level (1-tailed), **Correlation is significant at the 0.01 level (1-tailed)

Neutrophil and total leukocyte count showed low positive correlation and statistically significant having r=0.453 and p=0.001. Diameter and total leukocyte count showed very low positive correlation and statistically significant(r=0.279 and p=0.030) while diameter and neutrophil also showed very low positive correlation and statistically significant result i.e r=0.257 and p=0.042 (Table III). The result showed that a correlation was present among all variables and were statistically significant.

DISCUSSION

Acute appendicitis is an emergency and its accurate diagnosis is of importance (2).Variety of studies showed that ultrasound and lab tests are helpful in initial diagnosis of acute appendicitis. In the current

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study we are focused on to find out correlation between CBC parameters (TLC and NC) and ultrasound findings (specifically appendix seen on ultrasound and its increased diameter) and how both can help in decreasing the rate of negative appendectomy.

Our study included more male than female and there is no significant difference regarding gender of the patient. This study suggests the occurrence of acute appendicitis is more common in male than female. Other studies which also has male proportion greater than female was carried out by Al-Ajerami (2012), Celik et al., (2019), Minifee et al., and Xharra et al., (2012) (7, 17–19). The age range in our study was 7 to 56 y having mean age 21y almost same with the findings of a study conducted by Al-Ajerami in 2012 having age range 5 to 59y (mean age 19.7y). In 2012, Xharra et alcarried out a studyhaving mean age 20 y (18, 19).

In our study the values of TLC and NC of almost all patients were higher than the cut-off values selected by WHO criteria similar to the study of Kessler et al., (2004), they also observed higher value of TLCs and NC than the cut-off value selected by WHO criteria (20). In our study appendix diameter greater than 6mm was considered as pathological condition. In 2020, Daldal and in 2004, Kessler et al carried out a study who also considered 6mm diameter of appendix abnormal(20,21). After ultrasound results we compared appendix diameter mentioned on ultrasound with post operated results. We found a strong significant correlation ($p<0.001$) between these two variables. The study conducted by Minifee and his coworkers also showed significant correlation($p<0.05$) when they intended to study the relationship between patients undergoing ultrasound scan and appendectomy verses no ultrasound scan and appendectomy (17). Our study included patients whose appendix diameter were mentioned and value greater than 6mm, were all positively operated. This study proved that appendix diameter greater than 6mm mentioned on ultrasound report strongly suggest the diagnosis of acute appendicitis. The value of WBC and neutrophil increases with increasing appendix diameter similar to the results of Daldal in 2020 (20). Significant difference was found between total leukocyte count and neutrophil count having p value less than 0.001 similar to the result of Çelik and his colleagues when they performed a study at 2019 (7). Total leukocyte count and neutrophil value although increases in acute appendicitis patients, but its value was also higher in negatively operated patients so WBC and neutrophil are not considered as a specific marker for the diagnosis of acute appendicitis. High TLC and neutrophil values observed in negatively operated patients were due to an allergy or hypersensitivity. Out of 111 patients we got 46 patients whose appendix diameter was mentioned on ultrasound reports and then we correlated it with TLC and neutrophil count. The results showed statistically significant low positive correlation between appendix diameter, TLC and neutrophil count. The above result was supported by Daldal in 2020 which also reported statistically significant weak correlation between WBC, neutrophil and appendix diameter (20). Out of 111 patients, 106 patients were operated positively while 5 were operated negatively. The comment on the result of operation was made by surgeon. In those negatively operated patients, one appendectomy was performed on patient request because surgeons were not ready to perform his appendectomy due to very weak diagnostic results of acute appendicitis while the other four patients were negatively operated due to misdiagnosis. Thus In our study negative appendectomy rate is 4.5%. The study of Abdelrahim and Khair showed negative appendectomy of 7.1% (22). Lower negative results were because confirmation of post-operative results was based on surgical observation not histopathological confirmation. In our study a number of reports were found having either no visualization of appendix or appendix visualized but diameter was not mentioned on it. Two possibilities exist for not visualization of appendix on ultrasound, one is the position of appendix and other is the necrosis of the appendix. We cannot say the un-visualized appendix to be normal (normal appendix can rarely be visualized) because maximum were positive appendectomy patients so the above two possibilities are valid. Since persistent and continuous inflammation can result in necrosis, patients who use NSAIDs after experiencing inflammation might find temporary relief from pain. However, the inflammation may continue to progress inside the body and lead to increased severity, eventually causing necrosis. Detecting necrotic areas can be challenging, as they often manifest as atrophic regions that are hard to visualize on ultrasound.

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CONCLUSION

It is concluded from the current study that a significant correlation is present between total leukocytes count, neutrophil count and appendix diameter which shows that with increase in appendix diameter WBC and neutrophil count also increases. By considering leukocytosis, neutrophilia and increase in appendix diameter (greater than 6mm), most of the post operative results were positive. We noticed that mentioning diameter of appendix on ultrasound report would strongly suggest the diagnoses of acute appendicitis. It is also found from the study that negative appendectomy rate is 4.5% in Peshawar. It was observed that appendix diameter and positive appendectomy has a strong correlation with each other. On visualization of appendix on ultrasound, its diameter should be measured for accurate results. Each and every detail of the disease should be mentioned on the reports or any reason should be mentioned if no finding was observed. For this purpose assessment of knowledge of the ultrasound technologists and sonologists should be performed on regular basis and training should be given to them on specific diseases and their findings on ultrasound. CT is required for those patients whose appendix was not visualized on ultrasound or whose appendix is visualized but its diameter is not mentioned.

Funding:

This study was supported by the Offices of Research Innovation and Commercialization (ORICS) by Khyber Medical University, (DIR/ORIC/Ref/23/00015).

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