



Frequency and Risk Factors of Acute Appendicitis in Patients with Equivocal Appendicitis

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ARTICLE INFO

Keywords

Acute Appendicitis, CT Findings, Equivocal Appendix

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Declaration

Authors' Contribution: Sole authorship.

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History

Received: 22-12-2024 Revised: 26-03-2025
Accepted: 15-04-2025 Published: 26-04-2025

ABSTRACT

Objective: To determine the frequency of acute appendicitis in patients with equivocal appendix; CT interpretation and to assess risk factors that favor acute appendicitis in patients with equivocal appendix. **Study design:** Cross sectional study. **Study place and duration:** General Surgery Department of Tertiary Care Hospital in Karachi for 6 months from 11th July 2023 to 31st December 2023. **Patients and method:** After meeting selection criteria 172 patients were enrolled. The patient's data was filled using a performa, including details regarding age, gender, Neutrophil-to-lymphocyte ratio, and WBC count Using HIMS database by data collectors. The Alvarado score greater than 7 was followed with CT scan and Histopathology. All the collected data was entered and analyzed on SPSS version 20. **Results:** The mean age of the patients was 35.06 ± 14.24 years, 89 (51.7%) patients were male and 83 (48.3%) were diabetics. Appendicitis was detected on CT in 80 (46.51%) patients. In patients with positive appendicitis on CT, the mean neutrophil count was 88.87 ± 6.58 , mean lymphocyte count was 14.8 ± 3.07 and mean NLR was 6.27 ± 1.22 . In negative patients was 88.74 ± 6.57 (p-value=0.260). In patients with positive appendicitis on CT the and in negative appendicitis on CT patients was 14.75 ± 2.92 . In negative patients mean neutrophil count was 6.22 ± 1.17 , mean lymphocyte count was 14861.07 ± 3066.26 and mean NLR was 14751.52 ± 2917.27 . The difference in parameters was insignificant whether patients were positive or negative for acute appendicitis. **Conclusion:** This study concludes that the frequency of acute appendicitis in patients with equivocal appendicitis as determined by CT interpretation is 46.51% while factors include age, gender, BMI, diabetes, and raised NLR showed no association with appendicitis on CT scan.

INTRODUCTION

Traditionally, acute appendicitis is diagnosed clinically, while test results might occasionally support this diagnosis. But not every patient exhibits the "classical" signs and symptoms of acute appendicitis. Patients with ambiguous clinical characteristics are more challenging to diagnose with acute appendicitis. The challenge in diagnosing acute appendicitis clinically is to strike a balance between appendiceal perforation and diagnostic precision¹. Appendicitis is the term for the inflammation of the vermiform appendix². One frequent surgical emergency that arises in a hospital environment is acute appendicitis.³ In Northern America, there were 100 (95% CI: 91, 110) cases of appendicitis/appendectomy for per 100,000 person-years³. Appendicitis was discovered to be quite prevalent in industrialized nations in the Middle East, Asia, and Southern America in the twenty-first century³.

A safe and efficient way to cut down on imaging is to repeatedly score individuals who exhibit early, equivocal

indications of appendicitis. This approach reduces the number of patients who receive an appendicitis diagnosis and the number of acute appendicitis treatments⁴. The gold standard for appendicitis imaging is computed tomography, which has a sensitivity of 81–94% and a specificity of 90–94%⁵. A CT scan can be used to diagnose appendicitis based on a number of criteria, including peri-appendicular fat stranding, wall thickness, and appendiceal diameter. However, it becomes challenging to diagnose acute appendicitis if an appendix larger than 6 mm is devoid of peri-appendiceal inflammation⁶. The preferred method for identifying acute appendicitis is a CT scan⁷.

Because air in the gut makes it difficult to provide accurate results in situations with equivocal appendix, previous studies have demonstrated that ultrasonography results are inaccurate in diagnosing appendix^{8, 9}. Acute appendicitis symptoms can be mimicked by some medical conditions. Researchers recently looked at the

histological results of acute appendicitis patients. They came to the conclusion that CT scans and histological diagnosis are superior methods of evaluating appendicular lesions. According to histology, acute appendicitis was linked to male gender and a high WBC level¹⁰.

The non-specific appearance of equivocal appendix makes it difficult to distinguish it from other sources of abdominal discomfort, which poses a serious diagnostic problem. This ambiguity raises the chance of problems like sepsis and perforation obssess formation by causing unneeded procedures and therapeutic delays. In these individuals, appendicitis can lead to a more precise diagnosis, lowering the risk of an unsuccessful appendectomy and enhancing patient outcomes. Furthermore, by improving diagnostic criteria and creating a more accurate clinical education system, an awareness of these characteristics can assist maximize the use of imaging modalities and laboratory indicators, enabling improved clinical decision-making. In addition to lowering unneeded treatments and diagnoses, this study can help develop evidence-based guidelines and improve patient safety and healthcare efficiency, which would eventually benefit the patient and the healthcare system. Therefore, this study's goals were to ascertain the prevalence of acute appendicitis in patients with equivocal appendix, interpret CT scans, and evaluate risk variables that increase the likelihood of acute appendicitis in these individuals.

MATERIALS AND METHODS

This was cross sectional study that was carried out at section of General Surgery Department of Tertiary Care Hospital in Karachi. The duration of the study was six months after approval of research, i.e. 11th July 2023 to 31st December 2023. In this study equivocal appendix was labeled if appendiceal diameter greater than 6 mm is considered as an indication of acute appendicitis, with clinical signs of acute appendicitis. Patients having age range between 10-18 years were labeled as younger group, patients having age 19-39 years were fall in early adulthood and patients having age between 40-59 years were fall in middle adulthood. A simple way to measure inflammation is to calculate neutrophil-to-lymphocyte ratio using the differential WBC counts¹¹. Neutrophil-to-lymphocyte ratio offers information about immunological and inflammatory pathways, making it a possible marker to gauge the severity of appendicitis. Shift of white blood cell to left (greater than 82 %) High level of WBC count or left shift shows high sensitivity and an infection. The calculated sample size for this study was 172 using frequency equivocal findings on CT constitutes 12.8%.⁷ The confidence interval for this sample size was 95% and level of significance as 5%. The patients were enrolled in this study by applying non-probability consecutive sampling technique. Patients

between age 10-60 years and with clinical signs of acute appendicitis having equivocal appendix, with Alvarado score greater than 7 were fall in inclusion criteria and patients with appendicitis secondary to ongoing illness and patients having history of recurrent abdominal surgery were fall in exclusion criteria. After getting formal approval from CPSP Research Evaluation Unit (REU) the researchers were begin with data collection. The patients selected from online data base were further divided based on the exposure of previously mentioned risk factors. The patients' data was filled using a performa, including details regarding age, gender, Neutrophil-to-lymphocyte ratio, and WBC count Using HIMS database by data collectors. The Alvarado score greater than 7 was followed with CT scan and Histopathology. All the collected data was entered and analyzed on SPSS version 20. Categorical data was presented in the form of frequency and percentage and all the quantitative data was presented in the form of mean \pm SD. For each biomarker, cut-off values, sensitivity, and specificity with 95% CI, as well as the likelihood ratio, was calculated. Chi-Square test was used to assess the association between these variables. Instead, if any cell of any table has count of less than or equal to 5 then Fisher exact test was applied.

RESULTS

In this study, a total of 172 patients were enrolled. The mean age of the patients was 35.06 \pm 14.24 years, while their average weight, height, and BMI were 63.44 \pm 12.71 kg, 1.65 \pm 0.89 m, and 23.52 \pm 5.14 kg/m², respectively. According to this study 89 (51.7%) patients were male and 83 (48.3%) were diabetics. Regarding clinical parameters, the mean neutrophil count, lymphocyte count, neutrophil-to-lymphocyte ratio (NLR), and white blood cell (WBC) count were 89.26 \pm 6.58, 14.80 \pm 2.97, 6.25 \pm 1.19, and 6.25 \pm 1.19, respectively. Additionally, the mean ALVARADO score was 8.62 \pm 1.08, with a minimum value of 10.02 and a maximum of 19.97. (Table 1)

Table 1

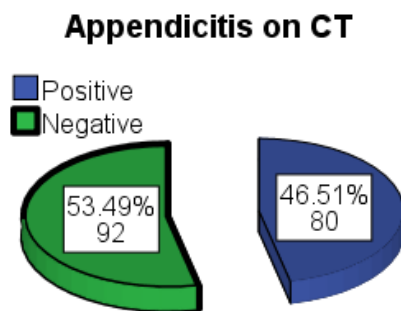
Descriptive Statistics of Demographic and Clinical Parameters

Variables		Frequency (%), mean \pm SD
Age (Years)		35.06 \pm 14.24 (11.0-60.0)
Gender	Male	89 (51.7%)
	Female	83 (48.3%)
Weight (Kg)		63.44 \pm 12.71 (40.0-94.0)
Height (m)		1.65 \pm 0.89 (1.52-1.83)
BMI (Kg/m ²)		23.52 \pm 5.14 (15.43-35.66)
History of Diabetes Mellitus	Yes	83 (48.3%)
	No	89 (51.7%)
Neutrophil		89.26 \pm 6.58 (75.00-99.0)
Lymphocyte		14.80 \pm 2.97 (10.02-19.97)
NLR		6.25 \pm 1.19 (4.81-19.97)
WBC		14802.47 \pm 2979.19 (10022.0-19974.0)
ALVARDO score		8.62 \pm 1.08 (7.0-10.0)

According to this study appendicitis diagnosed on CT was found positive in 80 (46.51%) patients. (Figure 1)

Figure 1

Frequency distribution of appendicitis on CT



In patients having age ≤ 50 years appendicitis on CT was found positive in 25 (47.2%) patients and in patients having age >50 years it was found positive in 55 (46.2%) patients (p-value=0.908). In male patients, appendicitis on CT was found positive in 44 (49.4%) patients and in female patients it was found positive in 36 (43.4%) patients (p-value=0.426). In patients having BMI ≤ 25 kg/m² appendicitis on CT was found positive in 56 (47.5%) patients and in patients having BMI >25 kg/m² it was found positive in 24 (44.4%) patients (p-value=0.713). In diabetic patients, appendicitis on CT was found positive in 39 (47.0%) patients and in non-diabetics it was found positive in 41 (46.4%) patients (p-value=0.904). (Table 2)

Table 2

Comparison of Appendicitis on CT between Age, Gender, BMI & DM of the Patients

Variables	Categories	Appendicitis on CT		Total	P-value
		Positive	Negative		
Age Groups	Upto 50	25 (47.2%)	28 (52.8%)	53 (100.0%)	0.908
	>50	55 (46.2%)	64 (53.8%)	119 (100.0%)	
Gender	Male	44 (49.4%)	45 (50.6%)	89 (100.0%)	0.426
	Female	36 (43.4%)	47 (56.6%)	83 (100.0%)	
BMI	Upto 25	56 (47.5%)	62 (52.5%)	118 (100.0%)	0.713
	>25	24 (44.4%)	30 (55.6%)	54 (100.0%)	
DM	Yes	39 (47.0%)	44 (53.0%)	83 (100.0%)	0.904
	No	41 (46.1%)	48 (53.9%)	89 (100.0%)	

In patients with positive appendicitis on CT the mean neutrophil count of the patients was 88.87 ± 6.58 and in negative appendicitis on CT patients was 88.74 ± 6.57 (p-value=0.260). In patients with positive appendicitis on

CT the mean lymphocyte count of the patients was 14.8 ± 3.07 and in negative appendicitis on CT patients was 14.75 ± 2.92 (p-value=0.811). In patients with positive appendicitis on CT the mean NLR of the patients was 6.27 ± 1.22 and in negative appendicitis on CT patients was 6.22 ± 1.17 (p-value=0.775). In patients with positive appendicitis on CT the mean WBC of the patients was 14861.07 ± 3066.26 and in negative appendicitis on CT patients was 14751.52 ± 2917.27 (p-value=0.811).

Table 3

Comparison of Appendicitis on CT between Neutrophil Count, Lymphocyte, NLR & WBC Count of the Patients

Variables	Appendicitis CT	n	Mean	P-value
Neutrophil	Positive	80	89.87 ± 6.58	0.260
	Negative	92	88.74 ± 6.57	
Lymphocytes	Positive	80	14.86 ± 3.07	0.811
	Negative	92	14.75 ± 2.92	
NLR	Positive	80	6.27 ± 1.22	0.775
	Negative	92	6.22 ± 1.17	
WBC	Positive	80	14861.07 ± 3066.26	0.811
	Negative	92	14751.52 ± 2917.27	

DISCUSSION

Since the risk of appendicitis in people with ambiguous CT scans for the condition can reach 30%, treating these patients is extremely difficult⁷. Nowadays, adult patients suspected of having appendicitis are evaluated with CT. Thankfully, the majority of CT scans for appendicitis may be simply read as either positive or negative. When appendicitis is present, there are typically many positive findings, such as the existence of an appendicolith, nearby inflammatory stranding or fluid, or appendiceal hypertrophy. The right lower quadrant often shows no abnormalities when appendicitis is absent. Regretfully, certain situations are complex and provide unclear outcomes.

Many previously published series¹²⁻¹⁸ have solely classified appendiceal CT results as positive or negative, ignoring ambiguous instances; however, several investigations have recognized the existence of an equivocal category. In their analysis of CT scans of the appendices that were conducted using only rectal contrast material, Funaki et al.¹⁹ No ambiguous instances were prospectively discovered in that series, despite the aim to designate cases as equivocal if ancillary symptoms were present but the appendix was not visible. In retrospect, the authors did observe that two false-positive instances of cecal neoplasm and cecitis most likely ought to have been regarded as ambiguous. No appendicitis was discovered during surgery in another case that was deemed positive (the appendix had a diameter of 9 mm, but there was no visible inflammatory change around).

About 8–13% of patients who received CT scans to diagnose appendicitis had equivocal CT findings,

according to a research by Massupa Krisem et al. Acute appendicitis affected almost one-third of these patients, which made diagnosis difficult for the doctors⁵. Arshad et al. Examine patients for intestinal injuries, appendix identification challenges, intraoperative dissection difficulties, etc. Compared to the delayed group, patients who had appendectomies right away experienced more postoperative problems²⁰.

Of the 869 patients, 71 (8.2%) exhibited ambiguous appendicitis results, and 63 (7.2%) were identified as most likely not having appendicitis, according to Ji Ye Sim et al. The CT combined with US re-evaluation group's sensitivity and specificity (100 percent and 98.1%, respectively) were higher than those of the CT alone group (93 percent and 99 percent; the equivocal group was regarded as having negative appendicitis, and 100 percent and 89.9 percent, respectively, $P < 0.0001$)²¹.

A typical diagnostic technique for acute appendicitis is the Alvarado scoring system, which consists of six clinical items and twelve laboratory measures²². Acute appendicitis has been linked to a number of characteristics, including age and gender. Appendicitis is most common in patients between the ages of 10 and 19²³. Also males are more likely to have appendicitis as compared to their counterparts^{9, 12-14}. Ozkan et al. found that individuals with a BMI over 30 or 40 years have a

delayed onset of acute appendicitis. In their investigation, no discernible gender disparities were discovered. Recent research has recognized the neutrophil-to-lymphocyte and platelet-to-lymphocyte ratios as indicators of inflammation in acute appendicitis. Furthermore, they stated that high platelet-to-lymphocyte, neutrophil-to-lymphocyte, and blood leukocyte values are useful in the diagnosis of acute appendicitis because the latter, in particular, rises with the severity of acute appendicitis²⁴.

Some limited data exists regarding the prevalence of appendicitis in patients with CT scans interpreted as equivocal for appendicitis, with a published range of 13-73%. Of the 10 equivocal CT scans reported by Balthazar et al^{25, 26}, five (50%) had appendicitis. In the series by Weyant et al.²⁷, 14 (73%) of 19 patients with equivocal CT scans were subsequently confirmed to have appendicitis. In two other series^{27, 28}, one (13%) of eight and 15 (41%) of 37 equivocal CT cases were subsequently proven to have appendicitis.

CONCLUSION

This study concludes that the frequency of acute appendicitis in patients with equivocal appendicitis as determined by CT interpretation is 46.51% while factors include age, gender, BMI, DM, NLR and WBC showed no association for CT findings of appendicitis.

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