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Original Research Article

Diagnosis of Appendicitis – Role of CT Scan in Ultrasound Negative Patients

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Abstract:

Background: Acute appendicitis ranks among the most frequent causes of acute abdominal emergencies, making accurate diagnosis and timely surgery essential. Ultrasonography (US) and computed tomography (CT) are pivotal in achieving accurate diagnoses for this condition. This study aimed to evaluate the accuracy of CT in identifying appendicitis in ultrasound-negative cases and to assess the efficacy of CT in identifying complications of appendicitis.

Methods: The study included patients aged 15 – 50 years, who were admitted to the surgical emergency ward with clinical symptoms suggestive of acute inflammation, such as right iliac fossa pain, fever, and vomiting. A total of fifty patients were selected as the study sample. Detailed clinical history was recorded using the prescribed proforma. Informed consent was obtained from all participating patients, and the study protocol was approved by the institutional ethical committee. Among the participants, 32 patients with either negative ultrasound findings or equivocal results underwent CT examination to obtain further diagnostic information.

Results: The examination of the position of the appendix on CT scan showed 78% of cases having retrocaecal appendix followed by the pelvic position in 14%, pre, and post-ileal in 6% of cases, and the rest in 2% of cases. The existence of free fluid was in 18% of cases, mesenteric lymphadenitis in 26% of cases, and normal appearance in 56% of cases. In this study, 38% of the study group has appendicitis, diagnosed by Computed Tomography. The age group 20-24 years has a higher incidence of acute appendicitis. Shows 6% of patients among the study population with free fluid in the Right iliac fossa show appendicular perforation/abscess.

Conclusion: CT plays a more precise role in diagnosing appendicitis, especially in cases where ultrasound results are negative. Although the role of ultrasound cannot be underrated as being non-invasive, having a quick acquisition time, being relatively cost-effective, and most importantly, not requiring the use of ionized contrast agents or oral preparation, thus eliminating radiation exposure. The CT scan can as a second-line investigation with higher significant sensitivity, specificity, positive predictive value, and negative predictive value.

Keywords: Acute appendicitis, Computed tomography, Diagnosis, Ultrasound

Introduction

Lower abdominal pain is a frequently encountered issue with a wide array of underlying causes. However, when specifically referring to right lower quadrant abdominal pain, acute appendicitis stands out as the most prevalent emergency condition, necessitating immediate management to prevent potential complications like perforation and peritonitis. [1, 2] The incidence of acute appendicitis appears to be stable in Western countries, ranging from 6% to 9%, but there is an observed increase in newly industrialized countries. [3] This upward trend could have multiple contributing factors, with reduced consumption of dietary fibers being one of the proposed theories. [3] Acute appendicitis commonly manifests during early adolescence and in the late 40s, with a slight male predominance over females, although no age group is entirely exempt from its occurrence.

The diagnosis of acute appendicitis (AA) typically relies on a combination of patient history, physical examination, and supportive laboratory investigations. Utilizing imaging modalities such as ultrasound (US) and computed tomography (CT) can significantly enhance diagnostic accuracy. However, the effectiveness of the US depends on the skill of the operator. [4, 5] The appendix's base attaches to the cecum, but its tip may be situated in various locations (retrocecal, pelvic, sub-cecal, pre-ileal, retro-ileal, and ectopic appendix), which can

complicate sonographic diagnosis. [6, 7] Pitfalls may include failure to identify segmental or tip appendicitis and an overestimation of the appendiceal diameter, leading to false positive diagnoses. Additionally, anatomical variations further complicate the diagnostic process. CT scan, on the other hand, exhibits higher sensitivity, specificity, and precision, offering encouraging results. However, the drawback lies in the risk of ionizing radiation, particularly concerning younger patients. [8-10] Given the frequent occurrence of acute appendicitis in general surgical practice, surgeons often encounter diagnostic challenges. Surgical intervention is a significant undertaking not only from the surgeon's perspective but also from the viewpoint of patients and their families, who may seek to avoid surgery if possible. Based on the above we in the current study tried to evaluate the accuracy of CT in identifying appendicitis in ultrasound negative cases and to assess the efficacy of CT in identifying complications of appendicitis.

Material and Methods

This cross-sectional study was conducted in the Department of Radiology, Department of Radiology, Prathima Relief Institute of Medical Sciences, Mulugu Road, Hanamkonda, Telangana State. Institutional Ethical approval was obtained for the study. Written consent was obtained from all the participants of the study. The sample selection was done by the convenience sampling method. Consecutive cases of suspected appendicitis were included in the study based on the inclusion and exclusion criteria

Inclusion criteria

1. Patients suspected of appendicitis have negative ultrasound findings.
2. Males and females
3. Aged from 15 – 50 years.
4. Reporting to Radiology for diagnosis
5. Voluntarily willing to participate in the study

Exclusion criteria

1. Patients who show typical findings of appendicitis in ultrasound.
2. Patients who are medically unfit to undergo contrast study like renal
3. failure patients.
4. Patients with hypersensitivity reactions.

Pregnant patients. The study enrolled patients aged 15 to 50 years who were admitted to the surgical emergency ward with clinical symptoms and signs of acute inflammation, such as right iliac fossa pain, fever, and vomiting. A total of fifty patients were included in the complete study sample, and their clinical history was recorded using the prescribed proforma.

USG Protocol: A routine abdominal and pelvic ultrasound (USG) examination was performed using a 3-5 MHz convex transducer on a SONOSCAPE machine. The primary objective was to detect any abnormalities related to solid organs and to assess the presence of free fluid. Subsequently, ranked compression and color Doppler ultrasound were carried out on the right lower quadrant, with particular attention to the area of maximal tenderness, using a linear transducer. For visualizing the normal appendix, it was identified as a blind-ended loop without any vermiculation. The graded compression technique was utilized to displace the intestinal loops, enabling differentiation between the incompressible, inflamed appendix and the compressible normal intestine loops. The diagnosis of appendicitis was based on the observation of a tubular blind-ended structure anterior to the iliac vessel, which exhibited non-compressibility and had a diameter greater than 6mm. Doppler study revealed increased peripheral vascularity in the appendix wall, indicating mural inflammation. Additional findings such as peri appendicular fat stranding, appendicolith, peritoneal fluid, and other relevant details were also documented. On average, a single study took approximately 15-20 minutes to complete. The USG findings were reported as either positive or negative for acute appendicitis. Any other relevant diagnoses or findings were also included in the report.

CT Protocol: The CT examinations were performed using a 16-slice MDCT machine (TOSHIBA) with the following parameters: 120 kVp and 100 mAs. Scans of the abdomen and pelvis were conducted from the xiphoid process to the pubic symphysis, with the administration of 80 mL of non-ionic contrast material (Iohexol 350, Omnipaque 350). The contrast material was injected into the cubital vein at the volar aspect of the elbow using an 18-gauge cannula, at a flow rate of 4 ml/s, and with a 50-second delay. Axial reconstructions from the raw data were obtained at a slice thickness of 3 mm. No oral contrast was administered. The reporting format included noting the presence of a normal appendix if visualized. The CT report provided results as positive, negative, or inconclusive for appendicitis, using criteria similar to those applied in the USG assessment. Additionally, any alternative diagnoses or other relevant findings were documented in the report.

Statistical analysis: All the available data was uploaded in MS Excel Spreadsheet and analyzed by SPSS version 19 in Windows format. The continuous variables were represented as mean, standard deviations, percentages, and categorical variables were calculated with the chi-square test, and p values of < 0.05 was considered significant.

Results

Table 1 gives the age distribution of patients experiencing right lower quadrant pain and showing negative ultrasound findings for appendicitis. Among the study population of 50 patients, the age group most affected is between 21 to 30 years, comprising approximately 56% followed by the age group 15 – 20 years with 20% of patients. Out of the 50 cases 34(68%) were males and 16(32%) were females. The age range of the cases in the study was 15 years to 47 years and the mean age of the cohort was 24.5 ± 5.5 years.

Table 1: Showing the Age wise distribution of cases in the study

Age group	Frequency	Percentage
15 – 20	10	20
21 – 30	28	56
31 – 40	07	14
41 – 50	05	10
Total	50	100

The common symptom reported in 100% of cases was pain in the right lower quadrant followed by the presence of fever in 48% of cases vomiting and painful micturition was experienced in 24% of the cases The other details of the symptoms have been depicted in table 2.

Table 2: Showing the frequency of symptoms reported by the patients

symptoms	Frequency	Percentage
Abdominal Pain	50	100
Fever	24	48
Vomiting	12	24
Constipation	3	6
Loose Stool	2	4
Low Back Ache	11	22
Painful Micturition	12	24

The duration of pain was less than 4 hours in 42% of cases, between 4 – 8 hours in 28% of cases, and more than 8 hours in 30% of cases.

Table 3: Ultrasonography findings of the cases

USG finding	Frequency	Percentage
Free Fluid	9	18
Mesenteric Lymphadenitis	13	26
Normal	28	56

The examination of the position of the appendix on CT scan showed 78% of cases having retrocaecal appendix followed by a pelvic position in 14%, pre, and post-ileal in 6% of cases, and the rest in 2% of cases. The existence of free fluid was in 18% of cases, mesenteric lymphadenitis in 26% of cases and normal appearance in 56% of cases depicted in figure 1.

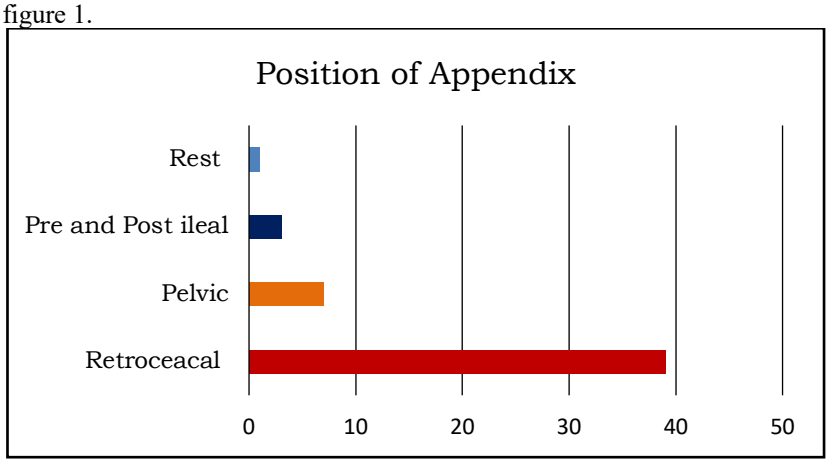

Figure 1: Position of Appendix in the patients of the study.

The diameter of the appendix in the CT scan among the study group was found to be <6 mm in 56% of patients. Between 6 – 7 mm in 10% of cases and 24% of patients have a diameter of 7-8 mm and >8mm in 10% of cases of study.

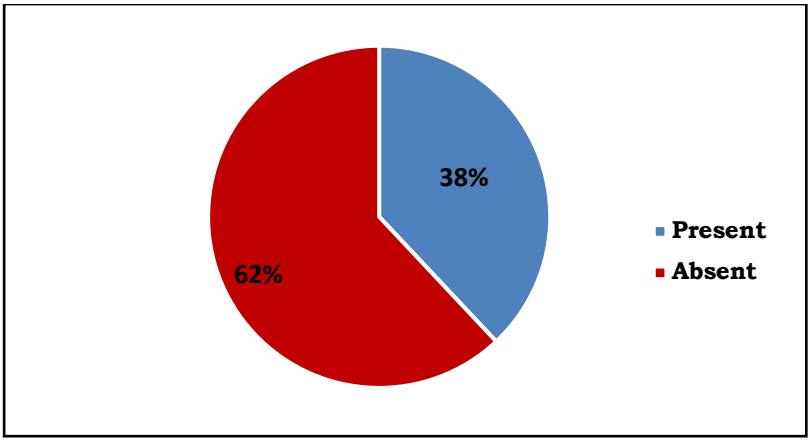

Figure 2: Peri appendiceal Fat Stranding with wall Enhancement

In this study, 38% of the study group has appendicitis, diagnosed by Computed Tomography depicted in Figure 2. The age group 20-24 years has a higher incidence of acute appendicitis. Shows 6% of patients among the study population with free fluid in the Right iliac fossa show appendicular perforation/abscess.

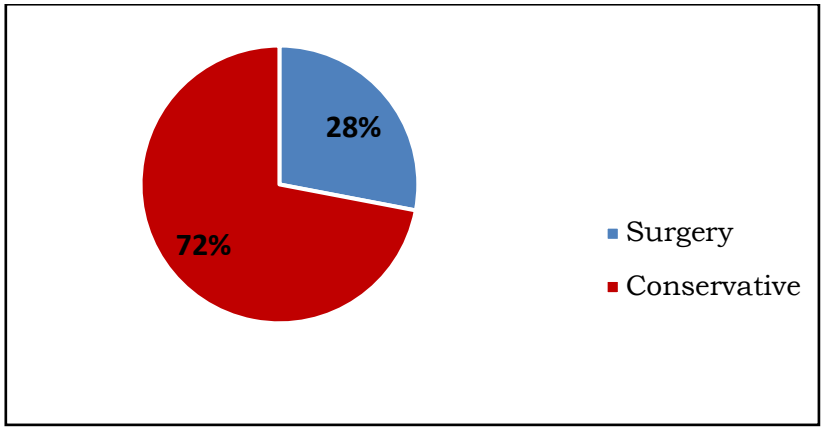

Figure 3: shows the management of patients with acute appendicitis

Out of 19 patients diagnosed with appendicitis 11 cases underwent surgery 3 cases of perforation underwent surgery and the rest cases were managed conservatively as given in Table 4.

Table 4: Diagnosis and management of appendicitis in the cases of the study

Diagnosis	Surgery	Conservative	Total
Appendicitis	11	8	19
Perforation	3	0	3
Other	0	28	28

This study found that patients with a CT finding of an appendicular diameter exceeding 6mm (especially 7-8mm) were diagnosed with Appendicitis, and this diagnosis was supported by other corroborative findings, intraoperative observations, and histopathological correlation. Consequently, the study found that CT plays a vital and more accurate role in diagnosing Appendicitis in cases where ultrasound results are negative, displaying notable sensitivity, specificity, positive predictive value, and negative predictive value.

Discussion

Acute appendicitis is one of the most common causes of abdominal pain in the right inferior quadrant. A total of 50 patients with right lower quadrant pain were subjected to ultrasound, plain CT, and contrast-enhanced CT. The efficacy and accuracy of CT in identifying appendicitis and its complications were assessed. The diameter of the appendix (measured from outer-to-outer wall) was assessed in all patients. The diameter was <6 mm in 56% of the patients. Between 6 and 7 mm in 10% of cases, 24% of patients had a diameter of 7-8 mm, and >8 mm in 10% of cases. The USG findings did not show an inflamed appendix; 26% of the patients had mesenteric lymphadenitis and 18% had free fluid. N Leite et al. [11] in their review found that an appendix diameter < 6 mm or > 6 mm diameter with a gas-filled appendix or 6 – 10 mm appendix without any other CT signs mentioned as "possible appendicitis." A diameter of 6 – 10 mm appendix

with wall thickening (i.e., >3 mm of wall thickness) and wall hyperenhancement with or without fat stranding as "probable appendicitis". The Appendix diameter is greater than 10 mm or 6 to 10 mm with wall thickening, wall hyperenhancement, and fat stranding as "Definite appendicitis." In our study, we found that 25% of the patients (equivalent to 50 patients) diagnosed with appendicitis exhibited an appendix diameter of 7 – 8 mm on contrast-enhanced CT scans, accompanied by peri-appendiceal fat stranding and wall enhancement.

In our study, the diagnostic performance of ultrasound (US) and computed tomography (CT) in diagnosing acute appendicitis (AA) was evaluated, and the following results were obtained. Ultrasound (US) sensitivity, 88.5; specificity, 72.5%; Positive Predictive Value (PPV), 90.2%; Negative Predictive Value (NPV),70.0%; Overall Accuracy, 85.5%. On the other hand, for computed tomography (CT), sensitivity: 99.0%, specificity: 90.1%, Positive Predictive Value (PPV): 98.7%, Negative Predictive Value (NPV): 87.2%, Overall Accuracy: 97.0%. Our findings were consistent with those of other studies, where sensitivity ranged from 75% to 98% and specificity from 86% to 100%, with positive and negative predictive values varying between 91% and 100%, and 89% and 99%, respectively. [12-14] It is worth noting that some studies reported lower sensitivity and specificity for ultrasound than for CT scans. [15]

According to a comprehensive systematic review, ultrasound (US) diagnosis of acute appendicitis (AA) showed the following performance metrics: sensitivity, 83.7%; specificity, 95.9%; accuracy, 92.2%; Positive Predictive Value (PPV), 89.8%; and Negative Predictive Value (NPV), 93.2%. [15] In comparison, the pooled estimates for the diagnostic value of computed tomography (CT) were as follows: sensitivity, 93.4%; specificity, 93.3%; accuracy, 93.4%; Positive Predictive Value (PPV), 90.3%; and Negative Predictive Value (NPV),95.5%. CT was more sensitive (88.4% vs. 76%) and slightly more specific (90.4% vs. 89.4%) than the US. [15] Another study of 2,871 patients reported a sensitivity of 98.5% and a specificity of 98% for the diagnosis of AA.[16] However, it is important to note that the diagnostic accuracy of the US varies widely among studies, with reported sensitivities ranging from 44% to 100% and specificities ranging from 47% to 100%.[17, 18] One study reported high sensitivity, specificity of 80 %, PPV, and NPV of 94.4%, 80%, 97.7%, and 61.53%, respectively. [19]

Conclusion

Within the limitations of the current study, it can be concluded that patients with a CT observation of an appendicular diameter greater than 6mm (specifically 7-8mm) were confirmed to have appendicitis. These results aligned well with other corroborating evidence, including intraoperative findings and histopathological correlation. Therefore, CT plays a more precise role in diagnosing appendicitis, especially in cases where ultrasound results are negative. Although the role of ultrasound cannot be underrated as being non-invasive, having a quick acquisition time, being relatively cost-effective, and most importantly, not requiring the use of ionized contrast agents or oral preparation, thus eliminating radiation exposure. The CT scan can be as a second-line investigation with higher significant sensitivity, specificity, positive predictive value, and negative predictive value in such situations.

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