Section: Miscellaneous

Original Research Article

ROLE OF COMPUTED TOMOGRAPHY IN THE EVALUATION OF SUSPECTED ACUTE APPENDICITIS WITH NEGATIVE ULTRASONOGRAPHY: A HOSPITAL-BASED OBSERVATIONAL STUDY

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ABSTRACT

Background: Acute appendicitis is one of the most common causes of acute abdomen. Ultrasonography (USG) is often used as the first-line imaging modality; however, its sensitivity is limited, particularly in atypical cases and certain anatomical positions of the appendix. Computed tomography (CT) has emerged as a more accurate diagnostic tool in such scenarios. The objective is to evaluate the diagnostic accuracy of CT in identifying acute appendicitis in ultrasound-negative cases, to assess CT efficacy in detecting appendiceal complications. To identify alternative causes of right lower quadrant pain. To determine the average CT diameter of the normal appendix in the Indian population. **Materials and Methods:** A hospital-based observational study was conducted in the Department of Radiodiagnosis at a tertiary care teaching hospital in Bangalore for a period of 6 months. Fifty patients with clinically suspected appendicitis and negative ultrasound findings were evaluated using non-enhanced CT, with contrast-enhanced CT performed when necessary. CT findings were analyzed and correlated clinically. Statistical analysis was performed using SPSS version 26. **Result:** Out of 50 patients, CT confirmed acute appendicitis in 24 cases (48%). The most common appendiceal position was retrocaecal (38%). An appendiceal diameter greater than 8 mm was observed in 46% of cases. Periappendiceal fat stranding with wall enhancement was present in all CT-positive cases. CT also identified complications such as appendicolith, perforation, and abscess, along with alternative diagnoses in ultrasound-negative patients. No significant association was found between age or sex and CT-diagnosed appendicitis. **Conclusion:** CT is a highly effective imaging modality in diagnosing acute appendicitis in ultrasound-negative cases. It plays a crucial role in identifying complications and alternative diagnoses, thereby reducing negative appendectomy rates and improving clinical outcomes.

INTRODUCTION

Acute appendicitis is one of the most common causes of acute abdominal pain requiring emergency surgical intervention worldwide, with a reported lifetime risk of approximately 7%.[1] It affects all age groups but is most frequently encountered in adolescents and young adults. Prompt and accurate diagnosis is critical, as delayed intervention may lead to serious complications such as perforation, appendicular abscess, generalized peritonitis, increased postoperative morbidity, and prolonged hospital stay.[2] Early diagnosis significantly reduces complication rates and healthcare burden.[3]

Despite advances in clinical assessment, the diagnosis of acute appendicitis remains challenging, particularly in patients with atypical presentations. Classical symptoms such as right lower quadrant pain, fever, nausea, and vomiting may be absent or nonspecific. Moreover, several gastrointestinal, urological, and gynaecological conditions—such as mesenteric lymphadenitis, ureteric colic, Crohn's disease, pelvic inflammatory disease, and ovarian pathology—can closely mimic appendicitis.[4] These diagnostic difficulties are especially pronounced in

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women of reproductive age, where gynaecological disorders frequently overlap in clinical presentation, contributing to higher rates of diagnostic uncertainty and negative appendectomy.[5]

Clinical scoring systems such as the Alvarado score and Appendicitis Inflammatory Response score have been developed to aid diagnosis; however, their accuracy varies widely across populations and clinical settings.[6] Consequently, imaging has become an essential adjunct to clinical evaluation in patients with suspected appendicitis.

Ultrasonography is commonly employed as the first-line imaging modality, particularly in children and young adults, due to its wide availability, low cost, lack of ionizing radiation, and ability to assess alternative diagnoses.[7] A normal appendix on ultrasonography is compressible and measures less than 6 mm in diameter. However, ultrasonography is highly operator dependent and its diagnostic accuracy decreases in obese patients, excessive bowel gas, retrocaecal or deep pelvic appendices, and early or mild inflammatory changes.[8] In many cases, the appendix may not be visualized, leading to inconclusive or falsely negative results despite strong clinical suspicion. Reported sensitivities of ultrasonography range from 44% to 86%, highlighting its limitations in equivocal cases.[9]

Computed tomography has emerged as a highly accurate imaging modality in the evaluation of acute appendicitis. CT offers excellent spatial resolution, wide field of view, and the ability to evaluate the appendix irrespective of body habitus or anatomical location. Typical CT findings of acute appendicitis include an enlarged appendix with a diameter greater than 6 mm, wall thickening and enhancement, periappendiceal fat stranding, appendicolith, and periappendiceal fluid collection.[10] CT is also superior in detecting complications such as perforation, abscess formation, phlegmon, and generalized peritonitis.[11]

Multiple studies have demonstrated that CT has a sensitivity and specificity exceeding 90% for the diagnosis of acute appendicitis.[12] Its use has been associated with a significant reduction in negative appendectomy rates, from as high as 20–25% in the pre-CT era to less than 5% in centers where CT is routinely utilized.[13] In addition, CT plays a crucial role in identifying alternative causes of right lower quadrant pain, thereby preventing unnecessary surgical intervention.[14]

Despite concerns regarding radiation exposure, especially in younger patients, the benefits of CT in equivocal or ultrasound-negative cases often outweigh the potential risks. Low-dose CT protocols have further minimized radiation exposure while maintaining diagnostic accuracy.[15]

In the Indian clinical setting, where patients often present late and with atypical symptoms, and where ultrasonography is frequently inconclusive, CT serves as an invaluable problem-solving tool. There is limited Indian data specifically evaluating the role of CT in patients with suspected appendicitis and negative ultrasound findings. Therefore, this study was undertaken to assess the diagnostic utility of CT in such cases, its ability to detect complications, and its role in identifying alternative diagnoses presenting as right lower quadrant pain.

Objectives

1. To evaluate the accuracy of CT in diagnosing acute appendicitis in ultrasound-negative cases.
2. To assess the role of CT in identifying complications of appendicitis.
3. To identify alternative diagnoses presenting as right lower quadrant pain.
4. To determine the average CT diameter of the normal appendix in the Indian population.

MATERIALS AND METHODS

This hospital-based observational study was conducted in the Department of Radiodiagnosis at a tertiary care teaching hospital in Bangalore for a period of 6 months. The study included 50 patients aged 12–55 years with clinical suspicion of acute appendicitis and negative ultrasound findings.

Patients with right lower quadrant pain and clinical suspicion of appendicitis, patients with negative or inconclusive ultrasound findings were included in the study. Ultrasound-confirmed appendicitis, Pregnant women and patients with Renal failure or contrast allergy were excluded from the study.

CT scans were performed using a 128-slice Siemens SOMATOM Perspective scanner. Non-enhanced CT was used initially, with contrast-enhanced CT performed when indicated. Axial images with coronal and sagittal reformations were analyzed. Diagnostic criteria included appendiceal diameter >6 mm, wall thickening, mural enhancement, periappendiceal fat stranding, appendicolith, and complications such as perforation or abscess.

Data was analyzed using SPSS version 26. Descriptive statistics were expressed as frequencies and percentages. Association between the groups was tested using Chi-square and Fisher's exact test, with $p < 0.05$ considered statistically significant.

RESULTS

A total of 50 patients with clinically suspected acute appendicitis and negative ultrasonography findings were included in the study.

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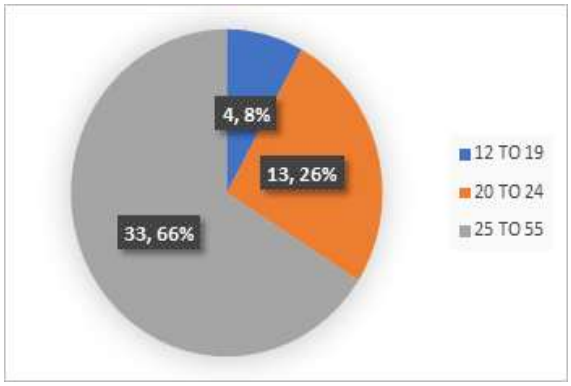

Figure 1: Age distribution

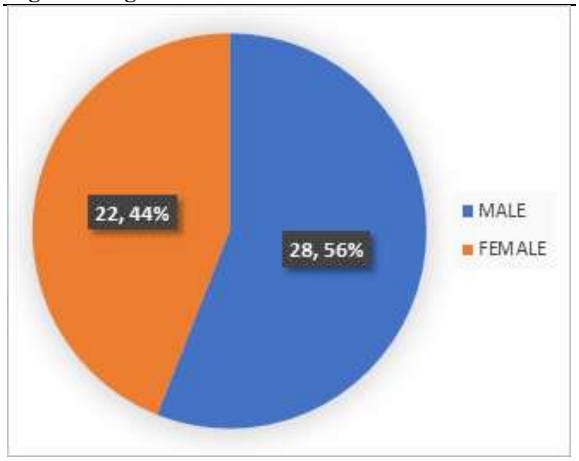

Figure 2: Gender distribution

The age distribution of the study population is shown in [Figure 1]. The majority of patients belonged to the 25–55 years age group (66%), followed by 20–24 years (26%) and 12–19 years (8%), indicating that appendicitis with equivocal ultrasound findings was more common in adults.

As depicted in [Figure 2], males constituted 56% (n=28) of the study population, while females constituted 44% (n=22).

Fever was present in 50% of patients [Figure 3]. All patients presented with right lower quadrant abdominal pain (100%), making it the most consistent symptom. Other associated symptoms included lower back ache (48%), vomiting (24%), constipation (20%), loose stools (16%), and painful micturition (6%).

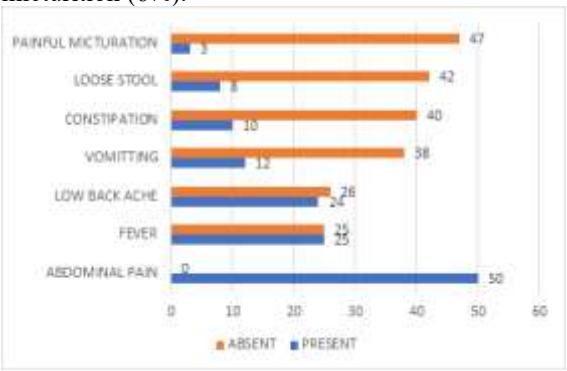

Figure 3: Clinical Presentation

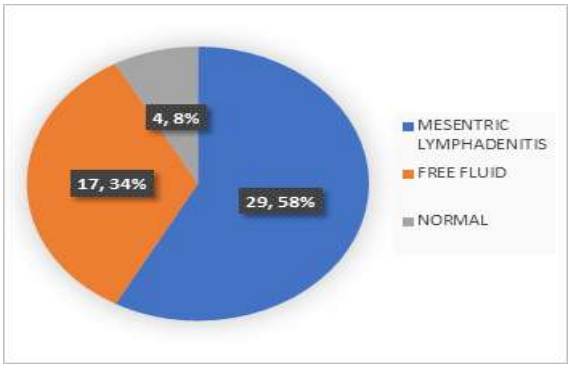

Figure 4: Ultrasonography Findings

Although all patients were ultrasound-negative for appendicitis, mesenteric lymphadenitis was noted in 58%, free fluid in 34%, and normal findings in 8% [Figure 4], highlighting the limitations of ultrasonography in these cases.

Table 1: Diagnosis of Appendicitis on CT

Appendicitis	No of patients	Percentage
Present	24	48
Absent	26	52

CT diagnosed acute appendicitis in 24 patients (48%) [Table 1].

Table 2: CT findings in subjects with Appendicitis

CT Finding		Frequency	Percentage
Position Of Appendix	Retroceacal	19	38.0
	Pelvic	6	12.0
	Pre & Post Ileal	4	8.0
	Rest	21	42.0
Diameter Of Appendix	< 6 MM	11	22.00
	6 - 7MM	7	14.00
	7-8 MM	9	18.00
	>8 MM	23	46.00
Periappendiceal fat stranding with wall enhancement	Present	24	48
	Absent	26	52

The most common appendiceal position identified on CT was retrocaecal (38%), followed by pelvic (12%), pre/post ileal (8%), and other positions. Appendiceal diameter assessment showed that 46% of patients had diameter >8 mm, while 22% had <6 mm, 14% had 6–7 mm, and 18% had 7–8 mm. Periappendiceal fat stranding with wall enhancement was present in all CT-positive cases [Table 2].

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Table 3: Complications and Alternative Diagnoses

Variable		Frequency	Percentage
Appendicular Perforation/Abscess	Present	14	28
	Absent	36	72
Alternate diagnosis	Mesenteric Lymphadenitis	20	77.0
	Distal Ureteric Calculus	3	11.0
	Ileocecal Thickening	2	8.0
	Oophoritis	1	4.0

CT detected appendicular perforation or abscess in 28% of patients [Table 3]. Among CT-negative cases, alternative diagnoses were identified, most commonly mesenteric lymphadenitis (77%), followed by distal ureteric calculus (11%), ileocecal thickening (8%), and oophoritis (4%) [Table 3].

Table 4a: Association between Diameter of Appendix and diagnosis of Appendicitis on CT

Appendix Diameter	Appendicitis		P value
	Present	Absent	
≥ 6 mm	21 (TP)	8 (FP)	0.000049*
< 6 mm	3 (FN)	18 (TN)	

*-Significant

Appendiceal diameter showed a significant association with appendicitis [Table 4a].

Table 4b: Diagnostic Performance of CT

Statistic	Value	95% CI
Sensitivity	87.50%	67.64% to 97.34%
Specificity	69.23%	48.21% to 85.67%
Positive Likelihood Ratio	2.84	1.57 to 5.16
Negative Likelihood Ratio	0.18	0.06 to 0.54
Positive Predictive Value (*)	72.41%	59.12% to 82.65%
Negative Predictive Value (*)	85.71%	66.88% to 94.69%
Accuracy (*)	78.00%	64.04% to 88.47%

Diameter ≥6 mm demonstrated a sensitivity of 87.5%, specificity of 69.2%, PPV of 72.4%, NPV of 85.7%, and overall accuracy of 78% (Table 4b).

Surgical management was undertaken in 66% of patients, while 34% were managed conservatively. Indications for surgery included acute appendicitis (57%) and perforation (43%).

A significant association was found between CT diagnosis and management strategy with all perforation cases undergoing surgery ($p<0.0001$).

DISCUSSION

Acute appendicitis remains one of the most common causes of acute abdomen requiring emergency surgical intervention. Despite advances in clinical scoring systems and laboratory parameters, diagnosis continues to be challenging, particularly in cases with atypical presentations and equivocal ultrasonography findings. In the present study, CT was evaluated as a problem-solving modality in 50 ultrasound-negative patients with suspected acute appendicitis.

Demographic and Clinical Correlation: In the present study, 66% (33/50) of patients belonged to the 25–55-year age group, followed by 26% (13/50) in the 20–24-year group and 8% (4/50) below 20 years. Debnath et al.16 reported 62% of cases in the 21–50-year age group, while Stroman et al,[17] observed a mean patient age of 34.8 years, demonstrating comparable age distribution. Although appendicitis is traditionally described in younger individuals, delayed presentation and atypical imaging features are increasingly reported in adults.

Male predominance was observed in the present study, with 56% males (28/50) and 44% females (22/50). Peck et al,[14] reported a male prevalence of 58%, and Rao et al,[18] reported 60% male predominance, whereas Stroman et al,[17] reported a slight female predominance (52% females), suggesting demographic variation across populations.

Right lower quadrant pain was present in 100% (50/50) of patients, confirming it as the most consistent clinical feature. Fever was noted in 50% (25/50) and vomiting in 24% (12/50) of patients. Andersson et al,[4] demonstrated that classical symptoms such as fever and vomiting had sensitivities of only 40–60%, reinforcing the limited diagnostic reliability of clinical parameters alone.

Limitations of Ultrasonography: Despite being the first-line imaging modality, ultrasonography failed to detect appendicitis in 100% of cases included in this study. The most common ultrasound finding was mesenteric lymphadenitis in 58% (29/50), followed by free fluid in 34% (17/50). Puylaert et al,[8] reported ultrasound sensitivity ranging from 44–77%, particularly reduced in retrocaecal appendices. Doria et al,[7] reported an overall ultrasound sensitivity of 83% but emphasized significantly reduced visualization in obese patients and atypical appendix locations.

In the present study, 38% (19/50) of appendices were retrocaecal, explaining the high rate of false-negative

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ultrasound findings and reinforcing the need for CT in equivocal cases.

Role of CT in Diagnosis: CT diagnosed acute appendicitis in 48% (24/50) of ultrasound-negative patients, highlighting its superior diagnostic performance. Rao et al,[13] reported CT sensitivity of 94% and specificity of 95%, Fefferman et al,[12] reported sensitivity of 97%, and Peck et al,[14] reported sensitivity exceeding 95%, all supporting CT as the most accurate imaging modality.

Appendiceal diameter was a strong diagnostic indicator. In the present study, 78% (39/50) had appendiceal diameter ≥6 mm, and 46% (23/50) had diameter >8 mm, with a statistically significant association with appendicitis ($p<0.05$). Ives et al,[18] reported appendicitis in 90% of patients with appendix diameter >6 mm, while Pinto Leite et al,[10] demonstrated that appendiceal diameter >6 mm combined with secondary signs yielded diagnostic accuracy exceeding 93%.

Periappendiceal fat stranding and mural enhancement were present in 100% (24/24) of CT-positive cases in this study. Choi et al,[11] reported fat stranding in 96% of acute appendicitis cases, and Rhea et al,[19] reported fat stranding as the most reliable CT sign with sensitivity of 98%.

Detection of Complications: CT detected appendicular perforation or abscess in 28% (14/50) of patients, all of which were missed on ultrasonography. Martin et al,[20] reported CT detection of perforation in 26% of cases, while Choi et al,[11] reported perforation detection rates of 29%, closely matching the present study. Early identification of complications in the present study directly influenced surgical management, with 100% of perforation cases undergoing immediate surgery.

Alternative Diagnoses and Reduction of Negative Appendectomy: CT identified alternative diagnoses in 52% (26/50) of patients. Mesenteric lymphadenitis accounted for 77% (20/26), ureteric calculus 11% (3/26), ileocecal pathology 8% (2/26), and oophoritis 4% (1/26). Peck et al,[14] reported alternative diagnoses in 35–50% of CT scans performed for suspected appendicitis, while Raman et al,[21] reported alternative diagnoses in 43% of cases.

Importantly, the negative appendectomy rate in the present study was 0%, compared with reported rates of 15–25% in the pre-CT era. Wagner et al,[22] reported a negative appendectomy rate of 20%, while Rao et al.13 demonstrated reduction to 4–6% with routine CT usage. Raja et al,[23] similarly reported a reduction to 3.6%, underscoring CT's impact on surgical decision-making.

Diagnostic Accuracy of CT: In the present study, CT based on appendiceal diameter demonstrated sensitivity of 87.5%, specificity of 69.2%, PPV of 72.4%, NPV of 85.7%, and overall diagnostic accuracy of 78%. Stroman et al,[17] reported CT sensitivity of 89% and specificity of 72%, while Peck et al,[14] reported sensitivity of 95% and specificity of 90%, indicating comparable diagnostic performance. Slightly lower specificity in the present study may be attributed to borderline appendiceal diameters in conservatively managed patients.

CONCLUSION

The study assessed the role of CT scans in 50 patients with USG-negative acute appendicitis and right iliac fossa (RIF) pain, predominantly affecting males aged 25 to 55. Findings revealed that 24 patients (48%) exhibited appendicitis on CT, with the retrocecal position being the most common for the appendix. The remaining 26 cases showed other conditions like mesenteric lymphadenitis (77%) and distal ureteric calculus (11%) without appendicitis signs. A significant link was identified between an appendix diameter over 6mm and presence of appendicitis ($p<0.05$), with a zero negative appendicectomy rate. Complications included appendicular perforation or abscess in 28% of patients. The study found CT scan sensitivity at 87.5%, specificity at 69.23%, and accuracy at 78% for diagnosing acute appendicitis. In conclusion, CT is a crucial modality for diagnosing appendicitis in patients with negative ultrasound results, aiding early intervention and reducing complications.

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