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Original Research Article

DETERMINATION OF ACCURACY OF 3-MILLIMETER THIN AXIAL SECTIONS OF 64-SLICE MULTI-DETECTOR COMPUTED TOMOGRAPHY SCAN IN DIAGNOSIS OF ACUTE APPENDICITIS

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Abstract: *Acute appendicitis is a common cause of acute abdominal pain requiring urgent surgical intervention. Timely diagnosis is crucial to prevent complications such as perforation and reduce morbidity and mortality rates. Clinical diagnosis alone can be challenging, leading to false positives and negatives. Multidetector computed tomography (MDCT) has emerged as a valuable tool in diagnosing appendicitis, but its efficacy can be enhanced by optimizing imaging protocols, particularly by utilizing thinner reconstruction sections. We conducted a prospective study involving 150 patients with suspected acute appendicitis. Un-enhanced 64-slice MDCT was performed, and axial images reconstructed from 3mm thin sections were analyzed. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated using SPSS version 19. Our study demonstrated a sensitivity of 97.8% and specificity of 76.9% for diagnosing acute appendicitis using 3mm thin section MDCT. The NPV and PPV were 76.9% and 97.8%, respectively, with an overall accuracy of 96%. Utilizing 3mm thin axial reconstruction in 64-slice MDCT significantly enhances diagnostic accuracy for acute appendicitis. This approach holds promise in reducing negative appendectomies and associated morbidity and mortality rates. Implementation of this imaging protocol can aid in timely diagnosis, optimizing patient care, and reducing unnecessary hospitalizations. 64-slice MDCT with 3mm thin section reconstructed images emerges as a highly accurate technique for diagnosing or excluding appendicitis in patients with equivocal presentations, contributing to improved patient outcomes and healthcare resource utilization.*

Keywords: Acute Appendicitis, Computed Tomography, Diagnosis, Multidetector Tomography, X-Ray

Introduction

Acute appendicitis remains a significant cause of acute abdominal pain globally, necessitating prompt surgical intervention to mitigate risks of perforation and associated morbidity and mortality (Sartelli et al., 2017). Despite advancements in diagnostic modalities, appendiceal perforation rates escalate with delayed diagnosis, emphasizing the criticality of early and confident identification (Sartelli et al., 2017). Clinical diagnosis, though fundamental, can be challenging, particularly in cases with atypical presentations or when mimicking other abdominopelvic pathologies, contributing to diagnostic delays and increased risks of complications (Brown and Kelso, 2014; Brownson and Mandell, 2015).

Conventional diagnostic approaches, reliant on patient history and physical examination, exhibit limitations, particularly in cases with equivocal clinical manifestations (Babcock et al., 2014; Brownson and Mandell, 2015). Multidetector computed tomography (MDCT) has emerged as a valuable adjunct in the diagnostic armamentarium for acute appendicitis, offering high sensitivity and specificity and aiding in expeditious decision-making 4. Despite its widespread acceptance, challenges persist, including occasional equivocal or false-positive results due to the non-visualization of the appendix, particularly in challenging clinical scenarios (Beardsley, 2017; Narasimhamurthy, 2019).

Advancements in CT technology, notably the evolution of multislice CT scanners, offer enhanced imaging capabilities, with thinner slice reconstructions facilitating improved visualization and diagnostic accuracy (Ginat and Gupta, 2014). However, selecting an optimal reconstruction section thickness remains a subject of investigation, with considerations for balancing diagnostic efficacy against potential drawbacks such as increased image noise and interpretation complexity (McGuigan et al., 2018).

While previous studies have explored the utility of thinner reconstruction sections in MDCT for appendiceal imaging, there remains a lack of local data examining the efficacy of 3-millimeter (mm) thin axial sections in 64-slice MDCT for acute appendicitis diagnosis, particularly in Pakistani populations (Bharti et al.; Sucharitha, 2017). Therefore, this study addresses this gap by evaluating the diagnostic accuracy of 3 mm thin axial sections in 64-slice MDCT for acute appendicitis, validated against histopathological findings.

The findings from this study hold significant implications for clinical practice. They potentially guide the selection of optimal section thickness in appendiceal MDCT protocols, thereby facilitating early and confident diagnosis, reducing unnecessary hospitalizations, and improving patient outcomes. Moreover, insights gained may inform alternate diagnoses in equivocal cases, further refining patient management strategies.

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Methodology

This cross-sectional study was conducted at the Department of Radiology, Aga Khan University Hospital, Karachi, from March 18, 2012, to January 18, 2012. A sample size of 150 patients was determined based on an assumed 95% sensitivity (accuracy) of multidetector computed tomography (MDCT) in diagnosing appendicitis, an 8% prevalence of appendicitis in the Pakistani population, and a 3.5% margin of error, with a 95% confidence level. Consecutive sampling was employed to select patients meeting the inclusion criteria.

Inclusion criteria encompassed patients of all ages and genders who presented with clinical suspicion of acute appendicitis, were referred to the radiology department for a 64-slice MDCT scan, and subsequently underwent appendectomy with histopathological confirmation at Aga Khan University Hospital, Karachi. Patients treated conservatively, lost to follow-up, or referred from external facilities with surgeries performed elsewhere were excluded. Patients with alternative diagnoses, such as ureteric calculus or adnexal pathology, were excluded.

Data collection commenced with the enrollment of eligible patients, following which informed consent was obtained and a brief clinical history recorded. Anthropometric measurements, including height, weight, and body mass index (BMI), were taken. MDCT scans of the lower abdomen and pelvis were conducted using a 64-slice Aquilion scanner (Toshiba Medical Systems) at 120 KVp and 350 mAs. Initially, volume data with 0.5mm slice thickness were acquired and reconstructed into 3mm axial planes.

A consultant radiologist with over five years of experience in abdominopelvic CT reporting interpreted MDCT findings regarding acute appendicitis on 3 mm axial images. Histopathological findings regarding acute appendicitis were retrieved from medical records.

Data regarding MDCT findings and histopathological confirmation of acute appendicitis were recorded on a standardized proforma. Statistical analysis was carried out using SPSS statistical package version 19. Frequencies and percentages were computed for age, gender, and BMI. The accuracy of 3mm axial sections of MDCT in detecting acute appendicitis, confirmed by histopathology, was calculated, controlling for potential effect modifiers such as age and BMI through stratification. The Chi-square test was applied to assess differences between strata, with significance set at a p-value of ≤ 0.05.

Results

total of 150 patients meeting the study's inclusion criteria were analyzed. The sample consisted of 93 (62%) male and 57 (38%) female patients aged 4 to 90 years. Among them, 26 (17.3%) were pediatric patients aged 1-15 years, while 124 (82.7%) were adults aged above 15 years. Furthermore, 113 (75.3%) patients had a BMI below 30 kg/m^2, and 37 (24.7%) were categorized as obese with a BMI above 30 kg/m^2. All patients were followed up for one week post-operatively (Figure 1).

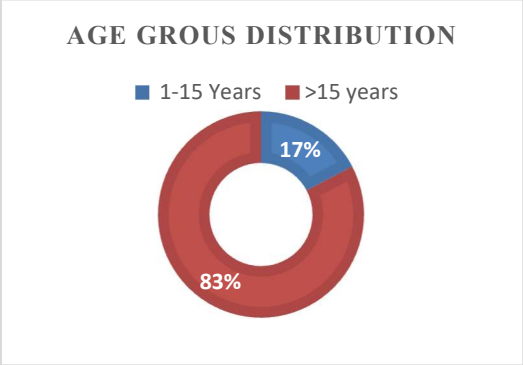

Figure 1: Distribution of age groups in the study population

Of the 150 cases, 137 (89.3%) were diagnosed positive for appendicitis on MDCT, including 6 cases initially diagnosed as appendicular lump. Histopathological examination confirmed acute appendicitis in 137 (90.6%) cases. Of 137 patients positive for MDCT, 134 were also positive on histopathology. Conversely, three patients diagnosed as unfavorable on MDCT were found to have acute appendicitis on histopathology, while three patients labeled positive on MDCT had lymphoid hyperplasia instead. Among the 14 cases deemed harmful on MDCT, 3 (21%) were histologically confirmed to have actively inflamed appendices.

Based on these findings, MDCT with 3mm thin sections exhibited a sensitivity of 97.8%, specificity of 76.9%, positive predictive value (PPV) of 97.8%, negative predictive value (NPV) of 76.9%, and an accuracy of 96%. (Table 1)

Stratification by gender revealed that 86 out of 93 males and 48 out of 57 females were positive for appendicitis on both MDCT and histopathology. The accuracy of MDCT with 3mm thin sections was calculated to be 95.6% in males and 96.4% in females.

Furthermore, stratification by age showed that 24 out of 26 pediatric patients and 110 out of 124 adult patients were positive for appendicitis on both MDCT and histopathology. The accuracy of MDCT with 3mm thin sections was 96.2% in pediatric patients and 95.9% in adults.

Additionally, stratification by BMI demonstrated that 99 out of 113 non-obese patients and 35 out of 37 obese patients were positive for appendicitis on both MDCT and histopathology. The accuracy of MDCT with 3mm thin sections was 96.4% in non-obese patients and 94.5% in obese patients.

The most frequently observed MDCT findings in actual positive cases included appendicular caliber enlargement and peri-appendiceal fat stranding. An appendicolith was found in 34 cases, with the enlargement of appendicular caliber in all but 6 cases. Notably, 2 cases were diagnosed negative for appendicitis on MDCT but later diagnosed with alternative conditions. (Table 2)

Overall, MDCT with 3mm thin sections demonstrated high diagnostic accuracy for appendicitis, with consistent performance across gender, age, and BMI categories.

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IMAGES OF STUDY CASES

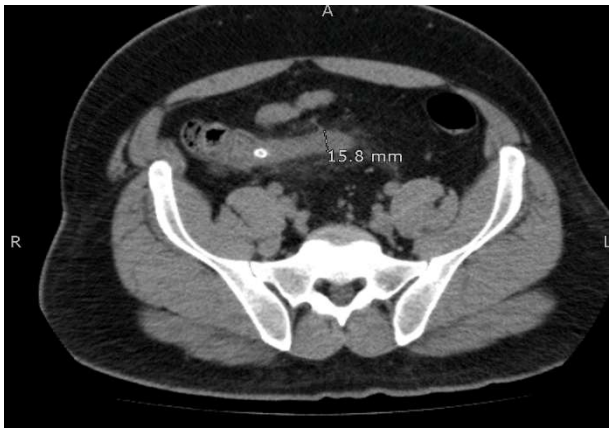

Image 1: A 3mm thin axial section of a 36-year-old male with right iliac fossa pain shows a dilated appendix of 15.8 mm with an appendicolith at its base.

Image 2: 3mm thin axial section showing dilated appendix with an appendicolith and peri appendiceal fat stranding.

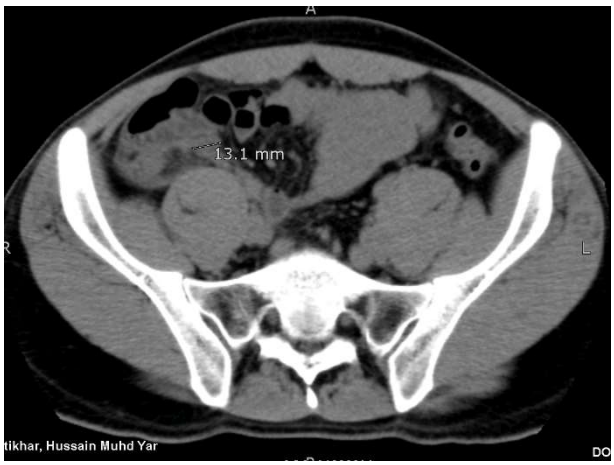

Image 3: A 3mm thin axial section image showing a 13mm dilated appendix with peri-appendiceal fat stranding suggestive of acute appendicitis.

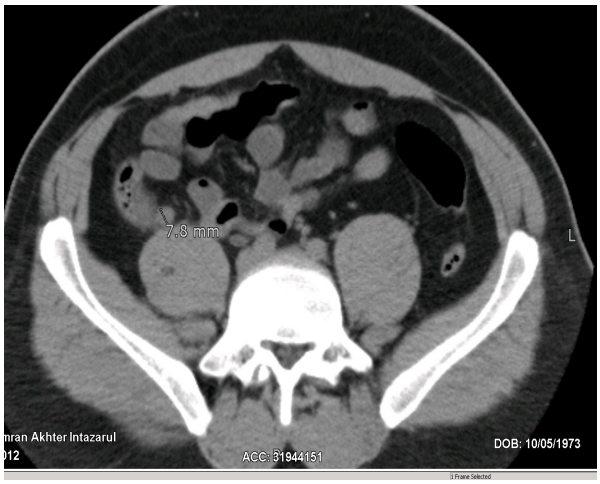

Image 4: A 3mm thin axial section image showing a 7.8-dilated appendix with peri appendiceal fat stranding suggestive of acute appendicitis.

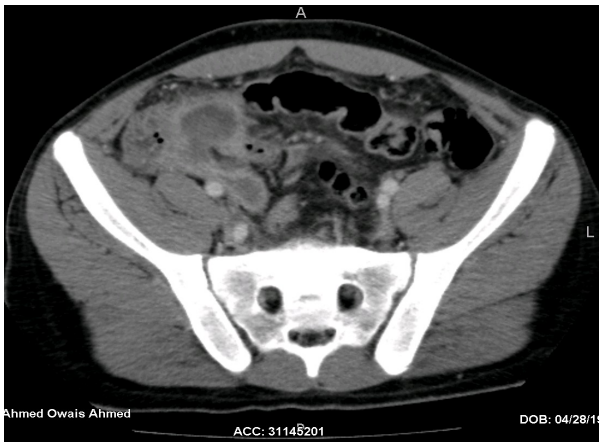

Image 5: A 3mm thin axial section image showing a hypodense collection in the right iliac fossa suggests a perforated appendix.

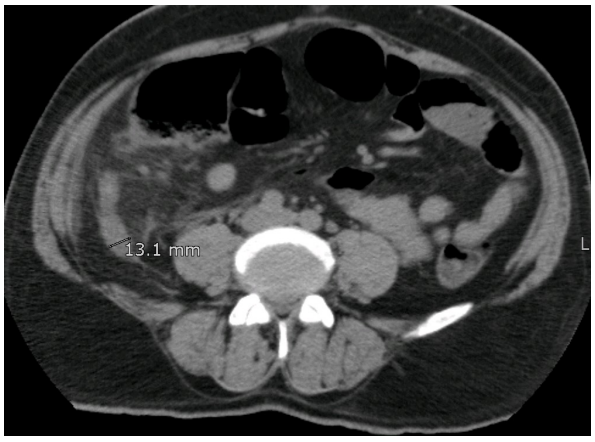

Image 6: A 3mm thin axial section image shows a 13 mm dilated appendix with peri-appendiceal fat stranding suggestive of acute appendicitis.

Table 1: Showing results of CT and histopathology and their comparison.

MDCT (Gold Standard)	Histopathology (Gold Standard)		Total
	Positive	Negative	
Positive	134 (TP)	3 (FP)	137 (90%)
Negative	3 (FN)	10 (TN)	13(10%)
TOTAL	137(86%)	13 (14%)	150(100%)
Accuracy of 3mm thin axial sections of MDCT 96 %			
TP: true positive, TN: true negative, FN: false negative, FP: false positive *Sensitivity =97.8 %, Specificity= 76.9 %, PPV = 97.8 %, NPV=76.9 %*			

Table 2 Comparison of MDCT and histopathology with gender, age, and BMI stratification.

Variables			HISTOPATHOLOGY	
		CT-SCAN	Positive	Negative
Gender	Male	Positive	86	2
		Negative	2	3
	Female	Positive	48	1
		Negative	1	7
Age (Years)	BELOW 15	Positive	24	1
		Negative	0	1
	ABOVE 15	Positive	110	2
		Negative	3	9
BMI (Kg/m^2)	LESS THAN 30	Positive	99	3
		Negative	1	10
	MORE THAN 30	Positive	35	0
		Negative	2	0

Discussion

The diagnosis of acute appendicitis presents a significant challenge due to its varied clinical presentations and potential for serious complications. In recent years, multidetector computed tomography (MDCT) has emerged as a valuable tool for accurately diagnosing this condition, offering several advantages over traditional diagnostic methods (Ibad et al., 2023; Liguori et al., 2015). Our study aimed to evaluate the diagnostic accuracy of MDCT with 3 x 3 mm thin section reconstruction in diagnosing acute appendicitis and to compare our results with previous studies in the literature.

Our findings demonstrate that MDCT with 3 x 3 mm thin sections reconstruction is highly accurate, with an overall accuracy of 96%. This is consistent with previous studies, such as the one by Maire et al., which reported a similar accuracy of 97%. However, our results outperformed those reported by Whyms et al., who reported an accuracy of 82.4% (Maire and Withers, 2014; Whyms et al., 2013). This highlights the importance of standardized imaging protocols and reconstruction techniques in optimizing diagnostic accuracy.

Furthermore, our study showed that MDCT with 3mm thin sections reconstruction offers improved diagnostic confidence and visualization of the appendix compared to thicker reconstruction sections. Previous literature indicates that thinner reconstruction sections are associated with increased visualization of the appendix and improved sensitivity and specificity for the diagnosis of acute appendicitis (Mostbeck et al., 2016). Although thinner reconstruction sections may result in increased image noise and viewing time, the benefits in terms of diagnostic accuracy outweigh these limitations.

Contrast administration remains a debated issue in the diagnosis of appendicitis. While some studies suggest that intravenous contrast may not significantly impact the visualization and diagnosis of appendicitis, others emphasize its importance, particularly in patients with minimal intra-abdominal fat (Giambelluca et al., 2019). Our study did not specifically evaluate the impact of contrast administration; however, it underscores the need for further research to determine the optimal imaging protocol for appendicitis diagnosis.

Additionally, expertise in cross-sectional anatomy and careful interpretation of CT findings are essential for accurate diagnosis, particularly in cases where the appendix is challenging to visualize or when alternative diagnoses are considered (Di Saverio et al., 2020). The identification of anatomic landmarks, such as the ileocaecal valve and iliac vessels, can aid in localizing the appendix and distinguishing it from other pathologies (Hodge et al., 2017).

It is important to note that while MDCT is a valuable diagnostic tool, it is not without limitations. False positive diagnoses, such as those due to lymphoid hyperplasia, and false negative diagnoses, particularly in patients with low body mass index, can occur (Xu et al., 2016). In such cases, complementary imaging modalities like ultrasound may be warranted to improve diagnostic accuracy.

Our study supports using MDCT with 3 x 3 mm thin section reconstruction as an accurate and reliable method for diagnosing acute appendicitis. However, further research is needed to optimize imaging protocols, address limitations, and improve diagnostic algorithms for this typical surgical emergency. Additionally, the clinical judgment of experienced healthcare providers remains paramount in diagnosing and managing acute appendicitis.

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The study has limitations due to its single-center design and the relatively small sample size. Using consecutive sampling could introduce selection bias, while the retrospective analysis may lead to errors or bias in data interpretation. Interobserver variability among radiologists in MDCT interpretation could affect diagnostic reliability. Lack of long-term follow-up data on patient outcomes post-surgery limits understanding of MDCT's efficacy in guiding management and predicting complications. The study did not comprehensively evaluate alternative diagnoses or compare MDCT with other imaging modalities, potentially impacting diagnostic accuracy assessment. Additionally, the study did not assess the clinical impact of MDCT findings on patient management.

Conclusion

Using 3 mm thin axial reconstructed images can improve the accuracy of diagnosing acute appendicitis. The 64-slice MDCT is a quick and promising tool for scanning the right iliac fossa without the need for bowel preparation or contrast medium. It's a highly accurate technique for diagnosing or excluding appendicitis in patients with an equivocal diagnosis. Incorporating this protocol can save unnecessary hospitalization and negative appendectomies.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department Concerned.
Consent for publication
Approved
Funding
Not applicable

Conflict of interest

The authors declared absence of conflict of interest.

Author Contribution

HAMMAD AHMAD SAQIB (Assistant Professor)
Study Design, Review of Literature
Conception of Study, Development of Research Methodology Design, Study Design,, Review of manuscript, final approval of manuscript
AFSHAN NOREEN (Assistant Professor)
Coordination of collaborative efforts.
Conception of Study, Final approval of manuscript
UMAMA SAEED (Assistant Professor)
Manuscript revisions, critical input.
Coordination of collaborative effort.
MAHWISH ZAHRA (Assistant Professor)
Data acquisition, analysis.
Manuscript drafting.
ZIA UL ISLAM (Associate Professor)
Data entry and Data analysis, drafting article
Data acquisition, analysis.
ATQA FIRDOUS (Associate Professor)
Coordination of collaborative efforts.
Manuscript revisions, critical input.

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