VOLUME - 14, ISSUE - 03, MARCH - 2025 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Radiology

ASSESSMENT OF THE DIAGNOSTIC PRECISION OF NON-CONTRAST COMPUTED TOMOGRAPHY AND ULTRASONOGRAPHY IN CASES OF ACUTE APPENDICITIS

Laxman Chhabhadiya	3rd Year Resident, Radiology Department, SBKS Medical Institute & Research Centre, Sumandeep Vidyapeeth, Vadodara, India
Sujay Shah	3rd Year Resident, Radiology Department, SBKS Medical Institute & Research Centre, Sumandeep Vidyapeeth, Vadodara, India
Kunal Solanki	Professor, Radiology Department, SBKS Medical Institute & Research Centre, Sumandeep Vidyapeeth, Vadodara, India
Ashutosh Patel	Assistant Professor, Radiology Department, SBKS Medical Institute & Research Centre, Sumandeep Vidyapeeth, Vadodara, India

ABSTRACT **Objective:** This study was conducted with the purpose of comparing the diagnostic accuracy of ultrasonography and non-contrast computed tomography in cases of acute appendicitis. **Methods:** The research was performed at the Department of Radiology of SBKS Medical Institute and Research Centre, Sumandeep Vidyapeeth University, Vadodara from September 2023 to September 2024. In this prospective investigation, 30 consecutive patients exhibiting clinical signs and symptoms of acute appendicitis were assessed using sonography (graded compression technique) and CT (unenhanced helical CT [5-mm section thickness]). The outcomes were compared with surgical results. **Results:** At surgery, twenty-nine patients were diagnosed with acute appendicitis, while one patient was not. The sensitivity rates for NCCT and sonography were 86. 2% and 62. 1%, respectively; specificity rates were 100% and 0%; accuracy rates were 86. 7% and 60. 0%; positive predictive values were 100% and 94. 7%. **Conclusion:** Unenhanced focused single-detector helical CT and graded compression sonography performed in a general community teaching hospital indicate that NCCT has superior accuracy for the diagnosis of acute appendicitis.

KEYWORDS : Appendicitis, Ultrasound, Computed Tomography.

INTRODUCTION

Reginald H.Fitz provided the first detailed description of acute appendicitis in 1886 despite previous mention of appendix that can be tracked in the 15th century (1). Acute appendicitis remains the main reason for emergency abdominal surgery. However, rapid and accurate diagnosis of this broad condition continues to carry out important challenges (2).

The pathophysiology of appendicitis begins with narrow light occlusion in the appendix, leading to tissue ischemia, excessive bacterial growth, permeation inflammation, appendicular attacks, and the possibility of perforation.Then, inflammation can quickly spread to the parietal peritoneum and adjacent structures (3).

Traditionally, approaches to the diagnosis of appendicitis are based on thorough history and physical examinations, with assessment of symptoms, clinical signs, and the intensity and sequence of major clinical tests, but for certain individuals It is based on presence or absence, and cannot be relied on symptoms or signs, diagnosis, nor can appendicitis be ruled out (4).

Abdominal examination may reveal localized tenderness in the right iliac fossa with guarding, rigidity and rebound tenderness. Often the site of maximum tenderness is located at McBurney's point. In a typical presentation, the three clinical findings with the highest predictive value for acute appendicitis are right lower quadrant pain, abdominal rigidity, and migration of pain from the periumbilical region to the right lower quadrant (5). Myriad gastrointestinal, genitourinary, and gynecologic conditions can have similar presentations. Ultrasound (US) has been an important tool used in the diagnosis of appendicitis since the 1980s. The graded compression technique involves applying steady, gradual pressure to the right iliac fossa, with emphasis over the site of maximal tenderness (6). Ultrasonography (USG) is a relatively inexpensive and uses no ionizing radiation, is rapid, noninvasive modality requiring no patient preparation or contrast material administration. On Sonography, the primary criterion to establish the diagnosis of acute appendicitis is direct visualization of the inflamed appendix: a concentrically layered (Target Sign), small, sausage like structure (Banana Sign) found at the point of tenderness. The classic appearance is an incompressible appendix with a diameter of 6 mm or larger and echogenic incompressible periappendicular inflamed fat with or without an appendicolith (7). Computed Tomography (CT) has been used for diagnosis of diseases of the appendix since 1981. CT is less operator dependent than US and shows detailed delineation of the extent of the disease (8). The examination can be performed on ill patients and the quality of the examination is unaffected by the presence of increased amounts of bowel gas, obesity, or severe abdominal pain (9).

On CT, Ancillary sign include an enlarged appendix measuring 6 mm or larger in outer diameter. Inflammatory changes involving the thickened appendix had to be present (i.e., streaking and poorly defined increased attenuation) in the periappendiceal fat. Thickening and prominence of the right lateroconal fascia and anterior pararenal fascia immediately adjacent to the edematous inflamed appendix is also a common finding. Detection of a calcified appendicolith within the thickened appendix is a useful finding. Some other features include focal caecal thickening due to edema at the origin of appendix (Caecal bar sign), luminal air in the caecum pointing toward the obstructed origin of appendix (Arrow head sign, which is seen in 30% cases of acute appendicitis). The advantages of CT are differentiation of phlegmon and abscesses, assessment of inflammatory involvement outside of the colon and full evaluation of the abdominal cavity especially for pneumoperitoneum (10).

MATERIALS AND METHODS

A comparative study was conducted in the Department of Radiology, SBKS Medical Institute & Research Centre, Sumandeep Vidyapeeth University, Vadodara from September 2023 to September 2024. Subjects were recruited from patients presenting in Surgery out- patient department, with a suspected diagnosis of appendicitis. The study

included 30 cases, as to compare diagnostic accuracy of US & Non Contrast CT in acute appendicitis. The sampling frame was bound by following inclusion and exclusion criteria.

The Inclusion criteria comprised patients aged 5 to 90 years suspected of having appendicitis (prior to treatment), whereas the exclusion criteria included pregnant patients and those requiring immediate surgery without prior investigation. The study protocol encompassed all patients whose medical history, physical examination, and laboratory test results suggest the possibility of appendicitis. Informed consent was obtained from every patient or from a parent for pediatric patients. Sonography assessments were conducted with C5-1 MHz (curvilinear array) and L12-3 MHz (linear array) transducers (GE)

The Inclusion criteria comprised patients aged 5 to 90 years suspected of having appendicitis (prior to treatment), whereas the exclusion criteria included pregnant patients and those requiring immediate surgery without prior investigation. The study protocol encompassed all patients whose medical history, physical examination, and laboratory test results suggest the possibility of appendicitis. Informed consent was obtained from every patient or from a parent for pediatric patients. Sonography assessments were conducted with C5-1 MHz (curvilinear array) and L12-3 MHz (linear array) transducers (GE LOGIQ P9). The diagnosis of acute appendicitis was determined through direct observation of an inflamed, thickened appendix (a small, concentric, sausage-shaped structure) located at the area of tenderness, along with an incompressible appendix having an outer diameter of 6mm or greater, and echogenic, incompressible periappendicular inflamed fat, with or without the presence of an appendicolith.

CT examinations was performed using a multidetector helical 16 slices CT scanner (SIEMENS somatom emotion). A single breath hold helical scan from top of L2 vertebra to pubic symphysis was obtained using 5mm beam collimation and 5mm/sec table speed (Pitch of 1, 120kv, 100-250mA). Images were reconstructed and photographed at 3-mm/sec intervals using different soft tissue window settings (width, 400H; level, 40 H). CT findings were interpreted as positive for acute appendicitis when enlarged appendix (with outer diameter equal to or more than 6mm) was identified, also when ancillary signs like right lower quadrant inflammation, appendicoliths and lymphadenopathy were seen. The outcome on surgery was considered as final diagnosis and compared with Sonography and CT findings.

RESULTS

This study was undertaken to comparative study of diagnostic accuracy of ultrasonography & non-contrast computed tomography in acute appendicitis.

In the study it was observed that the incidence of acute appendicitis is 33.3% in < 20 years (10 out of 30), 30% in 21 to 40 years (9 out of 30) and 41-60 years (9 out of 30) being more in the younger age group and the incidence decreases with age being least 6.7% (2 out of 30) in elderly age (>60 years) group.

According to the gender distribution of acute appendicitis, the disease's incidence was highest in men (22 out of 30), who accounted for roughly 73.3% of cases, with women (8 out of 30) making up the remaining 26.7%. Out of 30 patients, 20 had evidence of an inflamed appendix on ultrasonography, which accounted for 66.7 percent of the diagnostic features. Nineteen patients had periappendicular fat stranding, which accounted for 63.3% of the findings. The next two characteristics, probe tenderness and periappendicaeal collection, were observed in 17 and 16 individuals, respectively, and accounted for 56.7% and 53.3% of the US findings.

Increased vascularity was observed in approximately 11 patients, representing a contribution of 36. 7%. Appendicolith was found in only 4 of the patients, making it the least dependable diagnostic feature. The final diagnosis of appendicitis was confirmed in about 19 of the 30 patients, which corresponds to 63. 3% of the total sample, while 11 out of 30 subjects reported a negative result, making up the remaining 36. 7%. The most sensitive diagnostic feature on ultrasound was the inflamed appendix, which showed a sensitivity of 65. 5%, followed by periappendiceal fat stranding, which had a sensitivity of 62. 1%. The following two factors probe tenderness and peri appendiceal collection, displayed a sensitivity of 55. 2% each. Increased vascularity demonstrated a sensitivity of 34. 5%. The appendicolith exhibited the lowest sensitivity, at 13. 8%. However, the periappendiceal collection and appendicolith both achieved 100% specificity. The positive predictive value (PPV) was highest for the appendicolith and periappendiceal collection, both at 100%, followed by a PPV of 95% for the inflamed appendix. Periappendiceal fat stranding had a PPV of 94. 7%.

The PPV for probe tenderness was 94.1% followed by increased vascularity which had a PPV of 90.9%. Negative predictive value (NPV) for the periappendicaeal collection and appendicolith was 7.1% and 3.8% respectively. Inflamed appendix was the most accurate diagnostic feature having an accuracy of 63.3%, followed by periappendicaeal fat stranding which had an accuracy of 60.0%. Periappendicaeal collection and probe tenderness had an accuracy of 56.7% and 53.3%. Increased vascularity showed an accuracy of 33.3%. Accuracy was least for appendicolith as a diagnostic parameter. Out of 30 subjects, 29 were proved to have appendicitis on surgery while one was a negative appendectomy. Out of 29 proven cases 18 cases were aptly predicted to have appendicitis on US accounting for 62.1% while the result was given as negative in 11 subjects accounting for 37.9% which turned out to be positive appendectomies. On Non Contrast Computed Tomography (NCCT), out of 30 patients, 25 patients showed evidence of inflamed appendix and periappendicaeal fat stranding accounting for 83.3% and 83.3% of the diagnostic features while periappendicaeal collection was seen in the 12 patients accounting for 40.0% of the findings. Appendicolith was seen in only 6 of the patients hence being the least reliable diagnostic feature.

The location of the appendix was also assessed, with retroceacal and post-ileal being the most prevalent at 30% and 26. 7% respectively. Other locations included subcaecal (13. 3%), pre-ileal (6. 7%), paraceacal (6. 7%), and pelvic (3. 3%). The conclusive diagnosis of appendicitis was determined to be present in approximately 25 of the 30 patients, representing 83. 3% of the total sample, while in 5 out of 30 individuals a negative result made up the remaining 16. 7%. The final diagnosis of appendicitis was validated in 29 out of the 30 patients, equating to 96. 7% of the total sample, while in 1 out of 30 subjects a negative result accounted for the remaining 3. 3%. The most sensitive diagnostic features on NCCT were the inflamed appendix and periappendiceal fat stranding, each indicating a sensitivity of 86. 2%, followed by periappendiceal collection, which demonstrated a sensitivity of 41. 4%. The appendicolith exhibited the least sensitivity at 20. 7%. Nonetheless, all parameters showed 100% specificity and positive predictive value (PPV). The highest negative predictive value (NPV) was observed for the inflamed appendix and periappendiceal collection, each being 20%. The NPV for periappendiceal collection and appendicolith was 5. 6% and 4. 2%, respectively. Inflamed appendix and periappendiceal fat stranding were the most precise diagnostic features, each having an accuracy of 86. 7%. Periappendiceal collection had an accuracy of 43. 3%. The accuracy for appendicolith as a diagnostic parameter was the

lowest at 23. 3%. Non-contrast computed tomography (NCCT) exhibited a sensitivity of 86. 2%, which is significantly higher compared to ultrasound, which had a sensitivity of only 62. 1%. The specificity of NCCT was 100% in identifying acute appendicitis, while ultrasound was non-specific. The positive predictive value (PPV) of NCCT was 100%, contrasting with 94. 7% in ultrasound. NCCT had a negative predictive value (NPV) of 20%, which was non-existent in ultrasound. The overall diagnostic accuracy of non-contrast computed tomography was found to be 86. 2%, while ultrasound achieved an accuracy of just 60. 0%. Therefore, NCCT is a superior modality when compared to ultrasound.

DISCUSSION

Acute appendicitis is the leading reason for emergency abdominal surgery. Traditionally, the method of diagnosing appendicitis relies on thorough history taking and physical examination, which includes evaluating the intensity and order of symptoms, clinical signs, and basic laboratory tests (4). Nevertheless, prompt and precise diagnosis of this prevalent condition continues to be a significant challenge. The rate of negative results for appendicitis during laparotomy or laparoscopy according to these criteria is considerable. Conversely, a delay in diagnosing and treating appendicitis could heighten the potential risk of a complicated clinical progression. Therefore, selecting a preferred diagnostic method is of utmost significance. The research was carried out prospectively in 30 patients with suspected acute appendicitis by comparing US and NCCT predictions against the final surgical outcome.

In 1991, Balthazar et al. (10) prospectively studied the contrast- enhanced CT scans (using both oral and IV contrast media) of 100 patients who were suspected of having acute appendicitis. CT proved to be 98% sensitive, 88% specific and 95% accurate in revealing acute appendicitis. These patients were a selected group with nonspecific symptoms and signs or with atypical presentations for an appendicitis. Four categories were assigned in the study. In Category one there is identification of an abnormal appendix or heterogeneous pericaecal fat associated with appendicaeal calculi or pericaecal appendicular abscess. In category two there is normal examination with no evidence of appendicitis. Category three included non-specific diagnosis of appendicitis such as presence of pericaecal or heterogeneous appendicular fat, with or without an abnormal caecum, and no alterations that may indicate any other diagnosis (i.e. ovarian cyst, enlarged terminal ileum, ureteral calculus). The category four for other diseases of extra-appendicular origin.

Subsequently, in a similar group of patients. Balthazar et al. (12) prospectively compared contrast-enhanced CT with sonography in these 100 patients. CT had a higher sensitivity (96% versus 76%) and accuracy (94%versus 83%) than did US. These studies raised abnormal appendix identification rates from 18% to 94%. Similarly in our study NCCT (Non contrast computed tomography) had a higher sensitivity (86.2% versus 62.1%) and accuracy (86.7% versus 60%) when compared to US.

Michael J. Lane et al (7) demonstrated that unenhanced thin-section helical CT is an accurate, effective technique for diagnosing acute appendicitis. However, in this study patients with strong clinical evidence of acute appendicitis were not necessarily excluded, unlike the two studies by Balthazar et al (12) and Malone et al (9). The potential advantages of performing unenhanced CT compared with enhanced CT include the ability to immediately scan a patient without any preparation such as oral contrast material, the elimination of the risk of an adverse reaction to IV contrast material and the monetary savings when contrast material is not used. The results were similar to those of Malone et al (9). Thus CT is an accurate and effective technique for diagnosing acute appendicitis. In l09 patients, unenhanced helical CT was 90% sensitive, 97% specific. and 94% accurate. Similarly in our study NCCT scans yielded a sensitivity of 86.2 %, specificity of 100% and an accuracy of 86.7% for the diagnosis of acute appendicitis.

In 1998, Giuseppe D'eppolito conducted a study in 52 patients in which acute appendicitis was confirmed in 44 cases. Accuracy was 92%, sensitivity 91%, specificity 100%, and positive predictive value was 100%. Similarly in our study NCCT showed a 86.7% accuracy, 86.2% sensitivity, 100% specificity and 100% positive predictive value.

In 2000, Marc D. Horton et al.(15) suggested that a subset of patients presenting with possible acute appendicitis could benefit from imaging of the appendix prior to surgical consultation. For this group, CT scan appears superior to abdominal and pelvic US in terms of diagnostic accuracy and reliability. The study showed that in 89 subjects CT has prospectively have a greater diagnostic accuracy in adults (94% versus 83%) as well as a greater diagnostic yield of alternative diagnoses, including abscess or phlegmon (28% versus 17%). A negative CT scan could be considered definitive, whereas a negative or nondiagnostic US required further testing or observation. The study concluded that noncontrast CT scan was clearly the superior diagnostic modality. It was more specific, and the increased sensitivity was statistically significant. Similarly in our study NCCT proved to be better modality than US and showed a 86.7% versus 60.0 % accuracy and 86.2% versus 62.1% sensitivity and 100% versus 94.7% positive predictive value.

In 2000, another study by J.Styrud et al (13) in Sweden, suggested that CT seems to have a higher sensitivity (88% vs 82%) than ultrasound and a high specificity. In our study NCCT showed a 86.2% sensitivity in comparison to only 62.1% in US.

In 2002, research conducted by Steven S. Raman et al (14) revealed that non-focused helical CT was very effective in diagnosing acute appendicitis or indicating an alternative diagnosis in patients experiencing acute lower abdominal pain or pain in the right lower quadrant. The research exhibited an accuracy of 97. 6%, sensitivity of 96. 5%, specificity of 98%, a positive predictive value of 94. 5% and a negative predictive value of 98. 8%. Likewise, in our research, NCCT demonstrated an accuracy of 86. 7%, sensitivity of 86. 2%, specificity of 100%, positive predictive value of 100%, and negative predictive values of 20%.

REFERENCES

[1] Fitz RH. Perforating inflammation of the veriform appendix with special reference to eariy diagnosis and treatment. Am J Med Sci 1886;92:321-346.
[2] Liang K. Mike, Andersson E. Roland, Jaffe M. Bernard, Berger H. David. The Appendix. In: Brunicardi F. Charles editors. Schwartz's Principles of Surgery:10th. New York: McGraw-Hill;2015.p.1241-62.
[3] Gearhart L. Susan, Silen William.Acute Appendicitis and Peritonitis. In: Fauci S. Anthony editors. Harrison's Principles of Internal Medicine:17th .New York: McGraw- Hill;2008.p.1914-7.
[4] Lameris W, van Randen A, Go PM, Bouma WH, Donkervoort SC, Bossuyt PM, et al.Single and combined diagnostic value of clinical features and laboratory tests in acute appendicitis. Acad Emerg Med 2009;16:835–42.
[5] Jerry L. Old, Reginald W. Dusing, Wendell Yap and Jared Dirks. Imaging for Suspected Appendicitis. American Family Physician. 2005;71:72-7.
[6] J B Puylaert. US evaluation using graded compression. Radiology. 1986;158:255–360.
[7] Michael J. Lane, David M. Liu, Mylinh D. Huynh, R. Brooke Jeffrey, Robert E. Mindelzun, Douglas S. Katz. Suspected acute appendicitis: nonenhanced helical CT in 300 consecutive patients. Radiology. 1999; 213: 341–6.
[8] Balthazar E, Megibow A, Siegal SE, Birnbaum BA. Appendicitis: prospective evaluation with high-resolution CT. Radiology 1991;180:21-24.
[9] Wong CH, Trinh TM, Robbins AN, Rowen SJ, Cohen AJ.Diagnosis of appendicitis: imaging findings in patients with atypical clinical features. AJR 1993;161:1199-203.
[10] Andrea S. Doria, Rahim Moineddin, Christian J. Kellenberger, Monica Epelman, Joseph Beyene, Suzanne Schuh et al. US or CT for Diagnosis of Appendicitis in Children and Adults . Radiology. 2006; 241:83-91.
[11] Malone AJ Jr, Wolf CR, Malmed AS, Melliere BF. Diagnosis of acute

appendicitis: value of unenhanced CT. AJR 1993;160:763–6.
[12] Balthazar EJ, Birnbaum BA, Yee J, Megibow AJ, Rashkow J. Gray C. Acute appendicitis: CT and US correlation in 100 patients. Radiology 1994; 190:31-35.
[13] J.Styrud, T.Josephson, S. Eriksson. Reducing negative appendectomy evaluation of ultrasonography and computer tomography in acute appendicitis. International Society for quality in health care. 2000;12:65-68.
[14] Steven S. Raman, David S. K Lu, Barbara M. Kadell, Darko J. Vodopich, James Sayre, Henry Cryer. Accuracy of Nonfocused Helical CT for the Diagnosis of Acute Appendicitis:A 5-Year Review. AJR2002;178:1319-1325.
[15] Marc D. Horton, MD, Steven F. Counter, MD, Michael G. Florence, MD, Michael J. Hart, MD. A Prospective Trial of Computed Tomography and Ultrasonography for Diagnosing Appendicitis in the Atypical Patient American journal of surgery.2000;179