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COMPARATIVE STUDY OF DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY & NON-CONTRAST COMPUTED TOMOGRAPHY IN ACUTE APPENDICITIS

Radiology

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ABSTRACT

Objective: The present study was carried out with an aim to compare diagnostic accuracy of ultrasonography & non-contrast computed tomography in acute appendicitis.

Methods: The study was conducted in Department of Radiology of SBKS Medical Institute & Research Centre, Sumandeep Vidyapeeth University, Vadodara from September 2018 to September 2019. In this prospective study, 30 consecutive patients with clinical signs and symptoms of acute appendicitis were examined with sonography (graded compression technique) and CT (unenhanced helical CT [5-mm section thickness]. The results were correlated with surgical outcome.

Results: Twenty-nine patients had acute appendicitis at surgery, and one patient did not. The sensitivity of NCCT and sonography was 86.2% and 62.1%, respectively; the specificity was 100% and 0%; the accuracy was 86.7% and 60.0%; the positive predictive value was 100% and 94.7%; and the negative predictive value was 20% and 0%.

Conclusion: Unenhanced focused single-detector helical CT and graded compression sonography performed in a general community teaching hospital, NCCT have a better accuracy for the diagnosis of acute appendicitis.

KEYWORDS

Appendicitis, Ultrasound, Computed Tomography.

INTRODUCTION

Reginald H. Fitz first described acute appendicitis in the year 1886, although there are historical descriptions about appendix dating back as early as fifteenth century (1). Acute appendicitis is the most common cause for emergency abdominal surgery. However, quick and accurate diagnosis of this common condition is still a major problem (2).

Pathophysiology of appendicitis begins with obstruction of the narrow appendiceal lumen, leading to tissue ischemia, over-growth of bacteria, transmural inflammation, appendiceal infarction, and possible perforation. Inflammation may then quickly extend into the parietal peritoneum and adjacent structures (3). Traditionally, approach of diagnosing appendicitis is based on careful history taking and physical examination, with assessment of the intensity and sequence of symptoms, clinical signs and basic laboratory tests but the presence or absence of any particular individual symptom or sign cannot be relied upon to diagnose or exclude appendicitis (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 2018 to September 2019. 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 was patients aged 05-90 years old, with a suspected diagnosis of appendicitis (before treatment) while the exclusion criteria was pregnancy and patients who needed to undergo urgent surgery without investigation. The study protocol included all the patients whose history, physical findings and laboratory tests results raise the suspicion of appendicitis. Informed consent was taken from each patient or from a parent in case of paediatric patient. Sonography examinations was performed using C5-1 MHz (curvilinear array) and L12-3 MHz (linear array) transducers (GE LOGIQ P9). Diagnosis of acute appendicitis was made on direct visualization of inflamed thickened appendix (concentrically layered, small, sausage like structure) found at point of tenderness, incompressible appendix with outer diameter equal to or more than 6mm with echogenic incompressible periappendicular inflamed fat with or without 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. All the data was fed into MS-Excel 2013 software. Data was analyzed using Statistical Package for Social Sciences, version 21.0. Categorical data was represented as frequency (number) and proportions (percentages). Continuous data was presented as Mean + Standard deviation (SD). Mean and percentage was calculated for each quantitative parameter. Nominal categorical data between the groups were compared using Chi-squared test or Fischer's exact test as appropriate.

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.

Considering the gender wise distribution of the acute appendicitis, the incidence of the disease was found out to be maximum in the male gender (22 out of 30) accounting for about 73.3 % of the cases and the rest 26.7% being females (8 out of 30). On ultrasound, out of 30 patients, 20 patients showed evidence of inflamed appendix accounting for 66.7% of the diagnostic features while periappendicaeal fat stranding was seen in 19 patients which contributed 63.3% of the features. Probe tenderness and periappendicaeal collection were the next two features which were seen in the 17 and 16 patients respectively accounting for 56.7% and 53.3% of the findings on US. Increased vascularity was seen in about 11 patients amounting to 36.7% contribution. Appendicolith was seen in only 4 of the patients hence being the least reliable diagnostic feature. The final diagnosis of the appendicitis was present in about 19 of the 30 patients accounting for 63.3% of the total sample while in 11 out of 30 subjects a negative result accounted for the rest 36.7%. The most sensitive diagnostic feature on US was inflamed appendix indicating 65.5% sensitivity followed by periappendicaeal fat stranding which had a sensitivity of 62.1%. The next two parameters, probe tenderness and periappendicaeal collection showed a sensitivity of 55.2% each. Increased vascularity has a sensitivity of 34.5%. The appendicolith showed least sensitivity, being 13.8%. However the periappendicaeal collection and appendicolith had 100% specificity. The positive predictive value (PPV) was highest for the appendicolith and periappendicaeal collection being 100%., followed by 95% for inflamed appendix. Periappendicaeal 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 position of the appendix was also evaluated, retroceacal and post-ileal being the most common contributing 30% and 26.7%. Other positions being subcaecal (13.3%), pre-ileal (6.7%), paraceacal (6.7%) and pelvic (3.3%). The final diagnosis of the appendicitis was present in about 25 of the 30 patients accounting for 83.3% of the total sample while in 5 out of 30 subjects a negative result accounted for the rest 16.7%.The final diagnosis of the appendicitis was confirmed in 29 out of the 30 patients accounting for 96.7% of the total sample while in 1 out of 30 subjects a negative result accounted for the rest 3.3%.The most sensitive diagnostic feature on NCCT were inflamed appendix and periappendicaeal fat stranding indicating 86.2% sensitivity each followed by periappendicaeal collection which showed a sensitivity of 41.4% each. The appendicolith showed least sensitivity, being 20.7%. However all the parameters had 100% specificity and positive predictive value (PPV). Negative predictive value (NPV) was highest for the inflamed appendix and periappendicaeal collection being 20% each. NPV for periappendicaeal collection and appendicolith was 5.6% and 4.2%. respectively. Inflamed appendix and periappendicaeal fat stranding were the most accurate diagnostic features having an accuracy of 86.7 % each. Periappendicaeal collection had an accuracy of 43.3%. Accuracy was least for appendicolith as a diagnostic parameter being 23.3%.Non contrast computed tomography (NCCT) showed a sensitivity of 86.2% which is much higher as compared to ultrasound which had a sensitivity of only 62.1%. The specificity of the NCCT was 100% in detecting acute appendicitis while US was non specific. Positive Predictive Value (PPV) of the NCCT was 100% which was 94.7% in US. NCCT had a Negative Predictive Value (NPV) of 20% which was nil in US. Overall diagnostic accuracy of the non contrast computed tomography turned out to be 86.2% while US had an accuracy of only 60.0%. Hence NCCT is a better modality in comparison to US.

DISCUSSION

Acute appendicitis is the most common cause for emergency abdominal surgery. Traditionally, approach of diagnosing appendicitis is based on careful history taking and physical examination, with assessment of the intensity and sequence of symptoms, clinical signs and basic laboratory tests (4). However, quick and accurate diagnosis of this common condition is still a major problem. The rate of negative findings for appendicitis at laparotomy or laparoscopy based on these parameters is high. On the other hand, a delay in the diagnosis and treatment of appendicitis may increase the potential risk of a complicated clinical course. Hence choosing a diagnostic modality of choice is of prime importance. The study was conducted prospectively in 30 patients with suspected acute appendicitis by comparing US and NCCT prediction for the same with 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.

In 1993, Malone et al. (9) prospectively studied 211 patients who had possible acute appendicitis with an unenhanced conventional (nonhelical) CT scan using contiguous 10-mm axial images. Seventy-five (80%) of 94 patients who underwent surgery had pathologically proven acute appendicitis; the other 19 had pathologically proven normal appendices. Acute appendicitis was correctly revealed on a CT scan in 65 (87%) of' the 75 proven cases 121. Unenhanced CT scans yielded a sensitivity of 87%, a specificity of' 97%. and an accuracy of 93% for the diagnosis of acute appendicitis. Similarly in our study acute appendicitis was correctly revealed on a NCCT scan in 25 (86.2%) of' the 29 proven cases. Unenhanced CT scans yielded a sensitivity of 86.2 %, and an accuracy of 86.7% for the diagnosis of

acute appendicitis.

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, a study by Steven S. Raman et al (14) showed that non-focused helical CT was highly accurate in diagnosing acute appendicitis or suggesting an alternative diagnosis in patients with acute lower abdominal pain or right lower quadrant pain. The study demonstrated 97.6% accuracy, 96.5% sensitivity 98% specificity, 94.5% positive predictive value and 98.8% negative predictive value. Similarly in our study NCCT showed 86.7% accuracy, 86.2% sensitivity, 100% specificity, 100% positive predictive value and 20 % negative predictive values.

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