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Study on evaluation of ultrasound and CT scan in diagnosis of appendicitis

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***Abstract*---**Background: Acute appendicitis (AA) is a common abdominal emergency with a lifetime prevalence of about 7 %. As the clinical diagnosis of AA remains a challenge to emergency physicians and surgeons, imaging modalities have gained major importance in the diagnostic work-up of patients with suspected AA. Objectives of this study: The objectives of this study was to compare CT scan and USG abdomen for the diagnosis of AA. Materials and Methods: Surgical pathology was considered the gold standard for calculation of sensitivities of CT and US. Radiographic results were evaluated to calculate sensitivity and positive predictive values (PPV). Case sheet information was abstracted to determine negative appendectomy (NA) rates, clinical and laboratory findings. Statistical Analysis: Sensitivity, PPV, and NA were calculated. When calculating sensitivity, ultrasounds in which the appendix was not visualized were negative. Statistical analysis was done using Microsoft Excel spreadsheet, and statistical package for the social sciences (SPSS) version 20.0 software. Results: This study includes 200 patients who came in the department of radio diagnosis, for CT scan and USG abdomen during the study period of one year. Based on the inclusion criteria 47/100 were CT cohort and 68/100 were USG cohort. Discussion & Conclusion: As a means of balancing test performance with side effects and ED patient throughput times, a “first-pass” approach using US first and then CT if US is not diagnostic may be desirable.

***Keywords*---**ultrasound, computerised tomography, emergency department, sensitivity, positive predictive value.

Introduction

Acute appendicitis (AA) is a common abdominal emergency with a lifetime prevalence of about 7 %. As the clinical diagnosis of AA remains a challenge to emergency physicians and surgeons, imaging modalities have gained major importance in the diagnostic work-up of patients with suspected AA. As US sensitivity is limited, and non-diagnostic US examinations with non-visualization of the appendix are more a rule than an exception, diagnostic strategies and algorithms after non-diagnostic.[1-3] The clinical diagnosis remains difficult, both in the paediatric and adult population, as the presentation is often atypical. Symptoms are frequently non-specific and overlap with various other diseases. Despite all improvements in clinical and laboratory diagnosis and the publication of various scoring systems to guide clinical decision-making, the fundamental decision whether to operate or not remains challenging. In an ideal medical world, we would like to optimally diagnose and treat all patients with suspected AA without unnecessary appendectomies. As AA with perforation is associated with significant morbidity and an increase in mortality, there is broad agreement that high rates of negative appendectomies (around 15 %) have to be accepted in order to reduce the rate of perforation. A negative appendectomy might not only expose the patient to the risk of the surgical procedure. Recently, a higher risk of acute myocardial infarction related to surgical removal of the tonsils and appendix before age 20 has been reported. Accordingly, the rapid and now widely used application of imaging methods in the diagnostic armamentarium for AA is demonstrated by an increasing number of publications, starting from the first report on compression ultrasound (US) by JB Puylaert in 1986, Multi-detector computed tomography (MDCT) is considered the gold standard technique to evaluate patients with suspected AA, because of its high sensitivity and specificity, Magnetic resonance imaging (MRI) has also shown high accuracy in the detection of AA.[4-6]

Objectives of the study

The objectives of this study was to compare CT scan and USG abdomen for the diagnosis of AA.

Materials and Methods

Study site

This study was conducted at the Department of Imaging, S *Shri Balaji Institute of Medical Sciences, Mowa Raipur*

Study population

Patients referred to the radiology department for USG abdomen and CT scan of the abdomen.

Study design

Retrospective analysis was conducted, included two cohorts one cohort who underwent USG for diagnosis of AA and another cohort who underwent CT scan for the diagnosis of AA.

Sample size

Included 200 subjects admitted in emergency medicine and medicine department.

Time frame to address the study

12 months from January 2021 to December 2021.

Inclusion Criteria

- Diagnosed cases of AA in the ED
- at least one imaging study
- operative management
- documented surgical pathology results
- complete chart information for appropriate data abstraction. Patients meeting inclusion criteria were divided into two cohorts based on whether they were evaluated based on USG or CT.

Technique, Tools and Data collection

Surgical pathology was considered the gold standard for calculation of sensitivities of CT and US. Radiographic results were evaluated to calculate sensitivity and positive predictive values (PPV). Case sheet information was abstracted to determine negative appendectomy (NA) rates, clinical and laboratory findings, and the following chronological components: time from ED admission to imaging ordered; imaging ordered to imaging completed; imaging completion to ED discharge; and total ED length of stay. Ultrasound examination: Color Doppler sonography of the right lower quadrant was performed using the graded compression technique with a Phillips HDT 5000 linear 1-5 MHz transducer, according to body size. Visualization of an incompressible blind-ended appendix measuring more than 6 mm in diameter with additional positive findings, including echogenic periappendicular fat, hyperemic appendiceal walls, appendicolith, pericecal fluid, or abscess, was diagnostic of appendicitis. The US report was read as positive, negative, or not visualized (NV) for acute appendicitis.

Contrast-enhanced MDCT examination: CT exams were performed using a multi-slice CT scanner. The most common technique involved the use of triple contrast (oral, rectal, and IV). Serial 3-mm axial images were obtained from the diaphragm through the perineum. Additional delayed images were obtained through the lower abdomen after the patient was asked to lay on the right side for 10 min. Visualization of an appendix measuring more than 6 mm in diameter with additional positive findings, including periappendicular fat stranding, cecal wall thickening, appendicolith, abscess, or phlegmon, was diagnostic for appendicitis. The CT report was read by the radiologist as positive or negative for appendicitis.

CT scans were performed in the Department of Radiology by qualified technicians and read by senior level radiology residents. All studies were officially read by senior resident or attending radiologists at both sites at the time of imaging.

Statistical Analysis

Sensitivity, PPV, and NA were calculated. When calculating sensitivity, ultrasounds in which the appendix was not visualized were negative. Statistical analysis was done using Microsoft Excel spreadsheet, and statistical package for the social sciences (SPSS) version 20.0 software.

Results

This study includes 200 patients who came in the department of radio diagnosis, for CT scan and USG abdomen during the study period of one year. Based on the inclusion criteria 47/100 were CT cohort and 68/100 were USG cohort.

Table 1
Shows Demographic characteristics of CT cohort and USG cohort

Parameter	CT Cohort	USG Cohort	P value
Number of subjects	47	68	
Age (years)	43.2 (37.5-44.6)	33.4 (32.8-42.5)	S
Males	34%	46%	S
Females	66%	54%	
Temperature	36.5 (36.1-36.7)	37.2 (37-37.3)	S
Heart Rate	81.6 (78.2-85.8)	87.4 (78.2-85.8)	
BP	126/83	127/86	NS
TLC	14,000 cells/cmm	14,600 cells/cmm	NS

Table 2
Outcomes of CT cohort and USG cohort

Parameter	CT Cohort	USG Cohort	P value
Number of subjects	47	68	
Sensitivity	100%	68.5%	
PPV	100%	96.4%	
Negative appendectomy	Nil	7%	S

It is evident from the above table that the sensitivity, PPV was 100 percent and nil negative appendectomy in CT Cohort group as compared to USG Cohort group. This shows that the CT scan is more effective tool for the diagnosis of AA as compared to USG.

Discussion

Acute appendicitis (AA) is a common abdominal emergency with a lifetime prevalence of about 7 %. As the clinical diagnosis of AA remains a challenge to emergency physicians and surgeons, imaging modalities have gained major importance in the diagnostic work-up of patients with suspected AA. As US sensitivity is limited, and non-diagnostic US examinations with non-visualization of the appendix are more a rule than an exception, diagnostic strategies and algorithms after non-diagnostic.[7-9] Abdominal imaging is currently indicated in all but the most straightforward cases of appendicitis. However, the choice of which study to use–either US or CT– remains a point of contention. In children, ultrasound is a viable and commonly used choice, though in adults, the choice is less clear. CT clearly has its advantages, with sensitivity approaching 100% and the ability to perform the study in a way that is not operator dependent, in patients in which ultrasound is difficult to perform, such as those who are obese. However, the risks of contrast administration, exposure to ionizing radiation, and cost are all limiting factors. With an estimated 2% of future cancers being caused just by CT scans, clinicians need to determine ways to reduce this exposure.

Multiple studies have directly compared CT and US accuracy in the diagnosis of appendicitis. A meta-analysis of prospective studies of the accuracy of CT and US in the diagnosis of acute appendicitis in adults and adolescent patients, including four studies directly comparing the two, showed that CT was superior to US. CT sensitivity was 0.94 (95% CI: 0.91 to 0.95) and specificity 0.95 (95% CI: 0.93 to 0.96), while US sensitivity was 0.86 (95% CI: 0.83 to 0.88) and specificity 0.81 (95% CI: 0.78 to 0.84). Other studies have shown that modern CT scanners have a sensitivity of 90-100%, a specificity of 91- 99%, and a positive predictive value of 95-97%. In contrast, a carefully performed US has a sensitivity of 75-90%, a specificity of 86 100%, and a positive predictive value of 89-93%.[10-12]

Despite the established superiority that CT has over ultrasound for the diagnosis of appendicitis, recent studies have advocated for a first-line ultrasound approach with adult patients presenting with possible appendicitis. Lameris et al. recommend a conditional CT strategy, with initial US in adult patients presenting with acute abdominal pain, including suspected appendicitis, and CT only after negative or inconclusive US. With this strategy, only 50% of patients required CT scans with a low NA rate. Gaitini et al. found that routine referral of adult patients with clinical suspicion of acute appendicitis to color Doppler US and selected referral to CT based on US results and clinical judgment improved diagnostic accuracy and therapeutic management. Poortman et al. also concluded that a diagnostic pathway including an initial US and complimentary CT in patients with negative or inconclusive US results yields a high diagnostic accuracy in the management of acute appendicitis without adverse events. The message of these studies is the same: the positive predictive value of US is excellent; if the appendix is visualized and abnormal, the patient should go to surgery. If the appendix is not visualized, then the patient should have a CT. This approach has clearly been shown to be cost effective and safe in children, and we posit that it may be in adults as well. This stepwise approach in the pediatric population was also supported by Ramarajan et al., who found that by employing

US first in the diagnostic pathway of appendicitis, radiation exposure may be substantially reduced without a decrease in safety or efficacy.[12-14]

Conclusion

CT scan diagnosis of AA had superior sensitivity, positive predictive value and negative appendectomy compared to USG abdomen. Despite this we strong recommend that all negative USG should be revaluated with CT scan to rule out AA, though was significantly faster to perform, and avoided ionizing radiation and contrast in most of the patients. As a means of balancing test performance with side effects and ED patient throughput times, a “first-pass” approach using US first and then CT if US is not diagnostic may be desirable.

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