

COMPARATIVE ANALYSIS OF CT AND SONOGRAPHY IN THE DIAGNOSIS OF ACUTE APPENDICITIS

Dr. Ram Krishna Jha

Associate Professor, Dept. of Radiodiagnosis, SSPM Medical College & Lifetime Hospital, Sindhudurg (Maharashtra)

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Corresponding author: Dr. Ram Krishna Jha

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Abstract

Introduction: Acute appendicitis is the inflammation of the vermiform appendix which is usually diagnosed based on the physical examination, history taken from the patient, and the laboratory results. Appendicitis is diagnosed based on parameters of laparoscopy or laparotomy showed negative results of nearly 50%. Complications may occur due to delays in the diagnosis and treatment of appendicitis. The use of sonography and CT scan as a reliable diagnostic procedure for diagnosing acute appendicitis can be worthy only if the surgeon relies fully on the sonography and CT has done in the hospital.

Aims and Objective: To evaluate the Sensitivity, Specificity and Accuracy of CT and Sonography in diagnosis of acute appendicitis. The study also intended to find out the significance of the parameters between the two diagnostic tools.

Materials and Methods: The study design is prospective and was conducted during during the period of 18th months. After admission, each patient had to undergo sonography and also CT. The study conducted Mc Nemar test for sensitivity, specificity and accuracy.

Result: The study found that sensitivity of sonography was 95% and and specificity was observed to be at 76%. Again, the specificity and sensitivity for CT in this study were found to be 61.54% and 91.89%, respectively. The accuracy of Sonography and CT were found to be 91% and 84%, respectively. It was found that all these parameters in CT was less than Sonography ($P < 0.05$).

Conclusion: The study has concluded that the applicability of Sonography is statistically similar to CT in diagnosis of acute appendicitis ($P < 0.05$).

Keywords: CT, Sonography, Acute Appendicitis, Ultrasound

Introduction

Acute appendicitis was diagnosed based on the clinical findings, history taken from the patient, and the laboratory results in the olden days. Appendicitis is diagnosed based on parameters of laparoscopy or laparotomy showed negative results of nearly 50%. Complications may occur due to delays in the diagnosis and treatment of appendicitis [1,2].

Due to the disadvantages of the traditional diagnostic methods sonography and CT have been used in diagnosing acute appendicitis for the last two decades. The specificity and sensitivity of the helical CT are nearly 98% and 100% respectively and for sonography, it is 100% and 90% respectively [1].

Several studies were conducted on a selected group of patients with similar clinical signs and symptoms and on pediatric patients with acute appendicitis to compare sonography and CT scan. Most of these studies comparing examinations of CT and sonography were conducted in university hospitals by radiologists but only one study was conducted in a tertiary care hospital. The CT scan was evaluated by a radiologist with various degrees of experience in a study conducted by Wise et al., with an interobserver variability [1,2].

The main objective of the study was to compare and assess the accuracy of the graded compression sonography and unenhanced focused single-detector helical CT scan in patients diagnosed with acute appendicitis with no selection criteria of atypical and typical symptoms admitted in the teaching hospital of the general community. The evaluation of sonography and CT were done by both the general and imaging radiologists so as to make a realistic clinical experience [3].

A single detector helical CT scanner is used for the examination of CT scan by using a technique called rapid thin scanning. A beam collimator of 5mm at a speed of 5mm per second is used for the single breath-hold helical scan to scan from the L2 vertebra to the pubic symphysis. The resultant images were photographed and reconstructed at an interval of 3mm using various window settings of soft tissue. A 100mA tube current with a 5 reconstruction filter is used for patients below 10 years of age and a 150mA tube current with a reconstruction filter 4 is used for patients between 10 to 15 years of age, for patients above 15 years of age 250mA tube current with reconstruction filter 4 is used. The analysis of the CT scan was made both on a hard copy and at a workstation [4,5].

For doing sonography, graded compression can be used with curved array or linear array transducer. Curved array was used in obese patients for better penetration [6]. The reliability of the results obtained from CT scan or sonography is also an important point where the surgeon needs to believe that the results are true. The results of CT and sonography needs to be reliable before going for surgery. In many cases, the surgeons skip the radiologic examination and based on physical examinations, the surgeries are undertaken. There is a need to encourage the surgeons to do diagnostic procedure before surgery and also there is a concern to have reliability in the results of the diagnosis [5,7].

Materials and Methods

The study design is prospective and was conducted during the period of 18th months. The patients who visited the emergency department of our hospital with suspected appendicitis based on the result of physical examinations and laboratory tests, were only included. The patients included were taken consent for the study and agreed to go through the treatment protocol of the institution. The patients who were excluded from the study had chronic condition and dropped out of the treatment protocol of our institution. The patients who were given immediate surgery had to be excluded. After applying inclusion and exclusion criteria, the study considered 100 patients.

After admission, each patient had to undergo sonography and also CT. Within first 24 hours of admission, each patient was done CT and sonography. The final decision of surgery was taken by the surgeon. CT scan was done by single detector helical CT by the technique of rapid thin-scanning. The result

of CT scan was marked as positive (indicating acute appendicitis) if the appendix was found to be enlarged (outer diameter is ≥ 6 mm). CT result were considered as negative when the appendix was found to have filled with intraluminal air in CT plate. Even an appendix which ≤ 6 mm was also considered as normal.

For sonography, linear array transducers were used for non-obese patients while curved array transducer was used for obese patients to penetrate deeper. Visualization of inflamed appendix was considered to be the positive result in sonography. If the appendix is not enlarged in sonography result, then it was considered to be the negative sonography result. The sonography was performed and interpreted by experienced sonologist. As mentioned, both CT and sonography were performed by different radiologists. The radiologists was not informed about each other's interpretation and neither the surgeon was informed about the result of imaging. During the surgery, the surgeon made diagnosis of acute appendicitis by macroscopic observation.

Statistical analysis

The study conducted Mc Nemar test for sensitivity, specificity and accuracy. The level of significance was considered to be $\alpha = 0.05$.

Results

The study found that the mean value of patients' age is 26.32 ± 3.7 years. The percentage of males and females were found to be 55% and 45%. Out of 100 patients, surgical diagnosis confirmed by histological findings revealed that there was appendicitis in 22 patients (14 females and 8 males).

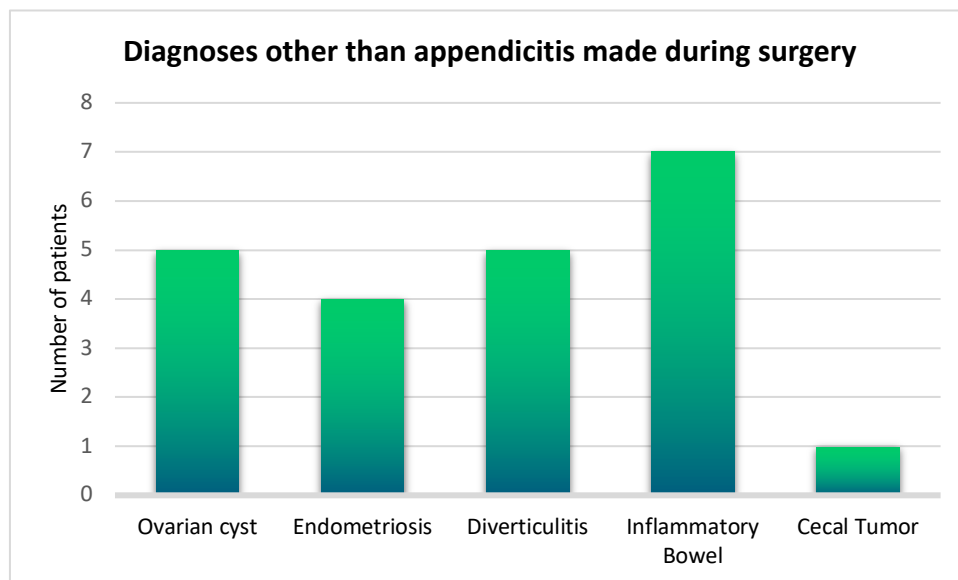


Figure 1: Number of diagnosis of conditions made other than appndicitis, during surgery

The positive and negative sonographic findings are correlated with the positive and negative findings made during surgery (Table 1) and hence various statistical parameters are analyzed (Table 2).

Table 1: Correlation between the findings of sonography and surgery

Surgery Findings	Sonography findings		Number of patients
	Positive	Negative	
Positive	72	6	78
Negative	3	19	22
Total	75	25	100

Table 2: The findings of various statistical parameters analyzed for sonographic result

Statistical Parameter	Value Obtained	95% Confidence Interval
Sensitivity	95%	88.75% to 99.17%
Specificity	76%	54.87% to 90.64%
Positive Predictive Value (PPV)	92.31%	85.64% to 96.02%
Negative Predictive Value (NPV)	86.36%	67.16% to 95.15%
Accuracy	91%	83.60% to 95.80%

Again, the positive and negative CT findings are correlated with the positive and negative findings made during surgery (Table 3) and hence various statistical parameters are analyzed (Table 4).

Table 3: Correlation between the findings of sonography and surgery

Surgery Findings	CT findings		Number of patients
	Positive	Negative	
Positive	68	10	78
Negative	6	16	22
Total	74	26	100

Table 4: The findings of various statistical parameters analyzed for CT result

Statistical Parameter	Value Obtained	95% Confidence Interval
Sensitivity	91.89%	83.18% to 96.97%
Specificity	61.54%	40.57% to 79.77%
Positive Predictive Value (PPV)	87.18%	80.63% to 91.74%
Negative Predictive Value (NPV)	72.73%	53.89% to 55.89%
Accuracy	84%	75.32% to 90.57%

From Table 2 and Table 4, sensitivity of sonography was found to be 95% and specificity of sonography was at 76%, respectively. The sensitivity and specificity for CT were found to be 91.89% and 61.54%, respectively. The accuracy of Sonography and CT were found to be 91% and 84%, respectively. It was found that all these parameters in CT was less than Sonography ($P < 0.05$).

Discussion

A study was conducted between 1998 and 2000 where the patients were examined by the senior resident or staff surgeon who presented with appendicitis in the emergency department. CT scan and sonography were performed on these patients who were selected as subjects for the study. The CT results showed that it is confirmed as positive when

it showed an enlargement of the appendix greater than 6mm. Inflammation of the appendix, lymphadenopathy, and appendicoliths are the ancillary signs that are recorded. 340 patients with suspicion of acute appendicitis were hospitalized of them 105 were excluded. 50 were admitted after 10 pm, surgery was done immediately for 10 patients as they cannot be included in the study group. Of the 340 patients, 235 were examined by sonography and CT scan [8,9].

The diagnosis of appendicitis on sonography was done by direct visualization of the appendix which is an inflamed, sausage-shaped structure with concentric layers was found at the point where tenderness is seen. Appendix presenting with a diameter of 6mm or more and an echogenic inflamed

periappendicular fat is the normal appearance of an appendix. Inflammation of the right lower quadrant, abscess, phlegmon and right lower quadrant which can be compressed without enlargement of the appendix are the negative findings seen on sonography useful for the diagnosis [10,11].

The examinations of sonography and CT scan were done within an hour by two radiologists who were not informed about the other findings. The radiologic diagnosis was not disclosed to the surgeon. An independent surgeon was notified if CT or sonography revealed abnormalities other than appendicitis that might have clinical implications. The independent surgeon determined if the radiologic diagnosis had any bearing on the surgical approach and whether the procedure should be cancelled or the kind of procedure altered (i.e., laparotomy by split-muscle incision or laparoscopy). [12, 13]

Of the 340 patients, 225 patients followed the protocol, among them 199 underwent surgery immediately. During the surgery, the diagnosis of acute appendicitis was done by macroscopic findings. The macroscopically normal appendix was seen, it is left intact. A split muscle incision was made on a normal appendix for excision. The excised part is analyzed microscopically. During the surgery, if no diagnosis could be done but strong suspicion is done that there is an abnormality intraabdominal then the radiologist is consulted, and then a strategy of surgery is determined [9].

In another study, it is found that during the surgery, more than 100 patients have proven positive for appendicitis among 199 of them underwent surgery. 4 among these patients a relevant diagnosis was done, and 67 present without appendicitis. I showed positive signs of appendicitis on sonography, and 28 patients showed acute appendicitis during surgery, however, the sonogram showed negative findings. 52 among 67 without appendicitis also showed negative on sonography. 100 among the 132 patients with appendicitis showed positive on CT scan the rest of 32 patients show appendicitis at the surgery with negative CT findings [1].

The CT examination done by the radiologists showed specificity, sensitivity, and positive and negative predictive values similar to sonography in this blinded prospective study. It is the first study to compare the reliability of CT with the administration of contrast material and the use of sonography in diagnosing acute appendicitis. A comparative study was conducted for the assessment of CT and sonography by Wise et al., with the use of contrast material. Aside from demonstrating that CT scans outperformed sonography, the study also revealed interobserver heterogeneity in CT scan judgment [12, 13].

Sonography and CT are essential for the diagnosis of acute appendicitis to reduce the negative findings and the incidence of perforation while performing laparoscopy or appendectomy. Sonography is rapid, invasive, and cost-effective and there is no need for the cooperation of the patient or the use of contrast material. It is a dynamic

investigating procedure and the photographs cannot be reevaluated. The specificity and sensitivity for perforated appendicitis are low than for non-perforated. Patients with retrocecal appendicitis and obesity can not be examined by sonography. Some authors state that CT is the accurate procedure for diagnosing appendicitis as it is easily available, operator-independent, and easily interpreted. CT can be done without the use of contrast material as the patients refuse to participate in the study with the use of contrast material. The results of sonography are found to be similar to other reports in diagnosing appendicitis whereas with the CT the results are found to be with lower accuracy [14,15].

Conclusion

The study has concluded that the applicability of Sonography is similar to CT in diagnosis of acute appendicitis ($P < 0.05$). Even the sonography can give better results as compared to CT in terms of accuracy and other parameters. The study further points that the radiation hazard is also absent in sonography and hence, it should be encouraged more. The installation and accessibility of sonography is also convenient. The study also suggests that there is need to conduct more studies with larger and varied population.

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