Research Article

INTERNATIONAL RESEARCH JOURNAL OF PHARMACY

www.irjponline.com

ISSN 2230-8407 [LINKING]

COMPARATIVE EVALUATION OF THE EFFECTIVENESS OF ULTRASONOGRAPHY VERSUS COMPUTED TOMOGRAPHY IN SUBJECTS WITH ACUTE APPENDICITIS IN THE INDIAN SETUP

Dr. Hulesh Mandle,[1] Dr. Shriranjan Rao[2*]

[1]Associate Professor, Department of Radiology, Rama Medical College Hospital & Research Centre, Hapur, Uttar Pradesh

[2*]Assistant Professor, Department of Radiology, Saraswati Institute of Medical Sciences, Hapur, Uttar Pradesh

Address for correspondence

Dr. Shriranjan Rao

Email id: panhealth121013@gmail.com

How To Cite: Mandle H, Rao S. Comparative Evaluation Of The Effectiveness Of Ultrasonography Versus Computed Tomography In Subjects With Acute Appendicitis In The Indian Setup. International Research Journal Of Pharmacy, 2018,9:4:77-82.

DOI: 10.7897/2230-8407.09465

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ABSTRACT

Background: An acute episode of appendicitis is the most frequent cause of abdominal surgery in India. Ultrasonography is a commonly used method for the safe assessment of appendicitis; nevertheless, it is not easy to conduct on large patients and requires an operator. Compared to ultrasonography, computed tomography (CT) scans have a nearly 95% accuracy rate.

Aim: In an Indian setting, this study sought to evaluate the relative effectiveness of computed tomography and ultrasonography in treating patients with acute appendicitis.

Methods: 115 patients who had a suspicion of acute appendicitis were evaluated for the current research. At first, Alvarado scores were used to diagnose acute appendicitis. The next procedure was abdominal ultrasonography. A CT scan with oral contrast was performed on participants whose ultrasonography results were uncertain or negative. Expert radiologists reevaluated the CT and ultrasonography data, and a comparison with the outcomes of surgery and pathology was established. Additionally, two groups were used for the comparison.
Results: In participants with minimal clinical suspicion, the negative predictive value, positive predictive value, specificity, and sensitivity of CT scans were, respectively, 79.5%, 94.6%, 87.7%, and 81.6% based on the pathology results. Based on pathology results, the ultrasonography's negative predictive value, positive predictive value, specificity, and sensitivity were, in people with minimal clinical suspicion, 67.8%, 94.3%, 74.7%, and 63.2%, respectively.

Conclusion: The current study finds that in patients with acute appendicitis, CT scan has a high sensitivity and specificity compared to abdominal ultrasonography.

Keywords: Acute appendicitis, computed tomography, CT scan, ultrasound, ultrasonography.

INTRODUCTION

About 7% of people will experience acute appendicitis at some point in their lives due to its high prevalence. The yearly incidence of acute appendicitis varies between 96% and 100% worldwide per 100,000 adult participants, with children and adolescents being the most susceptible to the condition. Acute appendicitis is the most prevalent cause of emergency abdominal surgery in the Indian context; nonetheless, it is important to distinguish this condition from other causes of stomach discomfort. In between 2% and 10% of the participants, the diagnosis of stomach discomfort is confounded by delayed instances of inflammatory mass and perforation.1.

The combination of radiography, laboratory evaluation, physical examination, and history taking is used to diagnose acute appendicitis. With these diagnostic tools, it is thought that over 90% of subjects can be diagnosed with acute appendicitis with accuracy and speed. This includes postmenopausal women, who may confuse acute appendicitis with other gynaecological conditions, and elderly subjects, who may experience generalised abdominal pain instead of localised pain and leukocytosis.2.

It is also shown that in people with clinical suspicion of acute appendicitis, radiographic imaging can reduce hospital costs, perforation morbidity, and negative appendectomy rate by 15%. Other imaging modalities, such as CT scans, are utilised when conventional radiography is unable to provide a definitive diagnosis. This shows that imaging is helpful in these circumstances since over half of the people with acute appendicitis do not exhibit the typical symptoms of the illness. Additionally, around one-third of patients with acute appendicitis have normal WBC counts and remain afebrile until rupture. In these situations, scans are beneficial.3.

Ultrasonography is one of the radiography procedures that is most accessible and is thought to be safe, with an accuracy range of 70% to 98%. Nevertheless, it is operator-dependent and presents a problem for individuals with large bodies. While the use of CT scans is controversial, their accuracy rates range from 93% to 98%. The expensive cost, possible problems with contrast material, and significant radiation exposure of CT scans are its downsides. Focused appendiceal CT with rectally given contrast media, oral and/or intravenous contrast media, and abdominal and pelvic CT without contrast were the three primary CT scan techniques employed in the past.

However, recent data depicts that the first imaging test in acute appendicitis should be an abdominopelvic CT scan.[4]

Abdominopelvic CT has revealed sensitivity and specificity of 94% and 95%, respectively. When evaluating the normal appendix, CT scans are more accurate than ultrasonography. An inflammatory appendix with a diameter more than 6 mm, appendiceal wall enhancement, and appendiceal wall thickening after contrast media infusion are all visible on a typical CT scan. Appendicitis is ruled out by the presence of contrast air in the appendix lumen. Although there are challenges with using ultrasonography on females, CT scan is a reliable modality for distinguishing appendicitis from the majority of other gynaecological disorders.5. In an Indian setting, the current clinical study sought to evaluate the relative effectiveness of computed tomography vs ultrasonography in patients with acute appendicitis.

MATERIALS AND METHODS

The present cross-sectional clinical study was aimed to evaluate in a comparative manner, in an Indian setting, the effectiveness of computed tomography vs ultrasonography in patients with acute appendicitis. The study was conducted at Department of Radiology with approval from the relevant institutional ethical committee. The research evaluated patients who suspected acute appendicitis when they visited the Institute with abdominal discomfort. Prior to their involvement in the study, all individuals provided their informed permission, both verbally and in writing. The study's inclusion requirements included being willing to engage in the research, experiencing severe abdominal discomfort, being referred to the emergency room, being of either gender, and being between the ages of 16 and 60. The exclusion criteria included patients who were less than 16 years old, had symptoms for less than 72 hours, were immunocompromised, had other systemic disorders, or had not given informed consent to participate in the trial.

115 people who met the inclusion criteria were considered the final sample size. Following final inclusion, a thorough medical history and demographic information about age and gender were obtained from each research participant. Following a thorough clinical evaluation of each participant, samples were gathered for the laboratory testing. Based on the observations, a preliminary diagnosis was established.

Alvardo ratings were used to diagnose acute appendicitis following an initial evaluation. A score of 7 or higher verified the diagnosis of acute appendicitis, whereas a score of 1-4 ruled it out. A 5–6 indicated that the person be watched in case more testing was required. The individuals in this study were limited to those having Alvarado scores of ≥7.6.

A radiologist, an expert in the field, performed abdominal ultrasonography on all the subjects. After ultrasonography, a diagnosis was made and the treatment was started. A dilated distal appendix measuring more than 6 mm in diameter and additional positive features such as periodical fluid, hyperemic appendiceal walls, appendicolith, echogenic peri-appendicular fat, and/or abscess were the diagnostic criteria for appendicitis on ultrasonography. The ultrasonography report for acute appendicitis was described as not visualised, positive, or negative. When the results of the ultrasonography were ambiguous or negative, a CT scan with oral contrast was performed. The radiologists reported the CT scan's findings. With an appendix lumen more than 6 mm and additional positive findings such as phlegmon, appendicolith, peri-appendicular fat stranding, abscess, or thickening of the cecal wall, the CT scan was used to diagnose appendicitis. The CT radiologist stated whether or not the scans showed evidence of appendicitis. [Images 1&2]

After that, the CT and ultrasonography data were evaluated once again by a different, highly qualified radiologist. The outcomes of the operation and the subject's final diagnosis in the event of pathology were then compared. The collected data were statistically analysed using the Student t-test, Chi-square test, and Fisher's exact test using SPSS software version 25.0 (IBM Corp., Armonk, NY, USA). The mean and standard deviation of the data were reported. A significance threshold of $p<0.05$ was maintained.

RESULTS

180 participants in all reported having stomach discomfort throughout the current research, which raised the possibility of acute appendicitis and led to further referrals for testing. Pathological data were lacking from 4 out of the 121 participants who had surgery; these subjects were not included in the current analysis.

In 2 subjects, further, Alvarado's scores were <7 and were also excluded from the study. The final sample size for the study was 115 subjects. The research participants ranged in age from 16 to 60 years old, with a mean age of 26.7±9.8 years. In the current study, there were 45.21% (n=52) females and 54.78% (n=63) men. In 29.56% (n=34) of the cases, abdominal CT was performed without the need for an intravenous contrast material injection. In 6.08% (n=7) of the subjects, ultrasonography reports raised suspicions about appendicitis. In 23.47% (n=27) of the subjects, there were negative findings on the test for appendicitis. These CT scans were deemed positive when the cecum and appendix showed signs of inflammation, density increased, an abscess or phlegmon formed with an appendicitis-like appearance, the intestinal arches and cecum expanded in the RLQ area, the small intestine's and the cecum wall thickened, and gas or fluid was present in the peri-appendicular area.

Pathological findings included an expanded intestine with a transverse diameter more than 2.5 cm and an increased cecum thickness of more than 5 mm. Results were considered favorable when there was no indication of acute appendicitis on the CT scan and no pathologic alterations in the abdominal or pelvic organs. Positive CT results for acute appendicitis were observed in 24 patients, and post-appendectomy pathology testing confirmed the diagnosis. After evaluating the correlation between the findings of CT scans and ultrasonography, it was discovered that 3 false negative and 1 false positive results were seen in the participants who had CT scans. The retrocausal appendix and decreased peritoneal fat were seen on CT.

It was observed that the anatomical location of the appendix and cecum, as well as insufficient fat around them, were the causes of false-negative findings and the absence of appendicitis symptoms. These patients benefited from a more thorough evaluation that included a CT scan and a contrast agent injection. Subjects who had a negative appendectomy were 26.4±7.9 years old on average, whereas those who had a positive appendectomy were 26.4±9.4 years old. With $p=0.43$, the age difference was statistically not significant. Additionally, there was no discernible difference between the male and female participants who had negative appendectomy ($p=0.26$). As seen in Table 1, pathology confirmed the diagnosis of appendicitis in 89.56% (n=103) of study participants, whereas 10.43% (n=12) of pathology disputed the appendicitis diagnosis.

Table 2 summarises the pathology results' negative predictive value, positive predictive value, specificity, and sensitivity. Based on the pathology results in participants with minimal clinical suspicion, the CT scans' negative predictive value, positive predictive value, specificity, and sensitivity were, respectively, 79.5%, 94.6%, 87.7%, and 81.6%. Based on the pathology results in people with minimal clinical suspicion, the ultrasonography's negative predictive value, positive predictive value, specificity, and sensitivity were, respectively, 67.8%, 94.3%, 74.7%, and 63.2%. The negative predictive value, positive predictive value, specificity, and sensitivity of ultrasonography in male patients based on pathology were 77.5%, 61.3%, 96.3%, and 83.1%, respectively, based on the ultrasonography and CT evaluation based on the gender of the research subjects.

Based on pathology, the CT scans' specificity, sensitivity, negative predictive value, and positive predictive value for male individuals were, respectively, 100%, 89.6%, 81.2%, and 100%. As shown in Table 2, the results of the CT scan were entirely compatible with the pathology findings in the female participants. The ultrasonography's specificity, sensitivity, negative predictive value, and positive predictive value were 100%, 93%, 84.1%, and 100%, respectively.

DISCUSSION

A total of 180 participants in the current research had abdominal discomfort that raised the possibility of acute appendicitis and were subsequently referred for additional testing. Four of the 121 patients who had surgery had missing pathology data, which prevented them from being included in the current analysis.

Furthermore, Alvarado's scores were less than seven in two participants, who were also eliminated from the research. There were 115 people in the study's final sample size. The research participants ranged in age from 16 to 60 years old, with a mean age of 26.7±9.8 years. In the current study, there were 45.21% (n=52) females and 54.78% (n=63) men. These results were in line with research by Podda M et al. (7) in 2021 and Moris D et al. (8) in 2021, whose authors evaluated appendicitis patients using the same Alvarado scores as those used in this investigation and evaluated them using demographic information similar to that of the current study.

It was observed that in 23.47% (n=27) of the participants, the findings of the appendicitis ultrasonography were negative, and in 6.08% (n=7) of the subjects, the appendicitis ultrasonography report was suspicious in these 29.56% (n=34) subjects abdominal CT was done with no intravenous contrast material injection. These CT scans were considered positive when there were inflammatory alterations around the cecum and appendix and there was an increase in the density, formation of phlegmon or abscess with appendicitis appearance, expansion of intestinal arches and cecum in the RLQ area, thickening in arches of the small intestine and cecum wall, and presence of gas or fluid in the peri-appendicular region. These results were in line with research conducted in 2020 by Pogorelic Z et al. and in 2019 by Jeon BG et al., when ultrasonography results that were negative were found to be positive on CT scans. According to the study's findings, pathological observations included an expanded intestine with a transverse diameter of more than 2.5 cm and an increased cecum thickness of more than 5 mm. Results were considered favourable when there was no indication of acute appendicitis on the CT scan and no pathologic alterations in the abdominal or pelvic organs. Positive CT results for acute appendicitis were observed in 24 patients, and post-appendectomy pathology testing confirmed the diagnosis.

These outcomes were in line with the findings of Zisman A et al. in 2022 and Karul M et al. in 2014, when a CT scan showed results comparable to those observed in the study's participants. Regarding the correlation between the findings of CT scans and ultrasonography, it was observed that among the participants who had CT scans, there were three false negative results and one false positive result. The retrocausal appendix and decreased peritoneal fat were seen on CT. It was observed that the anatomical location of the appendix and cecum, as well as insufficient fat around them, were the causes of false-negative findings and the absence of appendicitis symptoms.

These patients benefited from a more thorough evaluation that included a CT scan and a contrast agent injection. Subjects who had a negative appendectomy were 26.4±7.9 years old on average, whereas those who had a positive appendectomy were 26.4±9.4 years old. With p=0.43, the age difference was statistically not significant. Additionally, there was no discernible difference between the male and female participants who had negative appendectomy (p=0.26). In 89.56% (n=103) of the study participants, pathology confirmed the diagnosis of appendicitis, whereas

10.43% (n=12) of the pathology questioned the appendicitis diagnosis. These findings corroborated those of studies by Teng TZJ et al. (2021) and Fu J et al. (2021), which found a similar connection between the results of CT scan and ultrasonography as this research did.

According to the study findings, in participants with minimal clinical suspicion, the negative predictive value, positive predictive value, specificity, and sensitivity of CT scans were, respectively, 79.5%, 94.6%, 87.7%, and 81.6% based on the pathology results. Based on the pathology results in people with minimal clinical suspicion, the ultrasonography's negative predictive value, positive predictive value, specificity, and sensitivity were, respectively, 67.8%, 94.3%, 74.7%, and 63.2%. The negative predictive value, positive predictive value, specificity, and sensitivity of ultrasonography in male patients based on pathology were 77.5%, 61.3%, 96.3%, and 83.1%, respectively, based on the ultrasonography and CT evaluation based on the gender of the research subjects.

Based on pathology, the CT scans' specificity, sensitivity, negative predictive value, and positive predictive value for male individuals were, respectively, 100%, 89.6%, 81.2%, and 100%. The CT scan findings in female individuals were entirely compatible with the pathology results, and the ultrasonography's specificity, sensitivity, negative predictive value, and positive predictive value were 100%, 93%, 84.1%, and 100%, respectively. The present study's results were consistent with the research conducted by Leung B et al. (15) in 2019 and Kilkenny J et al. (16) in 2022, which indicated good sensitivity and specificity of CT scans.

CONCLUSION

Considering its limitations, the present study concludes that in comparison to abdominal ultrasonography, CT scan has high sensitivity and specificity in subjects with acute appendicitis. The present study recommends that a CT scan shall be performed in every negative case of ultrasonography to confirm acute appendicitis as it is highly accurate, avoid ionizing radiation, and contrast in the majority of the subjects.

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S. No	Variable		Appendectomy positive		Appendectomy negative		p-value
			n	%	n	%	
1.	CT scan (n=34)	Positive	24	96	1	4	<0.001
		Negative	3	33.3	6	66.66	
2.	Ultrasonography (n=115)	Positive	77	95.06	4	4.93	0.09
		Negative	27	79.41	7	20.58	

Table 1: Relationship between results of CT scan and ultrasonography in positive and negative appendectomy

S. No	Variable	CT scan	Ultrasonography
1.	Negative predictive value	79.5%	67.8%
2.	Positive predictive value	94.6%	94.3%
3.	Sensitivity	87.7%	74.7%
4.	Specificity	81.6%	63.2%

Table 2:

IMAGES

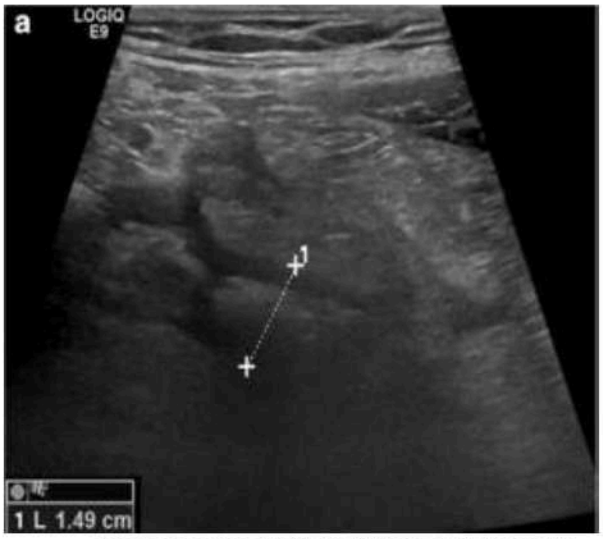


Image a: some fluid and thickened appendix,



Image b: contrast-enhanced CT: thickened appendix