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A Comparison of CT and USG Diagnostic Accuracy in the Diagnosis of Acute Appendicitis

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Abstract

Background: The most common complaint seen in any hospital's emergency department is vague abdominal pain. It may be accompanied by nausea, vomiting, fever, or diarrhoea, but the pain is the most unpleasant symptom. Because pain thresholds differ from person to person, the severity of the condition cannot be determined solely based on this symptom. The causes of abdominal pain can range from benign to life-threatening conditions. **Subjects and Methods:** The study included patients between the age of 15and 60 years, who were brought to the emergency department with clinical findings and symptoms of acute appendicitis such as right iliac fossa pain, fever, and vomiting. A total of 76 people were chosen for the investigation. In the specified proforma, the clinical history was obtained addressing the current history. **Results:** Male patients accounted for 63.2 percent of the study sample, while females accounted for 36.8%.The highest number of cases about 44.7% noted in the age group of 20-30 years irrespective of sex. The confidence interval is about 95 % for sensitivity and specificity of surgical findings with respect to clinical acumen in diagnosing appendicitis. USG as a modality for diagnosing acute appendicitis has 95% accuracy when done for a large group in the population not considering prevalence of disease in the community. **Conclusion:** CT has higher sensitivity, specificity, PPV, and NPV compared to USG. As a result, the CT examination is more accurate than the USG in diagnosing appendicitis.

Keywords: Computed Tomography, Ultrasound & Acute appendicitis.

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Introduction

The most frequent acute abdominal disease is acute appendicitis (AA).[1] Surgery is usually required, especially in the case of AA with perforation, because it is linked with high morbidity and death. Because the symptoms of AA are typically atypical and overlap with other disorders, emergency physicians and surgeons have had difficulty diagnosing it in both paediatric and adult populations.[2,3] The most common complaint seen in any hospital's emergency department is vague abdominal pain. It may be accompanied by nausea, vomiting, fever, or diarrhoea, but the pain is the most unpleasant symptom.[4] Because pain thresholds differ from person to person, the severity of the condition cannot be determined solely based on this symptom. The causes of abdominal pain can range from benign to life-threatening conditions. The surgeons or physicians need to diagnose and treat the condition in a timely manner.[5] Time is crucial since any delay might result in serious repercussions such as perforation, as well as morbidity and, in some cases, mortality. As a result, rapid diagnosis is critical and remains a difficulty for medical professionals. The most prevalent cause of abdominal pain in individuals brought to the emergency room is appendicitis.[6] Diagnosing this in a young male patient is usually straightforward, but in premenopausal women with identical clinical history and symptoms, it might be difficult. This is mostly owing to the fact that a variety of gynaecological issues in women can manifest as abdominal pain that mimics appendicitis. As a result, excluding the diagnosis in women is more difficult than finding a positive case of appendicitis. Problems develop at extremes of age due to a delay in seeking medical care or difficulty in obtaining history, and providing an accurate physical examination becomes a mountainous effort in these patients. Because of the serious complications of acute appendicitis, such as perforation, it is critical to diagnose and treat it as soon as possible. Even if there is no definitive diagnosis of appendicitis, some surgeons advocate for an early laparotomy based only on clinical signs. This is primarily done to reduce the chance of appendiceal per-

foration.

Aims and Objectives

Patients hospitalised to the emergency department with clinical suspicion of acute appendicitis were subjected to imaging techniques, including CT and USG. Using histopathological findings as the gold standard, to determine the sensitivity, specificity, positive predictive value, and negative predictive value for both CT and USG. The goal of this study was to determine the diagnostic accuracy of both imaging techniques in identifying acute appendicitis.

Subjects and Methods

From January, 2018 to March, 2019, this study was conducted in the Department of Radiodiagnosis of World College of Medical Sciences Research and Hospital, Jhajjar, Haryana, India. Acute appendicitis is primarily a clinically diagnosed disease, with surgeons or physicians relying on clinical scores, physical examination, and physical signs to make their diagnosis. However, based solely on clinical findings, the rate of negative appendectomy is increasing. As a result, surgeons prefer to employ imaging techniques such as CT and USG, if not in all cases, at least in atypical and equivocal ones when the diagnosis of acute appendicitis needs to be ruled out or confirmed. Many research have discussed the optimal method for detecting acute appendicitis, according to the literature. The majority of them come up with similar outcomes. USG is a non-invasive, low-cost, and widely available method that does not require contrast. However, because it is operator dependent, it is extremely reliant on the expertise and experience of the radiologist doing the scan. Furthermore, other factors such as the patient's built and the appendix's varied positions make it difficult for the scanning radiologist to see the appendix. CT, on the other hand, has the drawback of emitting ionising radiation, but it also has the advantage of definitively ruling out or confirming appendicitis due to its increased specificity. If appendicitis is ruled out, both the USG and CT have the advantage of providing another diagnosis. In recent years, these techniques have significantly reduced the rate of negative appendectomy. As a result, adding any or both imaging modalities to the treatment regimen would benefit the attending surgeon. To be cost effective and minimise unnecessary surgery, determining which technique is the best modality with high diagnostic accuracy is critical, and the study would provide answers to these questions. A prospective observational research was conducted.

Inclusion criteria

This is a prospective observational research that took place between Jan 2018 to March 2019.Patient with symptoms of acute abdominal pain and clinical findings strongly suspected of appendicitis who were admitted at the emergency department of World College of Medical Sciences Research and Hospital, Jhajjar. The main criterion was to include individuals who have undergone both CT and USG imaging modalities. The criteria were to choose individuals who had both imaging and clinical findings that led to surgery. The institutional ethical committee and the departmental review board accepted this study procedure, and institutional informed consent guidelines were followed.

Exclusion criteria

- Initial USG screening and history revealed a patient with an inflammatory focus, such as mesenteric adenitis.
- PID, or non-specific enterocolitis, was ruled out.
- Patients who needed surgery right away and didn't have time to wait for an imaging modality.
- Patient who refuses to consent.

Methodology

The study included patients between the ages of 15 and 60 years who were brought to the causality surgical emergency department with clinical findings and symptoms of acute appendicitis such as right iliac fossa pain, fever, and vomiting. A total of 76 people were chosen for the investigation. In the specified proforma, the clinical history was obtained addressing the current history. Each participant gave their informed consent, and the procedure was approved by the institutional ethical committee.

USG Protocol

To rule out alternative anomalies connected to solid organs and to rule out free fluid, a routine USG was performed in the BPL Alpinion E Cube 5 machine for the upper abdomen and pelvis using a 3-5–MHz convex transducer. A linear transducer was then used to perform graded compression and colour Doppler sonography of the right lower quadrant, paying special attention to the point of peak tenderness. Appendix was depicted as a closed loop with no peristalsis. The intestine loops are displaced using a graded compression approach, which allows for the distinction between an incompressible inflammatory appendix and compressible normal gut loops. A blind-ended tubular formation anterior to the iliac vessel with a diameter higher than 6mm indicated the existence of appendicitis. Due to the mural inflammation, there is an increase in peripheral vascularity in the appendix wall on Doppler. Other findings included an appendicolith, peritoneal fluid, periappendicular fat stranding, and others. On average, it took 10-15 minutes to complete the task. The USG findings for acute appendicitis were classified as positive, negative, or inconclusive. When alternative diagnoses were made, they were reported.

CT Protocol

The examinations were done on an MDCT with Hitachi SUPRIA 16 Slice CT Scanner at 120 kVp and 100 mAs, with

a pitch of 1. 80 mL of non-ionic contrast material Iohexol 350 (Omnipaque 350) was injected through an 18-gauge cannula implanted in the volar aspect of the cubital vein at a flow rate of 4 ml/s and a delay of 50 seconds during a CT scan of the lower abdomen and pelvis from the xiphoid to the pubic symphysis. Axial reconstructions from raw data were obtained in 3 mm thick increments at 2 mm intervals. The second data set was coronal reformatted in 3 mm increments with a thickness of 3 mm. There was no use of an oral contrast agent.The CT scan resulted in a positive, negative, or inconclusive result. Appendicitis is diagnosed using criteria similar to those used by the USG. When alternative diagnoses were made, they were reported.

Statistical analysis

SPSS was used to conduct the analysis (version 20.0, IBM Company, Chicago, IL). For categorical data, the Chi-square test is performed. The sensitivity, specificity, positive and negative predictive value (PPV, NPV) of ultrasound and computed tomography (CT) were calculated. The diagnostic efficacy of two imaging modalities was assessed using a receiver operating characteristic (ROC) curve, and the area under the ROC curve (AUC) was determined and compared. A probability value of less than 0.05 was considered significant.

Results

The gender distribution of 76 patients who underwent surgery is shown in [Table 1]. Male patients accounted for 63.2 percent of the study sample, while females accounted for 36.8%.

Table 1: Shows the distribution of patients according to Gender

Gender	No. of patients (%)
Male	48 (63.2%)
Female	28 (36.8%)
Total	76 (100.0%)

Table 2: Shows the distribution of patients according to age group

Age	No. of patients (%)
<20	26 (34.2%)
20-30	34 (44.7%)
30-40	12 (15.8%)
40-50	2 (2.6%)
50-60	2 (2.6%)
Total	76 (100.0%)

The above table provides frequency of distribution of age group in patients with appendicitis. The highest number of patients about 44.7% noted in the age group of 20-30 years irrespective of gender.

Table 3: Shows the CT and Ultra Sound diagnosis

Variables	No. of patients (%)	
	CT	Ultra sound
Normal	09 (11.8%)	11 (14.5%)
Positive	67 (88.2%)	65 (85.5%)
Total	76 (100.0%)	76 (100.0%)

Table No. 3 shows the number of cases reported positive for appendicitis among the study sample of 76 patients. 67 patients were diagnosed positive and 9 were diagnosed negative for appendicitis on CT study. Similarly, depicting the number of patients who were diagnosed positive and negative using USG.

Table No. 4 illustrates the association between CT and HPE findings. CT scans were found to be positive for acute appendicitis in 67 patients and negative in nine others. And, of the nine patients who had negative results, seven had negative histopathology findings and two had positive HPE results. Among the eight patients who tested negative for HPE, one exhibited a CT finding of minor fat stranding and a normal-sized appendix measuring 6 mm, which was classified as positive. Similarly, the USG findings were found to be positive in 65 cases and negative in 11 cases. A total of 05 of the 11 negative cases have an HPE finding of acute appendicitis. The remaining 06 cases were also found to be negative for the illness on HPE. Among 65 patients cases diagnosed as appendicitis on USG, 63 were also HPE positive for appendicitis, whereas the HPE report for 02 patients was negative.

Table No. 5 gives the sensitivity and specificity of CT and Ultra Sound in diagnosing appendicitis. The confidence interval is about 95%. CT and Ultra Sound as a modality for diagnosing a case of appendicitis has 95% to correctly diagnose it when done for a large group in the population not considering the prevalence of the disease in the community.

Table No. 6 gives the degree of agreement the kappa value and significance of correlation the P value.

Table No. 7 shows the number of cases that was found positive in surgery. of 76 n=75 was positive and n=01 were negative.

Table No. 8 shows the number of cases that was found positive in histopathology. Of 76 n=69 were positive and n=07 were negative.

[Table 9] Of the surgically positive case of n=75 n= 69 were found positive in HPE n=06 showed negative. Of the 011 negative cases in surgery it was also found negative in HPE reports

[Table 10] Gives the confidence interval is about 95 % for sensitivity and specificity of surgical findings with respect to clinical acumen in diagnosing appendicitis. USG as a modality for diagnosing a case of appendicitis has 95% to correctly

Table 4: Shows the CT and Ultra Sound Histopathology Correlation

Variables		Histopathology Examination		Total
CT		Inflamed Appendix	Normal	
	Normal	02 (22.2%)	07 (77.8%)	09 (100.0%)
	Positive	66 (98.5%)	01 (1.5%)	67 (100.0%)
	Total	68 (89.5%)	08 (10.5%)	76 (100.0%)
Ultra Sound	Normal	05 (45.5%)	06 (54.5%)	11 (100.0%)
	Positive	63 (96.9%)	02 (3.1%)	65 (100.0%)
	Total	68 (89.5%)	08 (10.5%)	76 (100.0%)

Table 5: Shows the CT and Ultra Sound sensitivity, Specificity, PPV & NPV

	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
CT	0.96	0.88	0.98	0.72
	(95% CI 0.92 to 0.98)	(95% CI 0.57 to 0.99)	(95% CI 0.93 to 0.99)	(95% CI 0.44 to 0.92)
Ultra Sound	0.93	0.79	0.99	0.52
	(95% CI 0.86 to 0.97)	(95% CI 0.46 to 0.96)	(95% CI 0.93 to .98)	(95% CI 0.28 to 0.74)

Table 6: Shows the Symmetric measurement

	Symmetric Measures					
			Value	Asymp. Std. error	Approx. T	P- value
CT	Measure of	Kappa	-.167	.073	-6.761	.001
Ultra Sound			-.152	.059	-4.521	.001

Table 7: Shows the surgical Correlation

Surgical Examination	No. of patients (%)
Inflammed appendix	75 (98.7%)
Normal	01 (1.3%)
Total	76 (100.0%)

Table 8: Shows the histopathology examination

Histopathology examination	No. of patients (%)
Inflammed appendix	69 (90.8%)
Normal	07 (9.2%)
Total	76 (100.0%)

Table 9: Shows the surgical and histopathology examination

Examination	Histopathology examination		Total
	Inflamed appendix	Normal	
Surgical examination Inflamed appendix	69 (92.0%)	06 (8.0%)	75 (100.0%)
Normal	00 (0.0%)	01 (100.0%)	01 (100.0%)
Total	69 (92.0%)	07 (9.2%)	76 (100.0%)

Table 10: Shows the CT and Ultra Sound sensitivity, Specificity, PPV & NPV

Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
1.0	0.22	0.93	0.50
(95% CI 0.96 to 1.00)	(95% CI 0.66 to 0.55)	(95% CI 0.86 to.96)	(95% CI 0.34 to 1.0)

diagnose it when done for a large group in the population not considering the prevalence of the disease in the community

The above table gives the degree of agreement the kappa value and significance of correlation the P value.

Discussion

The research was carried out in a tertiary care teaching hospital. Patients with stomach discomfort and classic acute appendicitis symptoms such as fever, right quadrant pain, and vomiting were checked by surgeons and recommended for surgery based on clinical symptoms were included in the study. Patients who did not have any imaging because of causes such as acute pain suspected of perforation, persons who did not consent for USG or CT imaging, or those who had only one imaging, such as CT or ultrasound, were excluded from the study. Women who showed indications of pelvic irritation were ruled out of the study. The study did not take into account the patient's age or gender, however the study's sex distribution revealed that male patients outnumbered female patients. There were 28 females (36.8%) and 48 males (63.2%) among the total of 76 patients. The most common age group for the presentation was 20-30 years, with 25 of 48 (52.1%) males and 9 of 28 (32.1%) females falling into this category. The next most common age group is less than 20 years, with 19 of 48 (39.6%) males and 7 of 28 (25.0%) females. When looking at the overall percentage of age groups, 44.7 percent falls in the 20 to 30 year range, 34.2 percent in the less than 20 year range, 15.8 percent in the 30 to 40 year range, 2.6 percent in the 40 to 50 year range, and 2.6 percent in the 50 to 60 year range.

CT scans revealed that 67 of the 76 patients had acute appendicitis, whereas the remaining nine were negative. Seven of the nine patients with negative results also had negative histopathology findings. One of the eight patients who tested negative in HPE had a CT showing of minor fat stranding with a normal-sized appendix measuring 6 mm, which was interpreted as a positive. In three cases, the appendix was inflamed surgically and pathologically with negative CT findings. Two of the patients had been treated with IV antibiotics for three days outside, according to their medical histories. It's unclear whether the picture findings were influenced by this history and intervention.

According to the USG findings of the 76 patients, 65 were found to be positive, indicating an acute appendicitis diagnosis. 11 of the results were reported to be negative. Five of the 11 negative cases have an acute appendicitis HPE finding. Two of the patients were obese and their appendix not visualized on USG. Other two patients were found to have inflammation of tip of appendix which was not identified on USG. These four cases were detected by CT, which resulted in a positive result. Two of the 11 patients were treated with antibiotics outside the hospital. The remaining three cases were also overlooked by the CT scan, which came out negative. The remaining 6 instances were truly negative, with HPE confirming the same. HPE positive for appendicitis was also found in 63 cases out of 65 positive results on USG. Two cases were reported as positive in USG despite the fact that all CT, HPE, and surgical results were negative. In order to reduce the reporting of false positive instances, some patients displayed probe soreness that was reported as negative but only mentioned as probe tenderness. This was decided because the pain threshold varies and cannot be safely given positive unless the appendix is visualised.

Patients in the research were scheduled for surgery based on the surgeon's clinical findings. Of the 76 patients who had surgery, 75 were diagnosed with an inflamed appendix. 69 of the 75 cases who were positive in surgery were also positive in HPE. As a result, there is a 92.0 percent chance of correctly diagnosing instances of acute appendicitis based on clinical features. One case was found to be negative, and it was also found to be negative in HPE.

The algorithm above depicts a summary of the histopathology report. 69 of the 76 cases that were scheduled for surgery had histology results that were positive. CT scans revealed positive results in 66 of the 69 patients, or around 98.5 percent. Hence With a confidence interval of 95 percent, CT has a 98.5 percent chance of correctly identifying a positive case of acute appendicitis. In terms of USG, of the 69 cases positive in histology, ultrasound revealed positive features in 63 individuals, or 96.9%, implying that USG has a 96.9% chance of accurately identifying acute appendicitis. In terms of negative findings in HPE, 7 of the 76 instances were reported as negative in histopathology. CT likewise revealed negative findings in 8 cases, accounting for 87.5 percent of the total, and USG revealed negative findings in 6 of the 8 cases that were reported as negative in histology. As a result, roughly 75.0 percent of the time, USG could correctly detect a negative case of appendix. According to the study, 9.2 percent of appendectomy cases are found to be negative, with 7 instances taken for surgery on clinical grounds being found

Table 11: Shows the Symmetric measurement

Symmetric Measures						
		Value	Asymp. error	Std.	Approx. T	P- value
Measure of agreement	Kappa	.342	.181		4.543	.001

to be negative. Six of the nine negative instances could have been averted if CT and USG results had been considered in addition to clinical acumen.

The gold standard is histology examination; hence the CT and USG findings are compared to the histopathology reports received. We determined the sensitivity, specificity, negative and positive predictive value. Sensitivity refers to the accuracy with which a diagnosis is made, and it correctly identifies those who have the disease. The capacity of a test to correctly identify all those who do not have the disease is known as specificity. The diagnostic power of a test is defined as its predictive value. It is dependent on the aforementioned factors as well as the disease's prevalence. The chi square test is used to obtain the P-value. It calculates the statistical significance of a difference in two proportions, with a value of 0.05 being statistically significant.

The study has a sensitivity of 96% and specificity of 88 percent, as well as a positive predictive value of 98 percent and a negative predictive value of 72%. The confidence interval for all of the values is 95 percent. If applied to a broad population, the study has a 95% chance of producing the desired outcome. The p value is also 0.001, which is a significant value. When the parameters are compared to those used in previous studies, the findings are very similar. Many investigations have come up with sensitivity and PPV values of -96 percent and -96 percent, respectively. Another study reported a sensitivity of 87-100 percent, specificity of 83-99 percent, and PPV of 92-99 percent, all of which are similar to our findings.[7]

The sensitivity of USG is 93 percent, the specificity is 79 percent, the PPV is 99 percent, and the NPV is 52 percent. The confidence interval for all of the values is 95 percent. If applied to a broad population, the study has a 95% chance of producing the desired outcome. The p value is also 0.001, which is a significant value. When the parameters are compared to those used in previous studies, the findings are very similar. Many other studies that have been evaluated in the literature have shown similar results. In his experiments, Puylaert et al,[8] discovered that the sensitivity and specificity were 89 percent and 100 percent, respectively. Terasawa and colleagues found 86% sensitivity,[9] 81 percent specificity, 84 percent PPV, and 85 percent NPV. Another Korean meta analysis found that sensitivity and specificity were 86.75 and 90 percent, respectively, which is similar to the study.[10]

Conclusion

We came to the conclusion that CT is higher sensitive, specific, PPV, and NPV. As a result, the CT examination is more accurate than the USG in diagnosing appendicitis. The majority of them come up with similar outcomes. In recent years, these techniques have significantly reduced the rate of negative appendectomy. In most studies, including ours, CT had higher sensitivity, specificity, negative predictive value, and positive predictive value when diagnosing appendicitis. Before deciding on which imaging modalities to use, evaluate the cost vs the radiation, as well as the true necessity to rule out appendicitis and the urgent need to find an alternate diagnosis. However, in acute appendicitis, CT has unquestionably superior diagnostic performance over USG, as our study demonstrates.

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