

Original Research Article

Diagonstic performance of ultrasonography and computed tomography in acute appendicitis in tertiary care centre**B Arun Kumar^{1*}, Manoranjan Mohapatra², Sudhansu Sekhar Mohanty³, Kamal Kumar Sen⁴, Manoj Kumar G¹**¹Resident, Department of Radio-Diagnosis, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India²Professor, Department of Radio-Diagnosis, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India³Assistant Professor, Department of Radio-Diagnosis, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India⁴ Professor & HOD, Department of Radio-Diagnosis, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India

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Abstract

Background: Appendicitis is the commonest cause of acute abdominal pain requiring emergency surgical intervention. Mimickers of Acute Appendicitis is hard to be ruled out clinically, wherein lies the importance of imaging. **Aims:** To evaluate the Sensitivity and Specificity of CT and USG in diagnosing Acute Appendicitis with Histopathology and Surgical correlation of radiological finding. **Methodology:** Comparative study between Ultrasonography and Computed Tomography was done between September 2018 and September 2020, involving a pool of 75 patients clinically suspected as acute appendicitis. All the patients were subjected to both USG and CECT modalities in same setting, with chief complaint of acute right lower abdominal pain, vomiting, and sometimes fever. Both the imaging finding were compared with histopathology specimen following appendectomy. **Results:** Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value, and Accuracy of USG is 84%, 67%, 98%, 15%, and 85% respectively and for CT the Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value and Accuracy of CT is 98%, 100%, 100%, 75% and 99% respectively. **Conclusion:** Ultrasound should be initial modality in all cases presenting as Acute Appendicitis, but in cases where it is equivocal and undetected CECT has advantage not only detecting but also providing surgical planning for surgeons basing on different anatomical locations and ruling out other differentials of right iliac fossa pain.

Keywords: Acute Appendicitis, Computed Tomography, Ultrasonography.

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Introduction

Appendicitis is the one of the commonest causes of acute abdomen in children and younger adults in whom surgical intervention is needed, with an estimated lifetime risk of 7–9%. Most commonly it presents as an Acute condition, within 24 hours in around 75% of cases and rarely it can present as a sub-Acute / chronic condition. Age of onset ranges from of 5 to 45 years commonly with an average age of 28 years. Males are more commonly affected and the incidence for men is ~8.9% and ~6.7% for women along with a male to female ratio of ~1.3:1. [1] Incidence of Appendicitis or appendectomy is ~100 per 100,000 in the world. Risk of rupture ranges from 2% at 36 hours to 5% with every 12 hours [1-3]. As compared to CT (computerized tomography) the precision and accuracy of USG is lower due to the many limitations (operator dependency, excess bowel gas, obese patients). However USG is an initial investigation of choice in evaluating Acute Appendicitis and having no radiation hazard hence can safely be used in pregnant women and children. [4] Advantages of CT include high sensitivity, specificity (~100%), accuracy, non-operator dependent and are preferred over USG due to lack of limitations like excess bowel gas,

obesity and in patients with severe abdominal tenderness where graded compression technique cannot be performed. However the major limitations of CT are exposure to ionizing radiation, cost, ease of availability and contrast related adverse reactions. [5] We evaluated the Sensitivity and Specificity of CT and USG in diagnosing Acute Appendicitis and Histopathology and Surgical correlation of radiological finding

Materials and methods

Study population- A Prospective study for a period of two years from September 2018 to September 2020 conducted in Department of Radio-Diagnosis in a tertiary care centre with a total of 75 consecutive subjects after clearance by Institutional Ethics Committee. Clinically suspected Acute Appendicitis referred for imaging and patients undergoing both the USG and CT evaluation followed by Surgery and Histopathology were included. Patients who have not, Surgery and Histopathology, who are subsequently managed conservatively and Patients with chronic appendicular lump were excluded. Ultrasound evaluation was undertaken by GE Voluson S6 scanner using curvilinear probe of 1.6-4.6 MHz and 5-13 MHz linear high-frequency transducer using graded compression technique. All patients with clinically suspected acute appendicitis underwent CT study following USG examination. CT scan of abdomen was done on, GE Optima 660, 64 slice Scanner (64 CHANNEL CONFIGURATION) using the following scan

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parameters i.e. 5 mm thick contiguous slice, reconstructed at 0.625 to 1.5 mm, 80-120KVp and variable mAs ranging from 250-375 in Helical mode with a Pitch of 0.984. Non contrast followed by contrast enhanced study using oral, rectal and IV was performed in all cases after obtaining informed consent. For opacification of bowel, 1.5 litres of diluted iodinated contrast 30ml of (60%) trazograff mixed with 1.5 litres of water) was used. For intravenous injection, 70ml (1ml/Kg body Wt) of non-ionic contrast (omnipaque

or iopamidol of 370 mg%) was injected at a rate of 2.2-2.5 ml/s followed by 30 ml of normal saline injected at a rate of 2ml/s.

Statistical analysis-The data was entered in MS Excel. Using IBM SPSS Statistics for Windows, version 27.0 (released 2020), and MedCalc 2020 (MedCalc Software), statistical analysis was performed. The data has been presented using descriptive statistics for calculating sensitivity, specificity, positive predictive value, negative predictive value and other variables.

Result

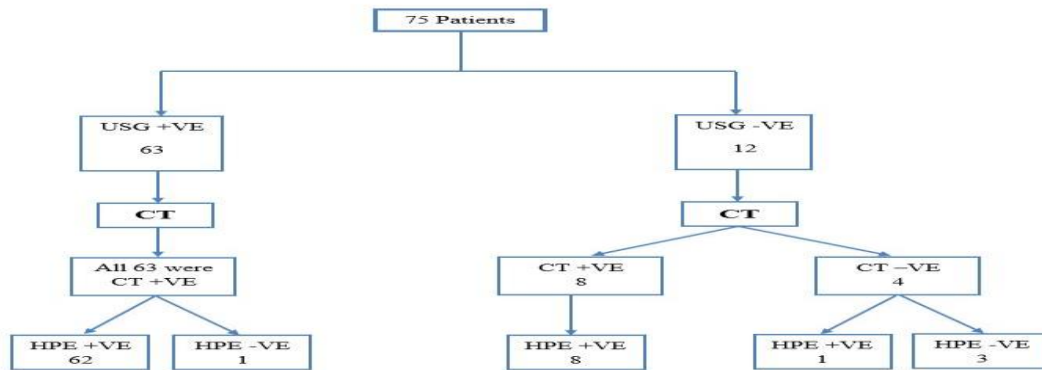


Fig 1: Flow chart of Observation

In our study Male to Female ration was 1.3:1. Maximum number i.e 38 out of 75(50%) of patients belong to 21-30 years age group and minimum number i.e 3 out of 75 (4%) of patients belong to 51-60 years age group. < 20 years is the next common age group is i.e 20 out of 75 patients (27%).

Table 1: USG and histopathology correlation

ULTRA SOUND	HISTOPHTHOLOGY EXAMINATION		Total
	INFLAMMED APPENDIX	NORMAL	
NEGATIVE	09	3	12
	75%	25%	100.0%
POSITIVE	62	1	63
	98.4%	1.6%	100.0%
Total	71	4	75
	94.6%	5.3%	100.0%

Table 2: CT diagnosis and Histopathology correlation

Computerized Tomography		HISTOPHTHOLOGY EXAMINATION		TOTAL
		INFLAMMED APPENDIX	NORMAL	
NEGATIVE		1	3	04
		25%	75%	100.0%
POSITIVE		70	1	71
		98.5%	1.5%	100.0%
TOTAL		71	4	75
		96.0%	4.0%	100.0%

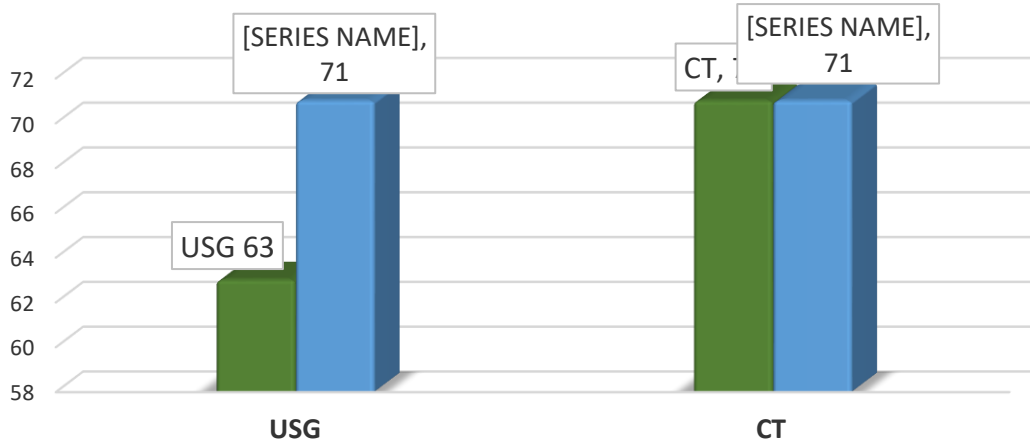


Fig 2:USG and CT

Out of 75 patients Ultrasound detected 63 cases of which 62(98.4%), were true positive 1(1.6%), was false positive. 9 cases (75%), were false negative and 3 (25%), true negative on comparison with histopathology.

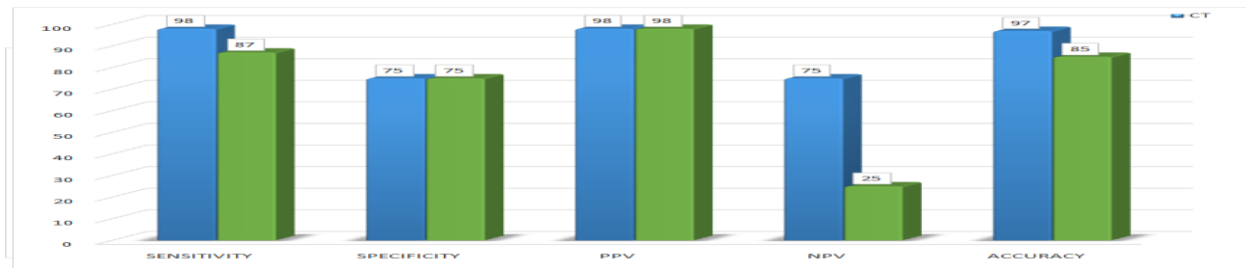


Fig 4: Depicting Sn, Sp, PPV, NPV, Accuracy of USG and CT

CT detected 71 cases of which 70 (98.5%) were true positive, 1 (1.5%), was false positive. 4 cases were undetected of which 1 (25%), false negative and 3 (75%), were true negative as compared with histopathology.

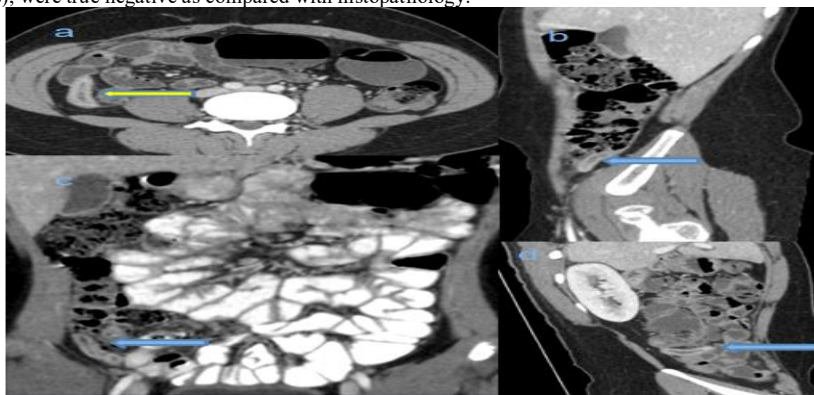


Fig 5: A 22yrs old male presented with history of pain abdomen, vomiting and fever. On examination he had tenderness over right iliac fossa. On USG due to retrocecal location Appendix is not visualized. On Axial, (A)Sagittal, (B, D) Coronal (C) CECT abdomen inflamed dilated Appendix (blue arrow) with surrounding fat stranding noted in right iliac fossa. On Surgery it was found Acute Appendicitis which was confirmed by Histopathology.

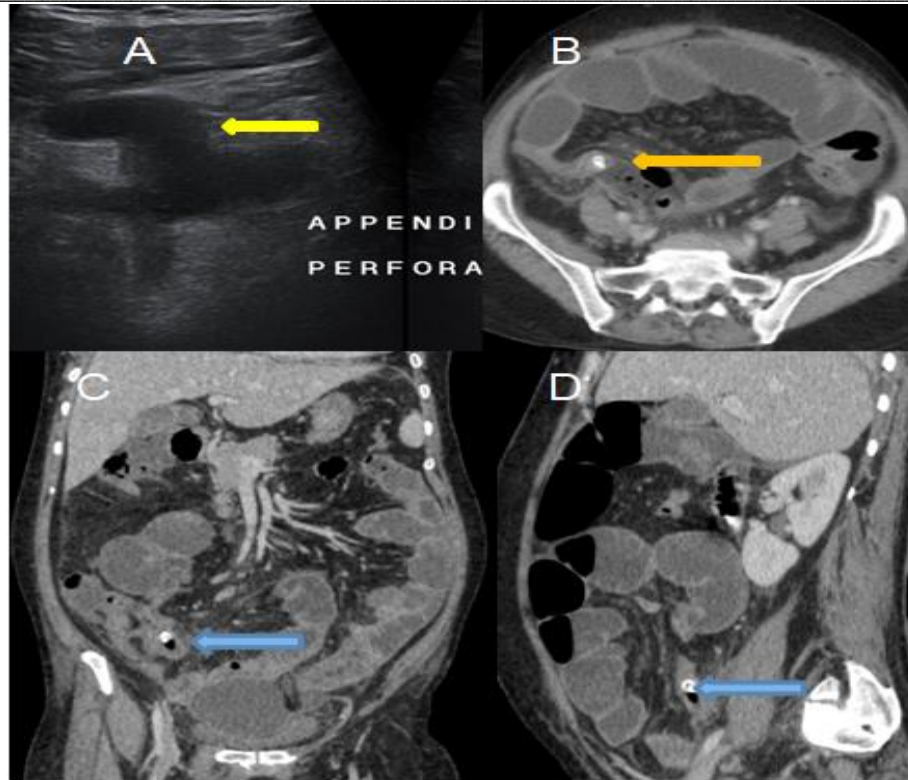


Fig 6: A 24yr old male presented with right iliac fossa pain, vomiting and fever On examination right iliac fossa tenderness was elicited. On USG, (A) Appendix is not visualised and collection is noted and due. Axial, (B) coronal, (C) and Sagittal (D) CECT revealed dilated Appendix (Yellow arrow) in RIF with Appendicolith (Blue arrow) within lumen. Minimal collection with multiple air pockets were noted in the peri Appendiceal region suggestive of perforation of Appendix which was confirmed on surgery.

Discussion

This study was carried out in a tertiary institution. Patients who came to emergency department with complaints of fever, pain abdomen, nausea/vomiting and with clinically suspected Acute Appendicitis which were examined by the surgeons and referred to the department of radiology for USG and CECT abdomen and pelvis to rule out Acute Appendicitis, followed by surgery and HPE, were considered as study population. Patients who did not undergo any of the imaging like USG or CECT abdomen and pelvis were excluded from the study. It may be the unwillingness of patient to undergo both USG and CECT abdomen and pelvis. It may be due to various other causes like absence of consent, previous history of contrast allergy, pregnancy, deranged renal parameters where contrast injection is contraindicated. All the 75 patients showed probe tenderness in right iliac fossa. Appendix was visualized in 63 (84%) patients with diameter measuring ≥ 6 mm in majority and maximum being 10.3mm (in one patient) and minimum was 6mm (in 5 patients). Edematous wall thickening (>2 mm) was noted in 30 patients (48.4%). Peri-Appendiceal collection was noted in 11(14.6%) patients. Increased vascularity of wall was noted in 8(10.6%) patients. In the remaining 13 patients (17.3%) Appendix was not visualized in USG however it was detected in CT. Out of 12 USG negative cases, CT was positive in 8 cases which was confirmed in HPE. From the remaining 4 USG negative cases, 3 were negative and 1 was positive on HPE. Out of the 63 positive cases of USG, 62 showed positive and 1 case showed negative findings of Appendicitis on surgery followed by HPE. (Table1) So in USG, true positive cases were 62, False positive 1, false negative 9 and true negative 3. So sensitivity, specificity,

Positive predictive value, Negative predictive value and Diagnostic accuracy was calculated to be 87%, 75%, 98%, 25% and 85% respectively. According to a study done by Mostbeck G et al sensitivity, specificity, Positive predictive value, Negative predictive values of USG in diagnosing Acute Appendicitis were 83.7%, 95.9%, 92.2% , 89.8% and 93.2% respectively which is showing similar values as of our study, except NPV. The possible explanation for significantly lower negative predictive value of our study is non-visualization of Appendix in USG there by unable rule out Acute Appendicitis in maximum cases. The causes of non-visualization of Appendix could be due to many causes like overlapping bowel gases, obesity, operator dependency and severe tenderness over RIF not allowing compression in RIF. In a study done by Yu SH et al , they found sensitivity and specificity of USG were 86.7% and 90.0% respectively. Kaiser et al in a study found that the sensitivity and specificity of USG to be 80% and 94%, respectively, whereas the sensitivity and specificity of CT were 97% and 93%, respectively. Among the 75 patients, 54(72%) cases showed peri appendicular collection on CT. Maximum appendicular diameter was found to be 15 mm in one patient and minimum 6mm in two cases. Peri appendicular fat stranding is the most common CT finding in our study which was found in maximum 72 cases (96%). Appendicolith was found in 47 cases (63%). CT was found positive for Acute Appendicitis in 71(94.6%) patients and negative in 4(5.3%) patients. Out of 4 CT negative patients 3 were also found to be negative and 1 was found to be positive in surgery followed by HPE. (Fig 4) So for CT True positive is 70, true negative is 3, false positive is 1 and false negative is 1. So sensitivity, specificity, PPV, NPV and diagnostic accuracy was calculated to be 98%, 75%, 98%,

75% and 97% respectively. (fig 2) According to Paulson EK et al, (2003) the sensitivity, specificity and positive predictive values of 90-100%, 91-99%, 95-97% respectively. According to them USG had a sensitivity, specificity and positive predictive value of 75-90%, 86-100%, and 89-93% respectively. According to a study done by Hlibczuk V et al, the sensitivity, specificity of CT in diagnosis of Acute Appendicitis was 92.7% (95% CI 89.5%-95.0%) and 96.1% (95% CI 94.2%-97.5%) respectively which is similar to our study. According to different studies in past two decades the sensitivity of

USG is ranging from 33% to 91.7%, specificity from 60% to 97%, PPV from 92% to 100%, NPV from 15% to 76% and accuracy from 67% to 89% respectively. For CT using different protocols like NCCT, oral, rectal and IV contrast, rectal and IV contrast and only IV contrast the sensitivity ranges from 86% to 99%, specificity from 87% to 100%, PPV from 91% to 100%, NPV from 33% to 99% and accuracy from 75% to 99% respectively. There is no significant statistical difference using different CT protocols (Reference from Table 3)

Table 3: Different Studies showing Sn, Sp, PPV, NPV and Accuracy of USG and CT

Study	Year	USG					CT					HPE/Surgery
		SN	SP	SUR	NPV	AC	SN	SP	PPV	NPV	AC	
E J Balthazar et al	1994	76	89	GERY	76	83	96	91	96	95	94	+
CJ Sivit et al	2000	78	93	+	-	89	95	93	-	-	94	+
D Pickuth et al	2000	89	74	92	63	-	95	87	97	92	-	
Lisa H.Lowe	2001	88	91	+	-	-	97	100	-	-	-	
Scott W.Wise	2001	33-35	85-89	-	-	73-75	86	91	-	-	87	
Teruhiko Terasawa	2004	86	81	+	-	-	94	95	-	-	-	
Gamanagatti	2007	67.3	75	-	15.8	71.2	95.8	100	100	60	90.3	
Betzalel Reich	2011	68.4	86	-	-	-	94.5	95	100	-	-	
Petroianu	2012	90	90	-	-	-	95	95	-	-	-	
Debnath	2015	81	88		71.6	83	96	89	93.5	93	93	+
Hanfei Zhang et al	2017	89	97	-	-	-	95	92	-	-	-	

Ahmed F. El-Deek	2017	91.7	77.8	-	70	88.9	98.8	88.9	98.8	88.9	97.8	+
Jing Wu	2017	85.5	95.5	+	15.4	66.7	87	87.8	97.7	33.3	75	+
Ashraf Othman Sayed et al	2017	55.6	85	-	-	71	97.8	100	-	-	99.3	
Mikayla E Hwang	2018	86	94	100	92	-	95	94	95	99	-	
Mohamed Aly El-Horbity	2020	83.3	66.6	90.9	50	80	95.4	75	91.3	85.7	90	+
Hameed Kadhem	2020	86.5	60	98.1	15	85.4	-	-	-	-	-	+

In present study, Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value, and Accuracy of USG is

84%, 67%, 98%,15%, and 85% respectively and for CT the Sensitivity, Specificity, Positive Predictive Value, Negative

Predictive Value and Accuracy of CT is 98%, 100%, 100%, 75% and 99% respectively which falls within the range found in the past studies and corroborates the finding with the studies.

Limitations of the study

1. Small sample size.
2. Suspected Acute Appendicitis in pregnancy with inconclusive USG finding could not be subjected for further CT correlation due to radiation hazard. Hence comparison between USG and CT modalities could not undertaken.

Conclusion

USG should be the primary imaging modality in all the patients with right iliac fossa pain or Acute abdominal pain is as it is readily available, least expensive and has no radiation hazard. So preferred in pregnant and paediatric patients. All the patients with abdominal pain showing probe tenderness over right iliac fossa in USG should be meticulously evaluated for inflamed Appendix. USG has certain limitations like operator dependency, variable resolutions and technical issues like extensive gaseous distension of abdomen, obesity and inability to give adequate compression in Acute severe abdominal tenderness. CECT has distinct advantage over Ultrasound in these situations. CECT abdomen and pelvis has more sensitivity, specificity, PPV, NPV and diagnostic accuracy in comparison to USG in the diagnosis of Acute Appendicitis. It also helps to identify the different anatomical locations thereby helping surgeons in treatment planning. So in cases of Acute Appendicitis which are undetected on USG should undergo CECT abdomen and pelvis for further evaluation.

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