

**Computed Tomography in Diagnosing Appendicitis in Ultrasound Negative Patients****M. Kishore<sup>1</sup>, Kishore Chautakuri<sup>2</sup>, Sarah Aishwarya E<sup>3</sup>, Abdul Rahman<sup>4</sup>**<sup>1</sup>Assistant Professor, Department of Radiology, Government Medical College, Siddipet, Telangana State<sup>2</sup>Associate Professor, Department of Radiology, Government Medical College, Siddipet, Telangana State.<sup>3</sup>Assistant Professor, Department of Radiology, Government Medical College, Siddipet, Telangana State<sup>4</sup>Assistant Professor, Department of Radiology, KBN Medical College, Gulbarga, Karnataka

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**Abstract****Background:** Appendicitis is the most common cause of abdomen pain in patients admitted at the emergency department. The two most common modalities in use are abdominal helical computed tomography (CT) and abdominal ultrasound (US).**Aim and Objective:** To evaluate the accuracy of CT in identifying appendicitis in ultrasound negative cases.**Material and Method:** This was hospital based observation study conducted on 120 patients, visited to Department of Radiology, Government Medical College, Siddipet, due to the right lower quadrant pain and negative USG findings, for the duration of one year, after following inclusion and exclusion criteria given below and also after approval of institutional ethical committee.**Results:** In the study we have included 120 patients, after their consent, of them majority were males followed by females. Majority of patients were from the age group of 21 – 30 years of age followed by 10 – 20 years and more than 30 years. Sensitivity and specificity of computed tomography in predicting appendicitis was 100% and 90.54% with accuracy of 94.17%.**Conclusion:** CT is the gold standard imaging modality to diagnose acute appendicitis in order avoid appendectomies in this Morden era but also ultrasound can be used as the first line imaging tool in diagnosing appendicitis.**Keywords:** Appendicitis, Computed tomography, Ultrasound etc.This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.**Introduction**

Appendicitis is the most common cause of abdomen pain in patients admitted at the emergency department. It may be associated with vomiting, fever and diarrhoea but the most distressing symptom is the pain. The various cause of the abdomen pain may vary from benign to life threatening disease. Traditionally, the diagnosis of appendicitis is mainly based on history, findings at physical examination, and results of laboratory tests. The rate of negative findings for appendicitis at laparotomy or laparoscopy based on these parameters may be as high as 50% [1–3]. On the other hand, a delay in the diagnosis and treatment of appendicitis may increase the potential risk of a complicated clinical course [4].

An imaging study allows an objective confirmation of the diagnosis before an invasive procedure is performed. The two most common modalities in use are abdominal helical computed tomography (CT) and abdominal ultrasound (US). Both are considered to have acceptable sensitivities, specificities, and

positive and negative predictive values, though CT has been shown to be superior in numerous studies. The introduction of CT has led to a marked decrease in the rate of negative appendectomy, as much as 48% in one institution. Abdominal ultrasound is safer, relatively inexpensive, and multiple meta-analyses demonstrate a satisfactory sensitivity and positive predictive value, though inferior to that of CT [5-9]. In Israel, for example, US is often the initial imaging study of choice, followed by CT for inconclusive cases [10]. In the United States, CT is currently recommended as the first-line test in the case of suspected appendicitis, and its use is increasing [11-13]. And due to common prevalence of acute appendicitis in general surgical practice, a surgeon is often confronted with a diagnostic dilemma. Surgical intervention is not only a major undertaking from surgeon's point of view but also from the perspective of patients and their relatives. They often insist on avoiding surgery if possible. These circumstances demand accurate diagnosis of appendicitis to avoid negative appendectomy.

Thus considering these all above issues, this study has undertaken, to evaluate the accuracy of CT in identifying appendicitis in ultrasound negative cases.

### Materials and Methodology

This was hospital based observation study conducted on 120 patients, visited to department of Radiology, Government Medical College, Siddipet, due to the right lower quadrant pain and negative USG findings, for the duration of one year, after following inclusion and exclusion criteria given below and also after approval of institutional ethical committee.

#### Inclusion Criteria :

- All patients suspected to have appendicitis and show negative findings in ultrasound.
- Those who were willing to participate in the study.

#### Exclusion criteria

- Patients who show typical findings of appendicitis in ultrasound.
- Patients who are medically unfit to undergo contrast study like renal failure patients.
- Patients with hypersensitivity reactions.
- Pregnant patients.
- Not Willing

#### Methodology

The clinical history concerning present history was taken within the prescribed proforma. Informed consent was obtained from every taking part patient. General examinations, vital signs were noted.

#### ❖ USG protocol

A routine USG was done in GE Company machine for the abdomen and pelvis employing a 3-5-MHz convex transducer to rule out various abnormalities associated with solid organs and to rule out free fluid. Then ranked compression and color Doppler ultrasound of the right lower quadrant giving attention to the location of maximal tenderness was performed employing a linear transducer.

The normal appendix was envisioned as a blind ended loop with no vermication. The graded compression technique is employed to displace the intestine loops, permitting differentiation between incompressible inflamed appendix and compressible

normal intestine loops. The presence of appendicitis is diagnosed as a tubular blind-ended structure seen anterior to the iliac vessel and it is non compressible with diameter greater than 6mm. Increased peripheral vascularity seen in the wall of the appendix on doppler study due to the mural inflammation.

Periappendicular fat stranding, appendicolith and peritoneal fluid and some other additional findings were also identified. On average of total time of 15-20 min was taken for a single study. The USG findings was reported as positive or negative for acute appendicitis. Other findings or diagnosis when achieved, was also reported.

#### ❖ CT Protocol

Examinations were performed on a 16 – slice MDCT using (CANON) at 120 kVp and 100 mAs. CT abdomen and pelvis were taken from xiphoid process to the pubic symphysis, with 80 mL of non-ionic contrast material Iohexol 350 (Omnipaque 350). The contrast material was injected in the volar aspect elbow in the cubital vein through a 18- gauge cannula at a flow rate of 4 ml/s and delay of 50 sec. Axial reconstructions from the raw data were done at 3 mm thickness. No oral contrast was used.

In reporting format normal appendix when visualised was reported. The CT report was positive, negative, or inconclusive. The criteria for appendicitis is similar to that of USG. Alternative diagnoses or other findings if any when achieved were reported.

#### Statistical Analysis

Collected data were entered in the Microsoft Excel 2016, for further statistical analysis. Categorical data were expressed in terms of frequency and percentages. Chi-square test was used to know association between variables, diagnostic test was used to predict sensitivity, specificity and others. Statistical analysis was done with the help of statistical software SPSS version 25.

#### Results and Observation :

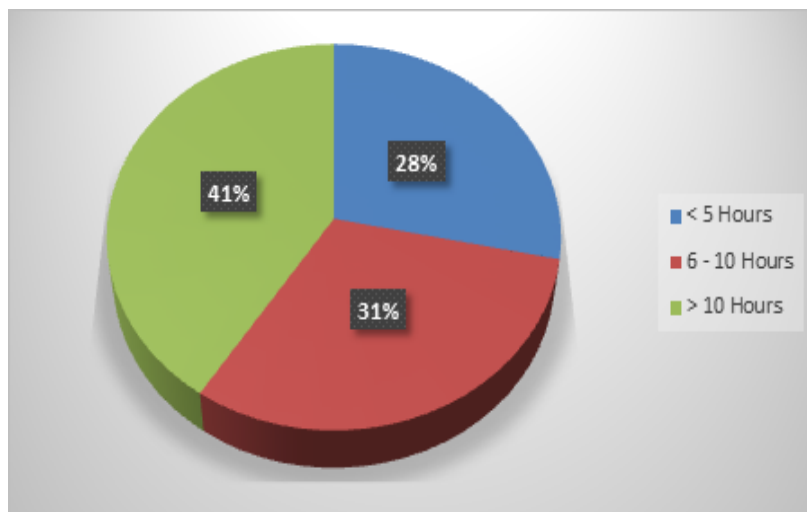
In the study we have included 120 patients, after their consent, of them majority were males followed by females. Majority of patients were from the age group of 21 – 30 years of age followed by 10 – 20 years and more than 30 years of age shown in the below table.

**Table 1: Demographic Profile among study population.**

Parameters	Frequency	Percentage
Age		
10 - 20 Years	35	29.17
21 - 30 Years	64	53.33
> 30 Years	21	17.50
Gender		
Male	94	78.33
Female	26	21.67

**Table 2: Distribution of Complaints among the study population**

Complaints	Frequency	Percentages
Abdominal Pain	120	100.00
Vomiting	15	12.50
Constipation	4	3.33
Fever	59	49.17
Low Back Ache	16	13.33
Painful Micturition	18	15.00



**Figure 1: Distribution of duration of pain among the study population**

**Table 3: Distribution of Complaints among the study population**

Observation	Frequency	Percentage
On USG		
Free Fluid	20	29.17
Mesenteric Lymphadenitis	30	53.33
Normal	68	17.50
On Computed Tomography (CT)		
Retrocaecal	102	85.00
Pelvic	11	9.17
Pre and Post Ileal	5	4.17
Other	2	1.67

**Table 4: Distribution of Complaints among the study population**

Diameter	Appendicitis		Total	P-value
	Present	Absent		
< 6 mm	0(0%)	67(91%)	67(56%)	<0.001
6-7 mm	5(11%)	7(9%)	12(10%)	
7-8 mm	30(65%)	0(0%)	30(25%)	
>8 mm	11(24%)	0(0%)	11(9%)	
Total	46(100%)	74(100%)	120(100%)	

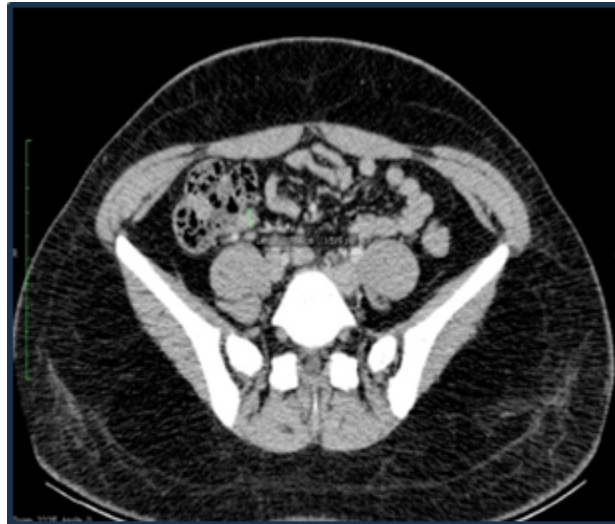
Above table showed that there was statistically significant association between finding of appendicitis and diameter level.

**Table 5: Distribution of Complaints among the study population**

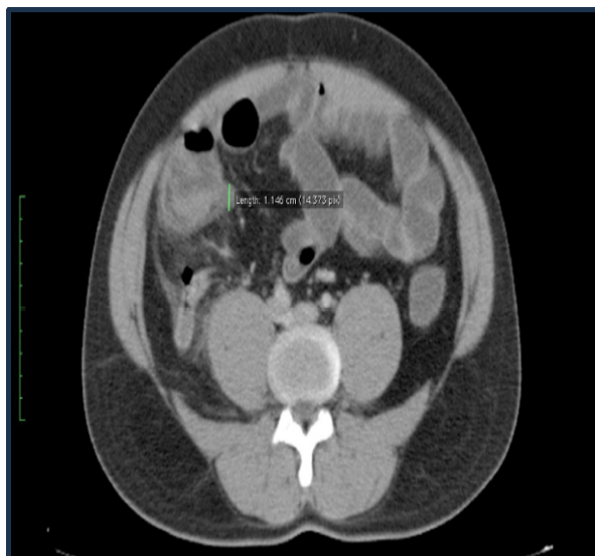
Diameter	Appendicitis		Total
	Present	Absent	
≥ 6 mm	46(100%)	7(9%)	53(44.17%)
< 6 mm	0(0%)	67(91%)	67(55.83%)
Total	46(38.33%)	74(61.67%)	120(100%)
<b>Diagnostic Test</b>			
Sensitivity	100.00%	92.29% to 100.00%	
Specificity	90.54%	81.48% to 96.11%	

PPV	86.79%	
NPV	100.00%	
Accuracy	94.17%	88.35% to 97.62%

**Case 1:** 17 years female c/o vague abdominal pain for 5 days with no evidence of fever, vomiting. CT shows appendix of diameter 7.5mm with peripancreatic fat stranding and no evidence in USG



**Case 2:** 38 years male c/o right lower quadrant pain on and off for past 3 months. TLC-4400cells/mm<sup>3</sup>. thickened appendix of diameter 11.2 mm with no evidence of fat stranding and no evidence of wall enhancement with no significance in USG.



## Discussion

Abdominal imaging is currently indicated in all but the most straightforward cases of appendicitis [14]. 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 [15]. CT clearly has its advantages, with sensitivity approaching 100% and the ability to perform the study in a way that is not operator dependent, and in patients in which ultrasound is difficult to perform, such as those who are obese [15,16]. Worldwide, CT scans are being increasingly performed as the

primary imaging modality over USG in suspected patients of appendicitis, especially for adults apparently for the sake of higher accuracy but with a relative disregard for the associated radiation burden. Literature is abundant with publications documenting higher accuracy of CT scan as compared to USG for diagnosing appendicitis.

In our study we have undertaken, 120 patients visited to Department of Radiology, due to the right lower quadrant pain and negative USG findings. Among all predominance of the male patients was observed compared to female in our study, also majority of patients were from the age group of 21 –

30 years of age followed by 10 – 20 years and more than 30 years. All the patients had Abdominal pain, 49.57% of the patients were suffered with fever followed by Low backache, vomiting and Painful Micturition. Though the USG findings did not show inflamed appendix, 30 patients were found to have mesenteric lymphadenitis and 20 patients had free fluid. Retrocaecal position of appendix was the commonest position found on CT 102(85%). This could explain the difficulty in detection in USG due to overlying bowel gas shadow.

Out of the CT criteria for acute appendicitis, the appendicular enlargement (>6 mm in diameter) has been shown to be the most specific CT finding of acute appendicitis with the highest sensitivity and negative predictive value [17, 18]. In most cases, identification of an enlarged appendix with contrast enhancement of the wall and periappendicular fat stranding allowed for the definitive diagnosis of acute appendicitis, and other signs were additional findings [18]. The diameter of appendix (measured from outer to outer wall) was assessed in all patients. In our study a diameter of more than 8mm was found in 11 patient and a diameter of 7-8mm was found in about 30 patients.

Nuno pinto Leite *et al.* on September, 2004 proposed that: Appendix diameter < 6mm or > 6mm diameter with gas filled appendix or 6 – 10 mm appendix without any other CT signs mentioned as “possible appendicitis”. 6 – 10 mm appendix with wall thickening (i.e. >3mm of wall thickness) and wall hyperenhancement with or without fat stranding as “Probable appendicitis”. Appendix diameter greater than 10mm or 6 to 10mm with wall thickening and wall hyperenhancement and fat stranding as “Definite appendicitis”.

In the present study, CT showed sensitivity of predicting appendicitis with sensitivity of 100% and specificity of 90.54% and a positive predictive value of 86.79%

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%.

Choi *et al.* [19] proposed complication of appendicitis like appendicular perforation/ abscess,

peritonitis, bowel obstruction, gangrenous appendicitis is mostly assessed by ultrasound but in few equivocal cases CT helps to come diagnosis, also they also stated that “Visualisation of appendicolith on CT increases the probability of appendiceal perforation. This is due to appendicolith increases the rate of appendicular perforation. Thus, presence of one or few appendicolith with periappendiceal inflammation is virtually diagnostic of perforation. Wagner *et al.* [20] (From 1995- 1999 and 2000-2007) found that CT imaging before appendectomy decreases negative appendectomy rate from 16% to 5% in both adults and children without increase in perforation rate.

large systematic review on 9121 patients of 25 studies reported a sensitivity of 83.7 %, a specificity of 95.9 %, an accuracy of 92.2 %, a positive predictive value (PPV) of 89.8 % and an NPV of 93.2 % for the US diagnosis of AA. [21]

### Conclusion

From the overall observation and discussion with other studies, we can undoubtedly conclude that CT is the gold standard imaging modality to diagnose acute appendicitis in order avoid appendicectomies in this Morden era but also ultrasound can be used as the first-line imaging tool in diagnosing appendicitis, because of its good reasons like short acquisition time, low cost and importantly free from ionized contrast agent and free from radiation exposure.

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