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DIAGNOSTIC ACCURACY OF COMPUTED TOMOGRAPHY FOR ACUTE APPENDICITIS KEEPING HISTOPATHOLOGY AS A GOLD STANDARD

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Abstract:
Aim: *To determine diagnostic accuracy of computed tomography in the diagnosis of acute appendicitis keeping histopathology as a gold standard.*
Study Design: *A Cross Sectional study.*
Place and duration: In the Department of Radiology, Khyber Teaching Hospital, Peshawar for six months duration from
Methods: *A total of 191 patients suspected of having acute appendicitis were included in the study by a non probability consecutive sampling technique and subjected to CT pre-operatively and histopathology post operatively for the acute appendicitis.*
Results: *The mean age of the patients was 29.5 ± 6.7 years. We had 53.4% males & 46.6% females. On CT we observed that the acute appendicitis was recorded in 58.1% of patients compared to 47.6% on histopathology. On applying the formulae for calculation, sensitivity of CT was found to be 89% and specificity 70%. The positive predictive value of the CT is 72.9% and negative predictive value is 87.5%.*
Conclusion: *CT is a highly sensitive and specific tool for the detection of acute appendicitis. As such, it is a useful radiological marker for diagnosis of acute appendicitis in adults and further studies are recommended to confirm its usefulness.*
Keywords: *Acute appendicitis, computed tomography, total leucocyte count, ultrasound, histopathology*

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INTRODUCTION:

Appendix is a small pouch attached to the beginning of large intestine.[1] Appendicitis, an inflammation of the appendix, is the most common acute surgical condition of the abdomen with lifetime risk of appendectomy of 12% for men and 25% for women.[2] Surgical removal of such inflamed appendix is the most commonly performed emergency operation in the world [3] and has long been considered the standard procedure of treatment of appendicitis. [4] If left untreated, this diseased appendix has the potential for severe complications, like perforation or sepsis. [2] Its peak incidence is between the ages of 10 and 30 years. [5] Differential diagnosis of appendicitis is often a clinical challenge because appendicitis can mimic several abdominal conditions.[6] Traditionally, acute appendicitis has always been a clinical diagnosis based on patient history, physical examination, and laboratory testing [7]. A high percentage of negative appendectomies (20%) was considered reasonable, based on the premise that delay would inevitably lead to perforated appendicitis and thus increased morbidity and even mortality [8]. This classical practice is currently being abandoned by most surgeons, as negative appendectomies are no longer considered acceptable. They carry a substantial morbidity, increase hospital costs and may be avoided by using preoperative radiological imaging or diagnostic laparoscopy [9]. There has been a continuous search for complementary diagnostic methods to limit the number of "unnecessary" appendectomies without delaying the diagnostic and therapeutic process and without increasing perforation rates [10]. Preoperative imaging has gained wide acceptance due to the improved diagnostic accuracy, with computed tomography (CT) outperforming ultrasound (US) in most studies [11]. The diagnostic modalities, however, that are considered to be the most accurate for making the diagnosis appendicitis, such as CT and laparoscopy, also have negative repercussions. Computed tomography exposes the patient to considerable ionizing radiation, and laparoscopy is an invasive procedure performed under general anaesthesia and thus carries a risk of morbidity [12]. Thus, use of imaging modalities such as ultrasonography (US) and computerized tomography (CT) has helped to decrease the rates of perforation, morbidity and mortality, in addition to shortening the length of hospital stay [10]. Although both US and CT are tomographic modalities, CT is not limited by its tomographic technique, as it is capable of delineating a wide, sequential field of view, unlike US which is constrained by its field of view and sections which are only as sequential as intervening structures and patient cooperation will allow [13]. In one study positive and negative predictive values for the clinical diagnosis of appendicitis were 94 and 97% respectively for CT. The negative appendicitis rate was 3.3% and the perforation rate was 23.5% [14]. In another study, the sensitivity & specificity of CT in detecting appendicitis was 94% 95% respectively [15].

The present study is designed to determine the diagnostic accuracy of CT in the diagnosis of acute appendicitis keeping histopathology as gold standard. Appendicitis is not uncommon in our population and early diagnosis and early treatment is of utmost importance to reduce morbidity and mortality particularly due to perforation. This study will provide us with a quick marker for diagnosis of appendicitis in our population presenting with clinical suspicion of appendicitis and if found to be significantly high, we will share the results of this study to other local surgeons and to formulate future recommendations for it.

MATERIALS AND METHODS:

This Cross sectional study was held in the Department of Radiology, Khyber Teaching Hospital, Peshawar for six months duration from14 November 2015 to 13 May 2016.

A total of 191 patients with acute appendicitis were selected by a non-probability consecutive sampling technique. The expected sensitivity of CT was 91% and specificity was 69%. The Prevalence of acute appendicitis was 10% with 95% confidence level and 13 percent marginal error.

SAMPLE SELECTION:

Inclusion criteria:

1. All patients presenting with clinical features suspicious of acute appendicitis as specified in the operational definition
2. Age group 18-45 years and either gender.
3.

Exclusion criteria:

1. Patients with history of surgical intervention in the abdomen in the last one month.
2. Patients with symptoms of Urinary Tract infection (dysuria, Urgency, frequency) with positive Urine R/E findings &/ or renal/ ureteric calculi on ultrasound
3. Patients with Renal insufficiency (serum urea of >50mg/dl and creatinine of >1.1mg/dl)

The above mentioned conditions act as confounders and if included will introduce bias in the study results.

DATA COLLECTION PROCEDURE:

The study was conducted after approval from hospitals ethical and research committee. All patients presenting to OPD with high suspicion of acute appendicitis was included in the study. The purpose and benefits of the study was explained to the patient, they was assured upon the purpose and benefits of the study, the risks involved and they was explained that the study is done purely for research and data publication and if agreed upon a written informed consent was obtained from the parents of the neonate.

All patients having suspected acute appendicitis clinically with symptoms as defined in the operational definition and fulfilling the inclusion criteria was subjected to CT Scan examination which was performed at the department of Diagnostic Radiology, Khyber Teaching Hospital, Peshawar using a multi-slice CT scanner (SOMATON Sensation or Definition, Siemens Medical Solutions USA, Inc., Malvern, PA). 145 cc of Isovue-300 IV contrast at a rate of 2 cc/s just prior to the scan was given. Serial 3-mm axial images was obtained from the diaphragm through the perineum. Additional delayed images was obtained through the lower abdomen after the patient asked to lay on the right side for 10 min.

Once done with CT, all the patients was subjected to appendectomy and biopsy was obtained. All surgeries was performed at the department of Surgery , Khyber Teaching Hospital using the same standard technique.

All the biopsy investigations was done by the histopathologist at the department of Pathology, Khyber Medical College, Peshawar. All the radiological investigations was done by single expert radiologist having minimum experience of five years. All the above mentioned information was recorded on a pre designed proforma. Strictly exclusion criteria was followed to control confounders and bias in the study results.

DATA ANALYSIS PROCEDURE:

The collected data was entered in SPSS version 20 and analyze through it, study variable was CT findings and Histopathology report. Frequency and percentage was calculated for catagorical variables like gender. Mean $\pm$ SD was calculated for continuous variables like age, Sensitivity, Specificity, positive predictive value (PPV), negative predictive value (NPV) was determined by taking Histopathology as gold standard from 2x2 table. All the results was presented in the form of tables and graphs.

Histopathology acute appendicitis

	+	-
+	a	b
-	c	d

CT:

Acute Appendicitis
Sensitivity of CT = (a / a+c) x100
Specificity of CT = (d / b + d) x 100
Positive predictive value (PPV) for CT = (a / a +b) x100
Negative predictive value (NPV) for CT = (d / c +d) x100
Accuracy of CT= (d + a) /overall patients
a = True positive, b = False positive, c = False negative, d = True negative

RESULTS:

The study was conducted on 191 patients suspected of having acute appendicitis. The mean age of the patients was 29.5 $\pm$ 6.7 years. The range of age in our study was 23 years with minimum age of 19 years and maximum age of 42 years. On grouping the sample in different age groups, we observed that 26.2% of patients were in the age group up to 25.00 years, 47.1% were in the age group 25.01 to 35.00 years and 26.7% of patients were in the age group 35.01 to 45.00 years (Table 1)

Table 1 shows the AGE-WISE DISTRIBUTION OF SAMPLE (n=191)

	n	Range	Minimum	Maximum	Mean	Std. Deviation
Age of the patient	191	23.00	19.00	42.00	29.5136	6.73198

Age Groups	Frequency	Percent
Up to 25.00 years	50	26.2
25.01 to 35.00 years	90	47.1
35.01 to 45.00 years	51	26.7
Total	191	100.0

While distributing the patients with regards to gender, we observed that in our study 53.4% of the sample was male and 46.6% were female gender. (Table 2)

Table 2 shows the GENDER-WISE DISTRIBUTION OF SAMPLE (n=191)

Gender	Frequency	Percent
Male	102	53.4
Female	89	46.6
Total	191	100.0

On CT, we observed that the acute appendicitis was recorded in 58.1% of patients. (Table 3)

Table 3 shows the FREQUENCY OF ACUTE APPENDICITIS ON CT (n=191)

Acute Appendicitis on CT	Frequency	Percent
Positive	111	58.1
Negative	80	41.9
Total	191	100.0

After surgery, acute appendicitis on histopathology was recorded in 47.6% of patients. (Table 4)

Table 4 shows the FREQUENCY OF ACUTE APPENDICITIS ON HISTOPATHOLOGY (n=191)

Acute Appendicitis on Histopathology	Frequency	Percent
Positive	91	47.6
Negative	100	52.4
Total	191	100.0

On applying the formulae for calculation, sensitivity of CT was found to be 89% and specificity 70%. The positive predictive value of the CT is 72.9% and negative predictive value is 87.5%. (Table 5).

Table 5 shows the CT & HISTOPATHOLOGY 2 x2 TABLE (n = 191)

		Acute Appendicitis on Histopathology		Total
		Positive	Negative	
Acute Appendicitis on CT	Positive	81 TP	30 FP	111
	Negative	10 FN	70 TN	80
Total		91	100	191

The Sensitivity of CT: TP/TP + FN was 89%, Specificity of CT: TN/TN + FP = 70%, Positive Predictive of Value CT: TP/TP + FP = 72.9% and Negative Predictive Value CT: TN/TN + FN was 87.5%.

DISCUSSION:

The clinical appreciation of a patient with suspected appendicitis remains challenging as it is complicated by nonsurgical diseases that mimic appendicitis. The

accuracy of the clinical diagnosis is approximately 80%, which corresponds to a negative appendectomy rate of around 20%[94]. This flaw in diagnostic accuracy has traditionally been accepted as it was considered most important to perform an early operation. Quality assurance focused on perforated appendicitis rather than negative appendectomy rates. This practice has become less accepted for several reasons: the morbidity and costs associated with a negative appendectomy are substantial and there is ample evidence that preoperative imaging can reduce the negative appendectomy rate and lessen the use of hospital resources. Even though some institutions have reported contradictory results, preoperative imaging for all patients with suspected appendicitis is gaining support. Another reason for abandoning indiscriminate explorations for suspected appendicitis is new insights into the natural history of appendicitis. These challenge the belief that the perforated appendicitis rate is inversely related to the negative appendectomy rate and thus avoidable by urgent appendectomy. Perforated appendicitis rates are not influenced by in-hospital delay and have not decreased with the increasing use of CT imaging. Evidence suggesting that resolving appendicitis is common can clarify this phenomenon. Quality assurance should therefore focus on the accuracy of the preoperative diagnosis, and not on the urgency with which it is made. CT is the degree of inter-observer variability among radiologists. Simple agreement in non-enhanced CT and contrast-enhanced CT interpretation for the diagnosis of acute appendicitis ranges from 80% to 97% and varies with specific radiologic findings (eg, appendicolith versus wall thickening). Studies assessing inter-observer variability report fair to excellent agreement according to a statistic. Of course, the experience and training of the radiologists may have an effect on the accuracy of interpretation. Two recently published meta-analyses comparing CT and ultrasonography in the diagnosis of appendicitis reported similar results to ours, with respect to the ability of CT to rule out appendicitis. The negative likelihood ratio of 0.08 according to our SROC analysis was consistent with that reported by van Randen et al. Terasawa et al [12] reported summary estimates of 94% (95% CI 91 to 95%) for sensitivity, 95% (95% CI 93 to 96%) for specificity, and 0.09 for the negative likelihood ratio. Terasawa et al125 observed that the test characteristics among the individual studies were similar despite variation in the use of contrast and CT technology but methodological limitations may have inflated estimates of diagnostic accuracy. As with any diagnostic test that does not have perfect sensitivity or specificity, CT cannot exclude appendicitis with 100% certainty and must be interpreted within the clinical context. Depending on the individual patient's condition and circumstances, clinical judgment must be used when deciding to perform contrast-enhanced or unenhanced CT for suspected appendicitis. 7.3% summary estimate for the false-negative rate is within the range of false-negative rates (3% to 17%) reported in a systematic review that included various CT contrast protocols [13]. The ultimate goal of CT imaging in patients presenting with abdominal pain suspicious for appendicitis is to make a prompt diagnosis and decrease the rate of appendectomies performed on patients without appendicitis. Although some authors have reported a decrease in the rate of appendectomies performed on patients without appendicitis with the use of helical CT14, others argue that there has been little change in the rate of surgical intervention or rate of perforation15. Unfortunately, these observations were made using older technology and this type of outcome data has not been reported since the introduction of multislice CT. In patients in whom the appendix has already perforated, as is the case in 20%–32% of paediatric patients at presentation, the diagnosis of perforation by using CT has been shown to have a sensitivity and specificity of 94.9% and 94.5%, respectively, in a retrospective, mixed-population study133 of pediatric and adult patients scanned with variable techniques. In the prospective study of 139 patients by Garcia Pena et al, the normal appendix was identified by using US 2.4% of the time and by using CT 84% of the time. Kaiser et al[129] visualized a normal appendix in 6% of patients with US and in 12% of patients with CT, an effect that may be related to a collimation of 7 mm in patients 6 years and older; however, by using a collimation of 3 mm, visualization of the normal appendix was as high as 94.1% in children older than 6 years, even without the use of any contrast material. These facts, and the surgeon's confidence in the imaging findings, translate into fewer unnecessary operations. In a retrospective study of 299 paediatric patients in a paediatric hospital, the negative appendectomy rate following US was 18%, compared with 2% in patients examined by using CT. In a retrospective study of 150 children, 78 of whom underwent US and 72 of whom underwent unenhanced CT, the rate for negative appendectomy following US examinations was 8%, and it was 0% following CT examinations. In a more recent computerized decision model on cost-effectiveness of US and CT that was based on lifelong survival data, which assumed a linear no threshold cancer risk and that was in turn based on Japanese survivor data, Wan et al found that for US to be more effective than CT, tube currents would need to exceed 547 mA in girls and 722 mA in boys. The computer model also predicted differences in

strategic cost effectiveness, depending on the disease prevalence: When the prevalence of disacquisition ease is low, 4% in males and 7% in females, US was a more effective imaging strategy; however, when the frequency was greater, a strategy that included CT was more effective. In other words, a modality without radiation exposure is more effective in a population relatively free of disease, despite its lower sensitivity; however, as the prevalence of the disease increases, the cost-effectiveness of CT also increases.

In conclusion, as in many other conditions, imaging in patients with appendicitis should be performed as an adjunct to, not instead of, the physical examination. Patients who clinically have or do not have appendicitis do not need imaging for diagnosis. Patients with right lower quadrant pain and an equivocal clinical diagnosis should be triaged to imaging examination. CT scans should be used judiciously, by using scanning parameters that are appropriate for patient size, and should be optimized for diagnosis with a single pass; additional passes are additional examinations, which are typically unnecessary.

CONCLUSION:

CT is a highly sensitive and specific tool for the detection of acute appendicitis. As such, it is a useful radiological marker for diagnosis of acute appendicitis in adults and further studies are recommended to confirm its usefulness.

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