

ORIGINAL ARTICLE

Ultrasound as a Sole Diagnostic Modality for Diagnosis of Acute Appendicitis-an Experience from Tertiary Care HospitalFARYAL EID¹, AYESHA KHAN AFRIDI², SANA UROOJ³, USBA JAMIL⁴¹Women Medical Officer, Services Hospital Peshawar²District Surgeon, Services Hospital Peshawar³Women Medical Officer, Services Hospital Peshawar⁴Women Medical Officer, Khyber Teaching Hospital, PeshawarCorresponding author: Ayesha Khan Afridi, Email: Aisha.afridikhan@gmail.com**ABSTRACT****Background:** Acute appendicitis is among the most frequent causes of acute abdominal pain that necessitates emergency surgery both internationally and in our country. Ultrasound is a readily available diagnostic modality, however with advancement in its resolution power and technological advancements, its diagnostic accuracy is improving with every passing year.**Objective:** To evaluate the diagnostic accuracy of ultrasound in diagnosis of acute appendicitis**Methodology:** This descriptive cross sectional study was carried out in the Surgery department of Khyber Teaching Hospital, Peshawar from 20/6/2020 to 20/12/2020. A total of 165 patients presenting with acute appendicitis with duration of symptoms 1-2 days, patients in age between 18-65 years and both gender (male/female) were included. A detail history, clinical examination and routine laboratory investigations were performed as per study protocol. All the included patients were referred to radiology department for ultrasound for the diagnosis of acute appendicitis. Acute appendicitis on ultrasound was labeled as positive or negative according to criteria defined in operational definition. After surgery the specimen was sent to hospital laboratory for histopathology. Acute appendicitis on histopathology was labeled as positive or negative according to criteria defined in operational definition.**Results:** In the present study mean age was 41 years with SD \pm 11.76. 91. Based on diagnostic accuracy of ultrasound, the sensitivity was 91.71%, specificity was 62.5%, PPV was 97.95%, NPV was 27.77% and the diagnostic accuracy was 90.30%.**Conclusion:** Our study concludes that ultrasound has the sensitivity of 91.71%, specificity 62.5%, PPV 97.95%, NPV 27.77% and the diagnostic accuracy was 90.30% in diagnosis of acute appendicitis.**Keywords:** diagnostic accuracy, ultrasound, acute appendicitis, histopathology.**INTRODUCTION**

Acute appendicitis is among the most frequent causes of acute abdominal pain that necessitates emergency surgery both internationally and in our country.^{1,2} Despite significant improvements in diagnostic techniques, between 30% and 40% of patients still need the clinical judgment of surgeon's.³ This results in an increase in the incidence of negative appendectomy to around 20%, which entails implications of both morbidity and mortality.^{4,5} Atypical clinical presentations, which are relatively widespread since many inflammatory and non-inflammatory disorders mimic the clinical picture of the illness, are one of the main contributing factors in diagnostic pitfalls. Patients at the extremes of age and women in the reproductive age group are particularly susceptible to these diagnostic mistakes^{6,7}. Above all, the variety in the organ's anatomical placements makes the clinical situation more challenging⁸. The patient's medical history, physical assessment, and a few supplementary tests, notably the Total Leucocyte Count, play a significant role in the diagnosis of acute appendicitis (TLC). In order to improve diagnostic accuracy, scoring systems such the Alvarado⁷, Ohmann, and Eskelinen scores have been developed. Additionally, abdominal computerized tomography (CT scan) and ultra-sonography (USG), both of which have certain inherent limitations, are employed to aid in identification the condition. TLC is a commonly practiced test in the diagnosis of acute appendicitis. Its advantages include that it is a readily available and cheap investigation. However, surfing through the literature it is hard to find a sensitivity and specificity of TLC more than 83 % and 62.1 % respectively.⁹ So, the general surgeons need to amplify TLC with a diagnostic test, which is simple, cheap and readily available, so that a certain diagnosis can be made to avoid negative interventions. Abdominal USG is another practiced non – invasive nature investigation. A visible appendix on an ultrasound is a diagnostic indicator of acute appendicitis. But because it is dependent on the operator and the findings vary from "patient to patient depending on the radiologist's experience as well as patient factors like obesity, gas-filled gut loops in front of the appendix, and the quantity of inflammatory fluid surrounding the appendix, it failed to become widely used as a pillar of diagnosis in the disease". Additionally, studies have

shown that 72% of people without appendicitis may see a normal appendix¹⁰. Numerous investigations on the subject that have used CT scans suggest that their negative predictive value is about 98%¹⁰. It has also been suggested that there is very little probability of findings varying across different centres since the examination is not operator dependent. The cost of a CT scan is significant for our underprivileged people and is not generally accessible in our nation. In addition, it puts the patient at risk for severe radiation exposure as well as anaphylaxis from intravenous contrast agents. Finding a diagnostic instrument that not only has high sensitivity and specificity but is also quick, affordable, widely accessible, and operator independent is thus imperative. Hepatocytes generate the acute phase protein C-reactive protein (CRP), which is a marker for acute inflammation. Its levels rise in the blood within 4 to 6 hours after stimulation and peaks at around 36 to 48 hours. Many studies claimed higher sensitivity and specificity in diagnosis of acute appendicitis when CRP is combined with TLC levels.^{11,12,13} CRP is a very simple and noninvasive laboratory test. It does not carry any hazards to the patient's health. It is not operator dependent.

In one study conducted by Nasiri S et al¹⁴ had reported that the "sensitivity and specificity" of USG were 71.2% and 83.3% while for Alvarado score were 65.7% and 37.5%, respectively. 6 Another study conducted by Gujar N et al¹ had reported that the "sensitivity and specificity" of USG were 98.33% and 90% while for Alvarado score were 98.44% and 94.4%, respectively. The current study was conducted to evaluate the diagnostic accuracy of ultrasound in acute appendicitis by taking histopathology as gold standard.

MATERIALS AND METHODS

The current descriptive cross sectional study was carried out at the Surgery Department, Khyber Teaching Hospital, Peshawar. The study duration was from 20/6/2020 to 20/12/2020. Sample size was 165 patients calculated on EPI software for sample size calculation by taking 48%⁹ prevalence of acute appendicitis, 71.2%¹⁰ sensitivity, 83.3%¹⁰ specificity of USG, confidence interval of 95% and margin of error as 10%.

Patients presenting with acute appendicitis (Acute appendicitis was diagnosed on the basis of presence of all of the followings features: Sudden onset of moderate to severe pain (VAS >4) in right iliac fossa (assessed on the basis of history), "Vomiting (forcible ejection of gastric contents even once) assessed on the basis of history, tenderness in right iliac fossa on physical examination and raised White cell count of ≥ 10000 cm³ /dl assessed on laboratory investigation)" with duration of symptoms 1-2 days, age between 18-65 years and both gender (male/female) were included. Patients presenting with pain in right iliac fossa (RIF) but urine routine examination suggestive of urinary tract infection (presence of bacteria and WBC >10 on urine analysis), pregnant women, patients with appendicular Abscess, biliary colic (presence of gallstones on USG) and patients with appendicular mass, were excluded. Patients with ovarian Cyst (cysts having mean diameter >3cm on ultrasound, patients with history of alcoholism as it has been associated with increase in total bilirubin level were excluded from the study. Justification: These criteria are aimed to minimize confounding and bias in the outcome of study.

Written inform consent was obtained from all the participants. Study design and protocol was approved by hospital ethical committee. A detail history, clinical examination and routine laboratory investigations were performed as per standard protocol for all the patients included at the time of admission. Patients with suspension of acute appendicitis were referred to radiology department for ultrasound. All the radiological examinations were done exclusively by two consultant radiologists to minimize the observational bias using high resolution..... Acute appendicitis on ultrasound was labeled as positive if a non-compressible blind loop ≥ 6 mm in anteroposterior diameter was seen and indicative of acute appendicitis or negative if the above-mentioned criteria wasn't fulfilled. Post operatively surgical specimen were sent to hospital histopathological department for the histological confirmation of acute appendicitis. Histopathological findings of acute appendicitis were categorized in to four subgroups. Group A: Histologically normal appendix with no evidence of any acute inflammation. Group B: Inflamed appendix (focal acute inflammation in the mucosa) Group C: Gangrenous appendicitis (polymorphonuclear infiltration of the entire appendiceal wall with presence of necrosis) Group D: Perforated appendix (rupture of the appendiceal wall to the serosal Surface. Group B,C and D histopathological finding were labelled as positive while group A labeled as negative. All the data including age, gender, duration of symptoms, obesity, diabetes mellitus, hypertension, socioeconomic status, residence was entered in predesigned proforma. Sensitivity of the ultrasound was defined as the "ability of USG to identify those patients who have acute appendicitis out of total patients (confirmed by histopathology group A, B and C) and was determined as, True positives / (true-positives + false-negatives) x100". Specificity of ultrasound was determined as the ability of USG to correctly identify those patients who do not have acute appendicitis out of total patients not having acute appendicitis (confirmed by histopathology) and was determined as, True-negatives / (true negatives + false positives)x100. True positives were defined, if acute appendicitis is positive on ultrasound and also positive on histopathology. True negatives were defined, if acute appendicitis is negative on ultrasound and also negative on histopathology. False positive defined as if acute appendicitis is positive on ultrasound but negative on histopathology and False negative, if acute appendicitis is negative on ultrasound but positive on histopathology. All the data were analyzed using statistical package for software (SPSS) version 23. Mean and Standard deviation was computed for age of the patients and duration of symptoms. Frequencies and percentages were computed for gender, obesity, diabetes mellitus, hypertension, socioeconomic status, residence acute appendicitis on ultrasound, acute appendicitis on histopathology. Diagnostic accuracy, sensitivity, specificity, positive predictive value, negative predictive value was calculated by using 2x2 table (given below).

SN, SP, NPV, PPV, diagnostic accuracy were stratified with age, gender, duration of symptoms, obesity, diabetes mellitus, hypertension, socioeconomic status, residence to see the effect modifications by using 2x2 table.

Acute Appendicitis of Histopathology

	+	-
+	A	B
-	C	D

"Sensitivity of USG = (a / a + c) x 100

Specificity of USG = (d / b + d) x 100

Positive predictive value (PPV) for USG = (a / a + b) x 100

Negative predictive value (NPV) for USG = (d / c + d) x 100

Diagnostic accuracy= (d + a) /overall patients

a= true positive, b = false positive, c= false negative, d = true negative"

RESULTS

Demographic characteristics of the study population are given in table. Mean age was 41 years with SD ± 11.76 and mean BMI was 27 Kg/m² with SD ± 2.87 . In this study, 107 (65%) patients were presented on second day of their symptoms compared to 58(35%) who were present in less than 24 hours since the onset of the symptoms

Table 1: Demographic characteristics of the study population (n=165)

	Mean		Percentage	Total (n=165)
Age	41 years with SD ± 11.76			
Gender	Male	91	55%	165
	Female	74	45%	
Age groups	18-30	48	29%	165
	31-65	117	71%	
BMI	Obese	71	43%	
	Non-Obese	94	57%	
Diabetes Status	Diabetic	101	61%	165
	Non-Diabetic	64	39%	
Hypertension Status	Hypertensive	92	56%	165
	Non-Hypertensive	73	44%	
Duration of Symptoms (From presentation)	Day 1	68	35%	165
	Day 2	107	65%	

In the present study a total of 165 patients were observed in which 48(29%) patients were in age range 18-30 years, 117(71%) patients were in age range 31-65 years. Mean age was 41 years with standard deviation ± 11.76 .

Acute appendix on ultrasound was positive in 147(89%) patients and was negative in 18 (11%) patients. Acute appendix on histopathology was positive in 157(95%) patients and was negative in 8(5%) patients. Based on diagnostic accuracy of ultrasound, the sensitivity was 91.71%, specificity was 62.5%, PPV was 97.95%, NPV was 27.77% and the diagnostic accuracy was 90.30%. (Table :2)

Table 2: diagnostic accuracy of ultrasound

		Histopathology		Total
		Positive	Negative	
Ultrasound	Positive	144 TP	3 FN	147
	Negative	13 FP	5 TN	18
	Total	157	8	165

Sensitivity = 91.71% Specificity = 62.5% Positive predictive value = 97.95% Negative predictive value = 27.77% Diagnostic Accuracy = 90.30%

Stratification of diagnostic accuracy of ultrasound keeping histopathology as gold standard with respect to gender, BMI and duration of symptoms is mentioned in Table:3

Table 3: diagnostic accuracy of ultrasound with respect to gender, BMI & duration of symptoms

	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Diagnostic Accuracy
Males	91.86%	60%	97.53%	30%	90.10%
Females	92.85%	75%	98.48%	37.5%	91.89%
Obese	92.53%	75%	98.41%	37.5%	91.54%
Non Obese	92.13%	60%	97.61%	30%	92.42%
Day 1 (<24 hours)	97.72%	66.6%	98.07%	33.33%	91.37%
Day 2 (>24 hours)	92.07%	66.6%	98.89%	33.33%	90.65%

DISCUSSION

The most frequent surgical emergency affecting the abdomen is acute appendicitis. It is estimated that 6.7% to 8.6% of Westerners may get appendicitis at some time in their life. Although appendectomies are done in large numbers every year around the globe, there has not been a consistent approach to treating appendicular stumps ¹. Acute appendicitis is still often treated by an appendectomy, which may be done laparoscopically or openly. The most common procedure worldwide, appendectomy carries a lifetime risk of 12% for males and 25% for women ². Despite the growing popularity of laparoscopic surgery, open appendectomy is still widely practised around the globe. There are two basic methods for closing a stump: simple ligation and stump invagination ³. The mean age in the current research was 41 years, and the standard deviation was 11.76. 74 patients (45%) were female and 91 (55%) were male. Analysis of ultrasound's diagnostic accuracy revealed that it had a diagnostic accuracy of 90.30%, a sensitivity of 91.71%, a specificity of 152.65%, a PPV of 97.95%, and an NPV of 277.71%. Similar findings were found in another research done by Salahuddin O et al ⁹ in which 75 individuals with acute abdominal pain participated. Of them, 42 were hospitalized due to lower abdominal and right iliac fossa discomfort. In the end, 36 people (48%) with an acute appendicitis diagnosis were included in the research. With an age range of 60 to 78 years and a mean age of 65.5 +/- 4.2 years, there were 20 (56%) males and 16 (44%) women. 25 (70%) of the patients had an associated disease. In 32 (90%) individuals, stomach discomfort was a symptom, along with 17 (48%) cases of nausea and 9 (25%) cases of emesis. Leukocytosis, fever (>99°F), and right lower quadrant discomfort were among the symptoms in 26 (74%) of the individuals. An essential diagnostic and therapeutic modality was laparoscopy. Of the patients, 12 (33.3%) had perforated appendices, whereas 9 (25%) had gangrenous appendices. 12 individuals in all (33.4%) had problems. Patients with 153 delayed diagnoses (5-7 days), perforations (5-9 days), and surgical problems had significantly longer hospital stays (5-15 days). Cardiopulmonary arrest claimed the life of one patient, who had a history of ischemic heart disease. Similar findings were found in another research by Nasiri S et al ¹⁴ that evaluated 55 male and 20 female patients. Acute appendicitis affected 89.3% of these individuals. Ultrasonography's "sensitivity, specificity, PPV, NPV, and accuracy rate" were, respectively, 71.2%, 83.3%, 97.4%, 25%, and 72.4%. By using a cutoff point of 7 (MASS score), The

determined sensitivity was 65.7%, 37.5% specificity, 89.8% PPV, NPV of 11.5% and 62.7% accuracy. By using a cutoff point of 7, The determined sensitivity was 85.1%, 25% specificity, 90.5% PPV, NPV of 16.7% and 78.7% accuracy. of A different research by Gujar N et al. ¹, which evaluated 55 male and 20 female patients, found comparable outcomes. Acute appendicitis affected 89.3% of these individuals. Ultrasonography has a "sensitivity, specificity, PPV, NPV, and accuracy rate of 71.2%, 83.3%, 97.4%, 154.25 percent, and 72.4%, respectively.

CONCLUSION

Our study concludes that ultrasound has the sensitivity of 91.71%, specificity 62.5%, PPV 97.95%, NPV 27.77% and the diagnostic accuracy was 90.30% in diagnosis of acute appendicitis.

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