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THE EFFECTIVENESS OF ULTRASOUND IMAGING IN THE DIAGNOSIS OF ACUTE APPENDICITIS

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Abstract

Acute appendicitis is still one of the most common surgical abdominal emergencies. Ultrasound could increase the diagnostic accuracy in those patients presented with unclear symptoms and signs of acute appendicitis.

The aim of this study is to evaluate the effectiveness of U/S in the diagnosis of acute appendicitis. This prospective study was conducted at the department of general surgery in AL-Sader Teaching Hospital from June 2008 to October 2011. It included 129 patients suspected to have acute appendicitis. Ultrasound (U/S) was done for all these patients. There were (66) males represent (51%) and (63) females represent (49%). These patients are grouped according to gender, age, signs & symptoms, laboratory tests, operative finding, the result of U/S examination and histopathological result. Ultrasound was positive in (111) patients (86 %) and negative in (18) patients (14%). Six patients out of (18) had true negative results while (12) patients were false negative. Ultrasound sensitivity was (90 %) in diagnosing acute appendicitis, specificity was (66.6%), accuracy rate was (88.3%), positive predictive value (97.2%) and negative predictive value (33.3%).

It is concluded that U/S is a useful tool in providing valuable information for the diagnosis of suspected cases of acute appendicitis.

Introduction

Acute appendicitis is still one of the most common surgical abdominal emergency[1]. Because of overlap with other clinical conditions, and associated significant morbidity, which increase with diagnostic delay, no single sign, symptom or diagnostic test accurately confirms the diagnosis of appendiceal inflammation in all cases[2]. Over the 10-year period from 1987 to 1997, the overall appendectomy rate decreased in parallel with a decrease in incidental appendectomy[3]. This fact due to the use of the Alvarado score and the facility of modern investigations, tools like U/S, CT, and MRI. Several investigators have created diagnostic scoring systems in which a definite number of clinical variables is elicited from the patient and each is given a numerical value, the sum of these values is used to predict the likelihood of acute appendicitis.

The best known of these is the Alvarado score, which tabulate migration of pain, anorexia, nausea and/or vomiting, tenderness in the RIF, rebound tenderness, elevated temperature, leukocytosis, and shift of WBC to the left[4]. (table I):

Table I: Alvarado score

symptoms	Migratory RIF pain	1
	Anorexia	1
	Nausea & vomiting	1
sign	RIF Tenderness	2
	Rebound tenderness	1
	Elevated temperature	1
laboratory	Leucocytosis	2
	Shift to left	1
Total score	10	

In Alvarado score all the patients with score between 7-10 were regarded as probable acute appendicitis, all patients with score <7 were submitted to a period of active observation, during which, if patient clinical condition changed significantly, the score was reassessed[4-11].

An ultrasound test is a radiology technique, which uses high frequency sound wave to produce images of the organs and structures of the body, the sound waves are sent through body tissues with a device called a transducer[11]. The appendix on sonography is an ovoid or round blind-ending tubular structure, which shows no peristalsis. Often air can be found intraluminally. The anteroposterior diameter of a normal appendix is less than 6 mm, if the appendix is compressible an inflammation is unlikely[11].

Recommended criteria for the diagnosis of appendicitis are summarized[12] as demonstrated in table II.

Table II

1-Noncompressible
2-Diameter 7 mm or greater
3- Appendicolith
4-High echogenicity surrounding fat
5-Surrounding fluid or abscess
6-Oedemaof caecal pole
7-Maximal tenderness over appendix

The most common error in the diagnosis of appendicitis with U/S includes misinterpretation of the terminal ileum as the appendix and misinterpretation of the normal appendix as an inflamed appendix[12].

Adherence to the diagnostic criteria is of importance. Poor quality examination undoubtedly account for some diagnostic errors, if the inflammation is localized to only the tip of the appendix, it can be missed. Therefore you must visualize the entire length of the appendix to avoid a false negative diagnosis. Other problem is related to the position of the appendix that makes it more difficult to appreciate, particularly when it is in the pelvis or retrocecal. Perforation of the appendix may lead to decompression of the appendix, and this will removes the specificity of the U/S study and also lead to diagnostic errors[13,14].

Picture (I):- (Ultrasound examination of the right lower quadrant demonstrates a hyporeflective, non compressible structure with diameter of 8 mm .hyporeflective aspect of adjacent fatty tissue is due to inflammatory oedema).

As for the U/S technique to detect the vermiform appendix graded compression technique described by Puylaert was used[15]. This technique based on the fact that compression should be always applied in graded manner to avoid pain.

Pain during the U/S examination should not exceed the pain experienced by the patients during the careful physical examination.

Compressions useful in order: To displace and compress bowel loop. To decrease the distance between the transducer and the bowel. To asses if a lesion is rigid or not by judging it's reaction upon compression[15].

Visible appendix is not enough for diagnosis of acute appendicitis because the normal appendix is frequently visualized. So other criteria are needed for confirmation of the diagnosis[16].

In 70% of patients with acute appendicitis, the diagnosis is made clinically based on classic sign and symptoms. In the remaining 30% of patients with uncertain clinical finding radiological imaging is needed to establish the diagnosis[16].

Either graded compression sonography or CT scan can be utilized to evaluate patients with suspected appendicitis[16].

This prospective study aims to evaluate the effectiveness of U/S in the diagnosis of acute appendicitis and to determine the usefulness of its use to increase the diagnostic accuracy in those patients presented with unclear symptoms and signs of acute appendicitis.

Patients and methods

A prospective study conducted from June 2008 to October 2011, during these three years there were too many patients admitted to the surgical unit suspected to have acute appendicitis and it was possible to have an ultrasound result for only 129 patients, there were no selection criteria. All patients were admitted to the surgical ward in AL-Sader Teaching Hospital in Basrah.

Initially, patients suspected to have acute appendicitis were admitted to the emergency ward and a preformed data sheet included the name, gender, age, complete history, and physical examination was recorded, laboratory tests like WBC, and GUE were done to all patients while chest X-ray and plain abdomen X- ray was done to certain patients according to their presentation.

Ultrasound examination was obtained to all patients. Twenty nine patients had their U/S were already done in private clinics, for 60 patients U/S were done in our hospital during the working hours, while 40 patients had their U/S done outside the working hours.

All patients suspected to have acute appendicitis, regardless their U/S report, were admitted to the hospital. All the operations were done by the same surgeon. The appendix was removed by classical appendectomy through Grid iron or Lanz incisions and all the specimens were send for histopathological examination.

For statistical analysis, we calculated the estimated U/S results. These probabilities include sensitivity, specificity, positive and negative predictive values and accuracy. Sensitivity: is the conditional probability that a diseased person has a positive result:

Sensitivity =(TP/TP+FN)×100%

Specificity: is the conditional probability that a diseased free person has a negative result: Specificity=(TN/TN+FP)×100%

Positive predictive value (PPV): is the conditional probability that a person with a positive test result is truly diseased:

PPV=(TP/TP+FP)× 100%

Negative predictive value (NPV):is the conditional probability that a person with a negative test result is truly free of disease:

NPV= (TN/TN+FN)×100%

Accuracy = TP+TN × 100%

TP+TN+FP+FN

TP:True positive. FP:False positive

TN:True negitive FN:False negative.

Results

Among (129) patients suspected to have acute appendicitis who were included in our study, there were 66 males representing (51%) and 63 females representing (49%). Table (III). The age of patients range from 10 to 65 years with mean age was 37.5 years. Table IV. Table V, show the relation of WBC count in all patients suspected to have acute appendicitis.

Table III:The Gender distribution of the patients

sex	No. of patients	%
Male	66	51%
Female	63	49%
Total	129	100%

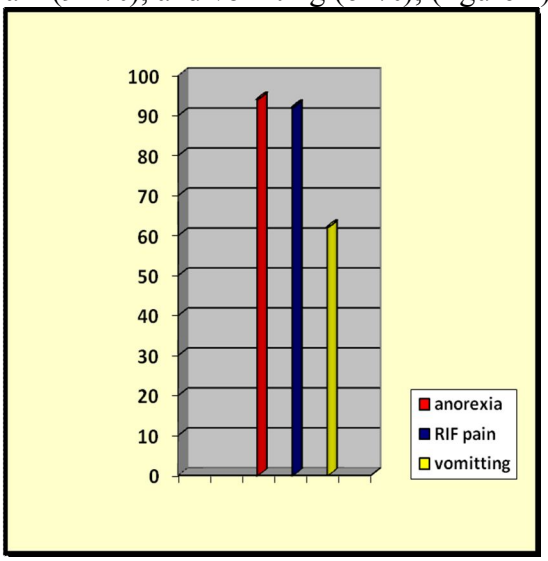
Table IV: The age distribution of the patients

Age(years)	No. of patients	%
20<	36	27.9
20-29	48	37.2
30-39	21	16.2
40-49	15	11.6
>50	9	6.9
Total	129	100

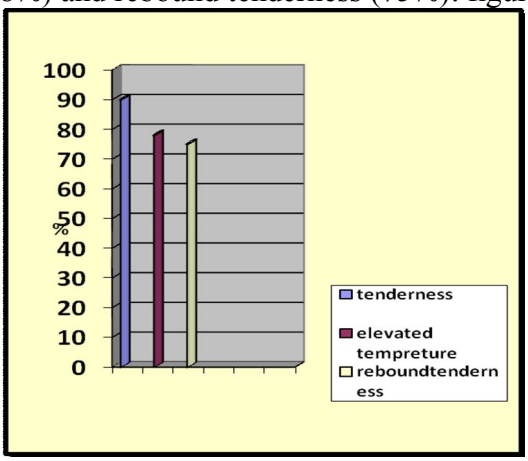
Table V

WBC count×109	No. of patients	%
4.0-11.0	77	59.6
11.1 -16.0	50	38.7
>16.1	2	1.5
Total	129	100

The patients were divided according to their most common symptoms: anorexia (94%), right iliac fossa (RIF) pain (92 %), and vomiting (62%), (figure 1)



They were also divided according to their most common signs: tenderness (90%), elevated temperature (78%) and rebound tenderness (75%): figure 2.



The U/S finding of acute appendicitis were positive in (111) patients and negative in (18) patients as in table VI.

Table VI

No.-%	U/S results		No.	%
111-86%	Positive	Noncompressible	81	72%
		Diameter >6 mm	52	%47
		Appendicolith	77	%69
		Echogenic fat	73	66%
		Fluid or abscess	47	42%
		Oedema of caecal pole	0	0
		Maximal tenderness	104	93%
18-14%	Negative			

Operation was done for all patients while 6 patients improved on conservative treatment and were discharged. The histopathological results of the specimens for all these patients who were operated on 123 are shown in the table VII.

Table VII: The data according to the histopathological results

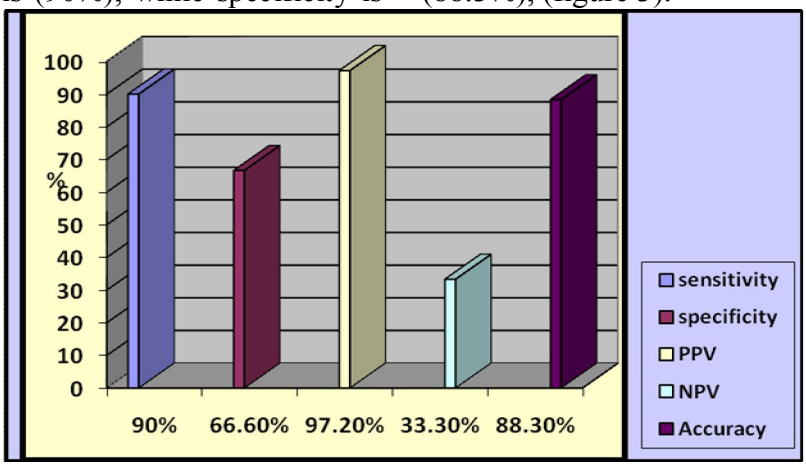
Result	No.of patients	%
Catarrrhel	63	51.2
Suppuration	22	17.8
obstruction	14	11.3
perforation	12	9.7
gangrenous	9	7.3
Normal	3	2.4
Total	123	100

The relationship between the U/S results, management, finding, and histo-pathological results was shown in the table VIII.

Table VIII

No.	U/S results	Management finding	histopathology
108 (83.7%)	True positive	Operative finding Acutely inflamed	61 catarrhal 18 suppuration 12 perforation 7 gangrenous 10 obstruction
3 (2.4%)	False positive	Operative finding Appendix not inflamed	normal
12 (9.7%)	False negative	Operative finding Acutely inflamed	7 catarrhal 3 obstruction 2 perforation
6 (4.8%)	True negative	Conservative treatment	No operation

According to this study, we can provide the following statistical variabilties; sensitivity of U/S in the diagnosis of appendicitis is (90%), while specificity is (66.6%),with positive predictive value (PPV) (97.2%), negative predictive value (NPV) (33.3%) and accuracy rate (88.3%), (figure 3).



Discussion

Ultrasound has been shown to be an excellent diagnostic technique for patients with acute appendicitis and may have major influence on the way of the treatment of those patients[17]. The first case report of the sonographic detection of an inflamed appendix was published 1981 by Preusser R[17]. A lot of studies followed that article to improve the criteria of U/S diagnosis, Jeffery RB et.al. on April 1987 confirmed that non–compressible appendix was the primary criterion for diagnosis of acute appendicitis. Jeffery returned on 1988 and added the diameter of the appendix whenever it was greater than 6 mm as another criterion[14].

Regarding the number of patients who were included in this study, there were 129 patients, and this number is small as compared to the number of patients in other studies, which was (250)[19], (452)[20] and (669)[21] patients. This is because we had no facilities for U/S out of the normal working hours and most patients in our study had their U/S during the working hours or in private clinics.

In this study, it was found that the peak incidence of acute appendicitis was between the age of 20-29 in both sexes, and this finding correlate with the finding of others[17,19,20,21].

The most common symptom was anorexia followed by abdominal pain and vomiting.

Maximum tenderness in RIF especially over Mcburney point was the most common sign followed by elevated temperature. As it is found in other studies mentioned below in table IX.

We have used the Alvarado score for assessment of our patients who were suspected to have acute appendicitis and did not depend only on the results of U/S to make our final decision.

In table VII, the histopathological result of the patients which were surgically managed. It was noticed that the majority of cases 120, (93%)) showed acute inflammation and it was catarrhal in 63 (51.2%), suppurative in 22 (17.8%), perforated in 12 (9.75%) and gangrenous in 9 (7.31%). Obstruction by fecolith was found in 14 (11.3%) while 3 patients (2.4%) had normal histopathology.

In comparing the result of U/S with the operative finding and histopathological reports, table VIII, it revealed that in 111 patients (86%), the U/S results showed one or more of the criteria of acute appendicitis and depending on this result together with our clinical judgement, surgery was done. For those patients, 108 (83.7%), they have inflamed appendix on histopathological examination (true positive).

Three out of (111) patients (2.4%), showed normal histopathological appearance of the appendix, one patient had rupture ovarian cyst and the other two were mesenteric lymph adenitis (false positive). When a normal appendix is affected by an adjacent lesion, reactive inflammation can cause secondary enlargement of the appendix giving a positive result of acute appendicitis[22,23]. This may be seen in women with a dilated fallopian tube or in inflammatory conditions such as tubo-overian abscess or Crohn's disease, which may secondarily affect the appendix.

Eighteen patients (13.9%), in whom U/S did not show sign of acute appendicitis, 6 of them where kept on conservative treatment because of our clinical judgement was not infavour of surgery, and all of these 6 patients were free of symptoms in the next 24 hours and were discharge home (true negative), while the other 12 patients (9.3%) underwent operations because there clinical presentation mandate surgery and all of them have histopathological finding of acute appendicitis (false negative).

False negative occur in retrocecal appendicitis, perforated appendicitis or in pregnant patients. In our study we believe it was due to the difference in the expert skills of the radiologist and the model of the instrument.

According to our results the sensitivity was (90%) and specificity was (66.6%) and accuracy rate (88.3%) and this is compared with the work of the others as show in table IX.

Table IX

No	study	No. of patients	sensitivity	Specificity	accuracy
1	Jeffery RB et al.198819	250	89.9%	96.2%	93.9%
2	Puylaert et al.,198722	111	75%	100%	-
3	Borushok et al.,199023	100	86%	60%|	-
4	Rama chardranP et al., 199620	452	90%	96%	95%
5	Zielke-A. et al.,199821	669	80%	96%	93%
6	Our study 2011	129	90%	66.6%	88.3%

Conclusion: Ultrasound has gained widespread acceptance as a reliable, highly accurate and highly sensitive modality in evaluation of patients with acute appendicitis. It may clearly outline those patients who require surgery or other form of intervention, so it can provide rapid, effective diagnostic

information to guide appropriate clinical management.

The usage of U/S in examination is very useful to detect unclear clinical diagnosis of acute appendicitis in some patients and especially in females. And in experienced hands graded compression sonography has more than 80% accuracy for diagnosing acute appendicitis[24].

Recommendations: It is suggested that arranging a U/S examination for those patients who have atypical clinical signs and symptoms of acute appendicitis.

We suggest that U/S should be available in the hospital during twenty four hours and the result should be reviewed and interpreted by experience radiologists.

Advantages with sonography include lower cost and real time observation of bowel peristalsis.

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