

Predictive Value of Alvarado Score and Ultrasound in the Diagnosis of Acute Appendicitis (A prospective study)

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Abstract

Background: Acute appendicitis is the commonest non traumatic cause of acute abdominal pain that needs surgical management .Alvarado score and ultrasonographies are the most cost effective, easy and available aids for diagnosis. The aim of the study was determining the reliability of Alvarado score and ultrasound in the diagnosis of acute appendicitis.

Patients and method: A prospective non-interventional study including patients admitted with suggestive history with signs and symptoms of acute appendicitis to the surgical emergency ward of Baghdad teaching hospital from July 1st 2017 to Feb 10th 2018, Alvarado score calculated and ultrasonography done for each patient enrolled in this study, then to be followed for intraoperative findings.

Results: The study was applied with 100 cases with different types of abdominal pain at presentation with 51 males and 49 females .The sensitivity was97.3% ,specificity 90%, and accuracy 89 of combined usage of Alvarado score and U/S findings preoperatively..

Conclusions: Combined application of Alvarado score and U/S has sensitivity 94.1% ,specificity 90% and accuracy 89% . In our medical facility and emergency ward, acute appendicitis remains as one of the top acute abdominal emergencies needing surgery in patients presenting with atypical clinical finding. So diagnosis becomes difficult. So Alvarado score along with ultrasound findings are useful for increasing the reliability in emergency department for accurate diagnosis of acute appendicitis therefore there should be training for the use of U/S by emergency physician and general surgeon in the diagnosis of acute appendicitis in order to decrease the rate of negative appendectomies .

Keywords: Alvarado, ultrasound, acute appendicitis.

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Introduction :

Abdominal pain is one of the main causes of emergency department admissions in which case of acute appendicitis (AA) is one of the most inpatient surgical emergencies. The increase in mortality and morbidity rates occurs when the surgical intervention is delayed in acute appendicitis (1). Regarding the symptoms of AA , they may overlap with a variety of conditions ,which make the diagnosis of AA a strong challenge (2). Ultrasonography is simple, easily available, noninvasive, conventional and cost effective (3).A non-compressible appendix with a threshold outer diameter of 6 mm under compression is the most accurate US finding for appendicitis; with high sensitivity, specificity, PPV, & NPV (4) . The Alvarado score is a representative 10 point clinico-laboratory scoring system that was chosen for this study due to its ease and speed of application in emergency centers beside it is a well-tested and highly available scoring system (5).

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Leukocyte count of over 10,000/mm³ was considered elevated (6). Elevated leukocyte count is one of the helpful laboratory investigations in diagnosing acute appendicitis. It is an easily available and economical investigation that can be done in almost any laboratory round the day. It has been reported to be significantly predictive of appendicular inflammation in patients with provisional diagnosis of acute appendicitis (7).The role of multi-detector CT(MDCT) has an important role in the management undiagnosed acute abdominal conditions in the emergency department. Acute pancreatitis is one of the main cause of undiagnosed acute abdominal conditions (8) .The aim of the present study was determining the reliability of Alvarado score and ultrasound findings in the diagnosis of acute appendicitis.

Patients and Method:

Study designs and settings

A prospective non-interventional study carried out in Baghdad teaching hospital emergency department surgical ward in the period from 1st July 2017 to the Feb 10th 2018. Patients presented to the Emergency department of Baghdad teaching hospital mainly at surgical ward of emergency department were the core population of the study.

Inclusion & Exclusion criteria

The study included Any patient presented with abdominal pain above age of 12 years of suspicion of acute appendicitis mainly new onset abdominal pain migrating to or in the right lower abdomen.

Any patient with abdominal pain that matches with the following was excluded:

- 1- Patients with the diagnosis of appendicular mass.
- 2- Patients with the diagnosis of appendicular abscess.
- 3- All patients who were admitted under suspicion of diagnosis and not operated on and treated conservatively then discharged.

The Sample

Character of abdominal pain, blood parameters and ultrasonography findings were used as methods of diagnosis compared later on with the intra operative findings. The informations are recorded in a questionnaire form for the study. Alvarado score was calculated from the form as described in the literature. The Alvarado score is a 10 point scoring system used as a diagnostic aid for acute appendicitis based on signs and symptoms, WBC and neutrophil count. The result of summation of points of the score and the ultra sound findings were both compared with the surgical findings obtained from operative notes of case sheet files of admitted patients whether inflamed or not inflamed appendix. Regarding U/S findings, three criteria used:

- 1- Non compressible appendix.
- 2- Dilated lumen of appendix of ≥ 6 mm.
- 3- Clear periappendicular fluid collection.

Data collection:

Data were collected by the researchers through direct interview and full filling a designed questionnaire form prepared already from patients. Demographic features, Alvarado score elements, including signs and symptoms and laboratory results were included and analyzed in the form as main criteria. Full history and physical examinations of patients is done by emergency resident, then blood sample and laboratory data are obtained from each patient, also abdominal ultrasonography taken by radiologist resident or experience ultra sound practitioner. Final diagnosis was made by senior specialist surgeon in the emergency department and later on by histopathology if could be arranged.

Ethical consideration:

- Approval was taken from the honorable administration of Baghdad teaching hospital.
- Oral consent was taken from each patients include in this study.
- The researchers were responsible with other colleagues in providing examination and treatment for the patients.

Statistical analysis

All patients' data entered using computerized statistical software; statistical package for social sciences (SPSS) version 17 was used. Descriptive statistics presented as (mean, standard deviation), and

frequencies as percentages. Chi-square used for categorical variables (Fisher exact test) was used.

The sensitivity, specificity, and accuracy of diagnosis of appendicitis using preoperative ultrasound findings and Alvarado score in relation to real cases after surgery. In statistical analysis, the Level of significance (p-value) set at ≤ 0.05 .

Alvarado score (9):

Symptoms

- Migration of pain to right lower quadrant(score 1)
- Nausea,vomiting (score 1)
- Anorexia (score 1)

Sign

- Tenderness in right iliac fossa (score 2)
- Rebound tenderness (score 1)
- Elevated temperature (≥ 37.3 °C) (scoe 1)

Laboratory test

- Leukocytosis (score 2)
- Differential leukocyte count(neutrophils $\geq 75\%$) (score 1)
- Total (score 10)

Results:

The study included 100 patient 51 males & 49 females with age distribution ranged from 12 years to 71 years old. The distribution of types of presenting abdominal pain (table 1), showed that right lower abdominal quadrant pain was the highest percentage (54.9%) as presenting abdominal pain followed by periumbelical pain(29.4%), then followed by epigastric pain (9.8%) and the least presenting abdominal pain was generalized abdominal pain (5.8%). Ultra sound findings preoperatively (table 2) showed highest percentage for suspected cases in males 88, 80 (90.9%) of them were intra-operatively +ve and 8 (9%) were negative cases. While -ve U/S findings were total 12 with 7. 8% of them are +ve intra-operative findings. Evidence of statistics is showing that negative cases are higher in percentage in females than those with males, while in contrast with suspected cases in which males are higher than females. With overall Sensitivity was 94.1% and Specificity was 53.3% for Ultra sound findings. The gender distribution of Alvarado score preoperatively (table 3) showed higher percentage for patients with score ≥ 7 are 88, 79(89.77%) of them are +ve preoperatively,9 (10.2%) are -ve. those with score<7 are 12, 8 (66%) were +ve of them. The same table is showing that Alvarado score ≥ 7 is higher in percentage in males than females, while for score <7, it is higher in percentage in females than males. With overall Sensitivity was 95% and Specificity was 69.23% for Alvarado scoring system. Regarding sensitivity, specificity and accuracy of U/S in (table 4) it shows sensitivity of 94.1% ,specificity53.3 % and accuracy88 % with positive predictive value (PPV) 91% and negative predictive value (NPV) 61/5% . For Alvarado score, it is showing sensitivity of 95 %, specificity 52.9%, and accuracy of 88%.

Table 1: Distribution of sites of presenting abdominal pain (preoperatively) in each gender.

sites of abdominal pain of presenting cases	Males		Females	
	N o.	%	No.	%
Epigastric pain	5	9.804	2	4.082
General abdominal pain	3	5.882	7	14.286
Right lower abdominal quadrant pain (RLAQ)	28	54.902	18	36.735
Periumbilical pain	15	29.412	22	44.898
Total	51	100	49	100

Table 2: ultrasound U/S findings (preoperatively)

Genders	pre operative negative cases	intra-operative findings		preoperative suspected cases	intra-operative findings		Total	
		+ve	-ve		+ve	-ve		
		No.	%		No.	%		
Males	No.	6	3	3	45	41	4	51
	%	11.76	5.8	5.88	88.23	80.3	7.8	100
Females	No.	6	4	2	43	39	4	49
	%	12.24	7.8	4.08	84.3	79.5	8.16	100
Total	No.	12	7	5	88	80	8	100
	%	12	58.3	41.7	88	90.9	9.1	100

$\chi^2= 0.0066$, p-value= 0.996 (NS)

Discussion:

Acute appendicitis is a common emergency. Emergency physicians should have always a high index of suspicion regarding this disease mainly in cases of equivocal signs and symptoms. This fact makes diagnosis of acute appendicitis a challenging difficulty and a burden on the health system especially when the net result of this challenge becomes a negative appendectomy (10). Regarding the descriptive analysis that showed the mean value of age for males of 31.43years, while for females the mean value was 24.9 years, this can be explained by the frequencies of the gynecological conditions that mimic acute appendicitis at presentation to the medical facilities in such age groups (11). The finding of this study showed that the higher age prevalence of the cases was in adult group aged 21-30 years (43%) and the least prevalence was in the age group 41-50 years (3%), this result may be due to the resemblance with other pathological condition of acute abdominal pain at presentation in this age group . These results are concordant with other study results (Nasiri et al, 2012 (12)). Concerning the distribution of types of abdominal pain (table 1), it is shown that the highest prevalence for types of pain was for the right lower quadrant abdominal pain (RLQAP) ,to be proceeded as in sequence of prevalence , periumbelical ,epigastric & the least was the generalized abdominal pain. The result of our study finding is agreed with Samir et al, 2016 (13). It is proposed that this clinical finding is due to Luminal distention of the inflamed appendix, which in turn stimulates the T10 visceral afferent nerves, causing per umbilical pain typically

Table 3: Gender distributions and Alvarado score (preoperatively)

Genders		Less than 7	intra-operative		More than ≥ 7	intra-operative		Total
			+ve	-ve		+ve	-ve	
Males	No.	6	4	2	45	41	4	51
	%	11.76	7.84	3.92	88.23	80.39	7.84	100
Females	No.	6	4	2	43	38	5	49
	%	12.2	8.16	4.08	87.75	77.55	10.2	100
Total	No.	12	8	4	88	79	9	100
	%	12	66	33.3	88	89.77	10.2	100

$\chi^2 0.0197$ p-value= 0.990 (NS)

The results of this study showing that for both Alvarado and U/S findings in the diagnosis of acute appendicitis, sensitivity of 96.3 %, specificity 90% and accuracy 89%.

Table 4: Sensitivity, Specificity and Accuracy of diagnosis of appendicitis using pre-operative U/S findings ,Alvarado score each independently and U/S findings and Alvarado score together

Variable	Sensitivity	Specificity	Accuracy
U/S	94.1%	53.3%	88%
Alvarado score	95%	69.23%	88%
U/S &Alvarado score together	96.3%	90%	89%

lasting 4 to 6 hours, leading to delayed presentation followed by localization to the right lower quadrant of abdomen (14). Regarding ultrasound findings (table 2) showed that it is of diagnostic value in 88 patients,80 of them(90.9%) ,who were found to be positive intra-operatively, while in negative ultrasound findings of the remaining 12 patients,7.8% were positive intra-operatively, with higher percentage for +ve findings in males than females in whom diagnosis may interfere with other gynecological conditions that still not clear in many occasions ,these results are agreeable with kurane et al (15) & Samir et al (13) , with non-significant gender difference($\chi^2 =0.0066$, P-value =0.996) . These outcomes are due to the fact that ultrasound benefits are only worthy when coordinated with clinical presentation of a patient and there are evidence that ultrasonography alone may not deliver the optimum results, and may not be different in significant matter from outcomes obtained by scoring system .sensitivity & specificity of ultrasonography also is dependent on the experience of radiologist or the performer, that it reached in some studies to 90%of uncomplicated cases (16). Concerning gender distribution of preoperative Alvarado score (table 3), it has been shown that Alvarado score preoperatively was presented in high percentage in both males and females for score ≥ 7 than score <7 as mentioned in other study(17). These values, although are with no significant gender difference (p-value=0.990, $\chi^2=0.0197$), but these findings should make Emergency physicians consider other gynecological pathologies (11), such as ovarian cysts, ectopic pregnancy, adnexal torsion and tubo-ovarian abscess.

Other ultrasonically detectable alternative conditions are caecal and sigmoid diverticulitis, cholecystitis, perforated peptic ulcer, Crohn's disease, urological conditions, small bowel obstruction and caecal carcinoma (18). Regarding the sensitivity, specificity, and accuracy of diagnosis of acute appendicitis using preoperative ultrasound findings and the Alvarado score (table 4), we found that an Alvarado score alone in suspected cases for diagnosing appendicitis has sensitivity of 95%, specificity 69.2%, and accuracy of 88%. While U/S alone has the sensitivity of 94.1%, specificity 53.3% and accuracy 88%. It showed a higher sensitivity (96.3%), specificity (90%), and accuracy (89%) when Alvarado score is combined with U/S preoperative findings than when each is used independently. In other study, Ohle et al (19) demonstrated a sensitivity of 82.0% and a specificity of 81.0% by Alvarado score of seven as the cut-off value for the diagnosis of appendicitis; these values are less than that of our current study results. The study of Kurane et al (15) had the results of sensitivity 78.26%, specificity 83.78% and diagnostic accuracy of 81%. The study of Samir et al (13) reported in males and those with scores between five and eight should undergo further ultrasound investigations. These results in our study are also showing a higher accuracy in the diagnosis of Acute Appendicitis with a predominant of values favouring the Alvarado score over U/S. These results are agreeable with Kurane et al (15). From another aspect, it is important for the emergency medicine resident (EMR) to be aware that the use of objective scoring will be an aid to interpret patients, not only more reasonably but also more quickly, not to forget the difficulty experienced by the EMR in scoring, because most patients were unable to define the symptoms and relatives had to be asked for assistance. This is a common problem faced by physicians working in developing countries with low socioeconomic status (20). The essential role for ultrasonography may be for the equivocal case, in which a combination of ongoing clinical assessment and ultrasonography may provide the additional information required to determine whether appendectomy is necessary (20). Nevertheless, the routine application of ultrasonography has only reduced the rate of negative appendectomies but without any significant improvement in missed diagnoses (21). In comparison with our study the previous studies showed that ultrasonography has an overall sensitivity of 86% (from 75 to 92%) and a specificity of 96% (from 94 to 100%) (Zielke et al) (22). The differences among these results, whether regarding Alvarado or U/S findings, may be due to various reasons, including the study design, the number of patients, the experience of physicians and U/S performers, factors of duration of presentation and conditions which mimic gynecological pathologies and the variations in the durations of presenting symptoms or the statistical methods used (20). Also, regarding U/S findings these results may vary due to patients' factors as obesity or technical specifications of the devices. Regarding the results of (table 4) both Alvarado scoring and U/S findings

sensitivity of 96.3%, specificity 90% and accuracy 89%. The results of the current study are showing a higher accuracy in the diagnosis of Acute Appendicitis when both Alvarado score ≥ 7 & U/S findings are used in coordination than when used for evaluation independently, and in comparison with other studies as Kurane et al (15) & Samir et al (13). Javidi et al (23) performed a study that assessed ultrasounds of only patients with Alvarado scores between four and seven. The authors found that ultrasound in these groups had an overall sensitivity of 75.0%, a specificity 69.2%, and an accuracy of 73.6%. In a similar study by Douglas et al (18), ultrasound was only performed in patients with scores between five and eight; patients with scores of nine and ten underwent appendectomies, and patients with scores between one and four were discharged. Samir et al (13) reported U/S was 100% specific with Alvarado scores of six, seven and eight but sensitivity was less (51%). In other words, a positive ultrasound records 100% specificity for appendicitis, but a negative ultrasound can not necessarily exclude appendicitis.

Conclusion:

- 1) Alvarado scoring system is a non-invasive, safe diagnostic procedure that is simple, cheap, fast, and reliable. The application of this scoring system improves diagnostic accuracy.
- 2) Combined Alvarado score and U/S preoperative findings has:
 - a) Sensitivity 96.3%.
 - b) Specificity 90%.
 - c) Accuracy 89%.

Authors' Contribution:

Waleed S. Ahmed: data collector, analyzer & writing manuscript.

Salah M. Tajer: primary mentor & established investigator

Hend M. Sayaly: second mentor & established investigator.

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القيمة التنبؤية من مقياس ألفارادو والموجات فوق الصوتية في تشخيص التهاب الزائدة الدودية الحاد (دراسة إستطلاعية)

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د. هند محمود سيالي

الخلاصة

الخلفية: التهاب الزائدة الدودية الحاد هو السبب الأكثر شيوعاً من آلام البطن الحاد الذي يعالج جراحياً. إن مقياس ألفارادو للفحص بالموجات فوق صوتية هي الوسيلة الأكثر فعالية من حيث التكلفة وسهولة متاحة للتشخيص.

الهدف من الدراسة: تحديد موثوقية مقياس ألفارادو والموجات فوق الصوتية في تشخيص التهاب الزائدة الدودية الحاد.

المرضى والطريقة: دراسة إستطلاعية تشمل المرضى الداخليين مع علامات سريرية موحية وأعراض التهاب الزائدة الدودية الحاد إلى جناح الطوارئ الجراحي في مستشفى بغداد التعليمي من 1 يوليو 2017 إلى 10 فبراير 2018، تم حساب مقياس ألفارادو والموجات فوق الصوتية لكل المرضى المسجلين في هذه الدراسة، ثم متابعة النتائج أثناء العملية.

النتائج: تم تطبيق الدراسة مع 100 حالة مع أنواع مختلفة من الآلام في البطن عند العرض مع 51 ذكور و 49 إناث. وكانت الحساسية 97.3%، والخصوصية 90%، والدقة 89 من الاستخدام المشترك لمقياس ألفارادو والموجات فوق صوتية قبل الجراحة.

الاستنتاجات: أن مقياس ألفارادو جنباً إلى جنب مع نتائج الموجات فوق الصوتية مفيدة لزيادة موثوقية التشخيص الدقيق لالتهاب الزائدة الدودية الحاد لذلك ينبغي أن يتوفر التدريب اللازم لاستخدام جهاز الامواج فوق صوتية من قبل طبيب الطوارئ والجراح العام في تشخيص التهاب الزائدة الدودية الحاد من أجل تقليل معدل استئصال الزائدة الدودية السلبية.

كلمات المفاتيح: ألفارادو، الموجات فوق الصوتية، التهاب الزائدة الدودية الحاد.