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Comparative study between modified Alvarado score and abdominal ultrasound in the diagnosis of acute appendicitis

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Abstract

Aim & Objective: To compare the accuracy of modified Alvarado score and ultrasonography in the diagnosis of acute appendicitis to reduce the morbidity and mortality from appendicitis and also reduce the negative appendectomy rates

Methodology: This study was undertaken in 100 patients with a provisional diagnosis of acute appendicitis getting operated in Prathima Institute of Medical Sciences, Karimnagar from November 2016 to October 2018. Modified Alvarado score and USG findings were applied in the preliminary diagnosis, which was confirmed by intra operative and histopathological findings.

Results: Fifty five patients were females and forty five were males. There was no statistical significance in the male to female ratio. The highest incidence (37%) was found in the age group of 21-30 and the lowest (4% each) was seen in the age group of 51-60 & 61 & above respectively. Ninety nine patients presented with anorexia and tender RIF. Ninety eight patients had migratory RIF pain. Nausea & vomiting, rebound tenderness, and leucocytosis were seen in 58, 53 and 39 patients respectively. Only 27 patients had elevated temperature. Forty three patients had a score of >7 out of which 42 had appendicitis and 1 was normal on histopathological examination which contributed to 97.7% and 2.3% of the patients respectively. Sensitivity, specificity and accuracy of MAS was 44.6%, 83.3%, 47% respectively. Sixty one patients were found to have appendicitis by USG out of which 60 had appendicitis and 1 was normal on histopathological examination, with a sensitivity of 63.8% and a specificity of 83.3% & accuracy 65%. Ninety four patients were diagnosed to have appendicitis by histopathological examination and 6 were reported to be normal. Accuracy of ultrasound to diagnose acute appendicitis was 65% and MAS was 47%.

Keywords: mortality, morbidity, appendicitis, ultrasonography, Alvarado score

Introduction

Acute Appendicitis is one of the most common acute abdominal emergencies; the diagnosis of which is often challenging. It is estimated that as much as 6% to 7% of the general population will develop appendicitis during their lifetime, with the incidence peaking in the second decade of life ^[1, 2]. The diagnosis of acute appendicitis requires a high index of suspicion on the part of the examining surgeon to facilitate prompt treatment of this condition, thereby avoiding the substantial morbidity (and even mortality) associated with perforation. This disease has a lifetime prevalence of approximately 1 in 7.

Advances in modern radiographic imaging have improved diagnostic accuracy; however, the diagnosis of appendicitis remains essentially clinical, requiring a mixture of observation, clinical acumen and surgical science and as such it remains an enigmatic challenge and a reminder of the art of surgical diagnosis. Methods advocated to assist in the diagnosis of Acute Appendicitis include Ultrasonography ^[3], Scoring Systems ^[4, 5], Computed Tomography ^[6], Magnetic Resonance Imaging ^[7], and Laparoscopy ^[8]. Graded compression Ultrasonography is the least expensive and least invasive of the imaging modalities and has been reported to have the sensitivity of the range from 78% to 83%, whereas the specificity ranges from 83% to 93% according to various studies ^[9]. Furthermore, it has been argued that findings at Sonography should not supercede clinical judgment with the aid of clinical scoring in patients with a high probability of Appendicitis. This raises questions about whether Ultrasonography should be performed at all in patients at high risk and whether is there some reliable means of selecting those who can benefit from Imaging.

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We subjected all our patients to Clinical Scoring by Modified Alvarado Score and Ultrasound presenting to the hospital with clinical suspicion of Acute Appendicitis and excluding a few patients by exclusion criteria and findings were co-related with Histopathological findings after Appendicectomy, and thus sensitivity, specificity and accuracy of Modified Alvarado Score and Abdominal Ultrasound was evaluated.

Hence the main aim of the present study is to; Evaluate the sensitivity, specificity and accuracy of Modified Alvarado Score and Ultra sound (MANTREL Score) in diagnosing Acute Appendicitis co-relating with Histopathology in 100 patients.

Comparison of Modified Alvarado Score and Abdominal Ultrasound to diagnose Acute Appendicitis in 100 patients and reduce the rate of negative appendicectomy.

Materials and Methods

Source of data

This is a study of 100 patients with provisional diagnosis of acute appendicitis getting admitted and operated in the surgical department of Prathima Institute of Medical Sciences, Karimnagar from November 2016 to October 2018. Modified Alvarado score was applied and ultra sound abdomen was done using Siemens G-50, linear transducer 5-10 MHz, pre operatively. The decision for surgery was made independent of the score and ultra sound finding. Diagnosis of patients who underwent appendicectomy was confirmed by both operative finding and histopathology.

Criteria for acute appendicitis by Modified Alvarado score; Modified Alvarado Score ^[10]

	Clinical feature	Score
Symptoms	Migratory RIF pain	1
	Anorexia	1
	Nausea / vomiting	1
Signs	Tender RIF	2
	Rebound tenderness	1
	Elevated temperature	1
	Leucocytosis	2
	Total	9

Score of 7 to 9- Probable acute appendicitis
 Score of 5 to 6- Possible diagnosis of acute appendicitis
 Score of 1 to 4-Unlikely to have appendicitis

Criteria for acute appendicitis by ultra sound

Sonographically, appendicitis is suggested by the presence of pain on graded compression of the area in which abnormal appendix was seen as a tubular, blind ending, aperistaltic bowel loop which is non compressible with a diameter of 7 mm or greater in antero posterior direction. The presence of a fecolith or prominence of peri appendicular fat was an indirect sign. Ultra sonography was considered negative when the appendix could not be found or was normal, or if non appendicular pathology was discovered.

Criteria for appendicitis by histopathology

A histological criterion for the diagnosis of acute appendicitis is polymorphous leucocytic infiltration of the muscularis mucosa.

Exclusion criteria

1. Patients who have diagnosed to have other causes of right lower quadrant.
2. Age less than 14 years.
3. Pregnant females
4. Patients who were managed conservatively
5. Patients who had a palpable abdominal mass

Statistics

The results of Modified Alvarado score and ultra sound were correlated with the operative and histopathological examination using chi-square test.

Observation and results

In the present study, 100 cases were provisionally diagnosed of acute appendicitis and were operated during the study period.

Table 1: Age incidence

Age	Frequency	Percent
14 - 20	28	28.0
21 - 30	37	37.0
31 - 40	15	15.0
41 - 50	12	12.0
51 - 60	4	4.0
61 & above	4	4.0
Total	100	100.0

From the above table, in the present study, 37 patients were found in the age group of 21-30(37%), 28 patients were found in the age group of 14- 20(28%), 15 were found in the age group of 31-40(15%), 12 patients were found in the age group of 41-50(12%), and 4 each were found in the age group of above 51-60(4%) and 61 & above respectively.

Table 2: Sex incidence

Sex incidence	Frequency	Percent
F	55	55.0
M	45	45.0
Total	100	100.0

According to this study 55 patients were female and 45 patients were male.

Table 3: Mantrel Distribution

Mantrel	No of patients	p value
M	98	0.0001
A	99	0.0001
N	58	0.0049
T	99	0.0001
R	53	0.005
E	27	0.0047
L	39	0.0047

The above table shows the distribution of MANTREL. 99 patients had tenderness in the right iliac fossa and anorexia. 98 patients had migratory RIF pain. 58 patients had nausea and vomiting, 53 had rebound tenderness. Only 39 patients had elevated leucocytosis >10 x 10⁹ and 27 had fever. The p values of each of the above parameters, when individually compared to the histopathological report as seen in the table is <0.05 which is statistically significant.

Table 4: Modified Alvarado score distribution

		Outcome		Total
		Present	Normal	
Total 3		1	0	1
		100.0%	.0%	100.0%
4	A	14	2	16
		87.5%	12.5%	100.0%
5	A	14	3	17
		82.4%	17.6%	100.0%
6	A	23	0	23
		100.0%	.0%	100.0%
7	A	24	1	25
		96.0%	4.0%	100.0%
8	A	17	0	17
		100.0%	.0%	100.0%
9	A	1	0	1
		100.0%	.0%	100.0%
Total		94	6	100
		94.0%	6.0%	100.0%

From the above tables it is concluded that in our study, out of 100 patients, 1 patient had a score of 3 and histologically he was found to have appendicitis. 16 patients had a score of 4, out of which 14 had inflamed appendix and 2 were found to be normal. 17 patients had a score of 5 out of which 14 were inflamed and 3 were normal. 23 patients had a score of 6 and all had inflamed appendix. 25 patients had a score of 7, out of which 24 were inflamed and 1 was normal. 17 patients had a score of 8 and all were inflamed. Only one patient had a score of 9 and it was inflamed.

Table 5: Group wise sensitivity of Modified Alvarado score

Groups	Score	Appendicitis	Normal	Total	Sensitivity
III	1-4	15	2	17	88.2%
II	5-6	37	3	40	92.5%
I	7-9	42	1	43	97.67%
Total		94	6	100	94%

From the above tables in the present study, 43 patients were included in group I among which 42 were found to be acute appendicitis and 1 was normal on per operative and histopathological examination with sensitivity of 97.67%. 40 patients were included in group II among which 37 were appendicitis and 3 were found to be normal with a sensitivity of 92.5%. 17 were included in group III, among which 15 were appendicitis and 2 were normal with a sensitivity of 88.2%. The overall sensitivity was found to be 94%.

Table 6: Overall sensitivity of MAS

		Outcome		Total
		Present	Normal	
Modified Alvarado score	A	42	1	43
		97.7%	2.3%	100.0%
	N	52	5	57
		91.2%	8.8%	100.0%
Total		94	6	100
		94.0%	6.0%	100.0%
		100.0%	100.0%	100.0%

From the above table it is seen that 97.7% of patients who were thought to be positive by modified Alvarado score (>7) actually had acute appendicitis by histopathology whereas 2.3% of the patients were actually normal by histopathology. From this the

sensitivity of MAS is calculated to be 44.7%.

91.2% of the patients who were thought to be normal by Modified Alvarado score (<7) actually had acute appendicitis by histopathology while 8.8% of patients who were thought to be normal by Modified Alvarado score were actually normal by histopathology.

Thus the sensitivity, specificity and accuracy of MAS to diagnose acute appendicitis in our study is 44.6%, 83.3%, 47% respectively.

Table 7: USG findings with histopathological findings

		Outcome		Total
		Present	Normal	
USG	A	60	1	61
		98.4%	1.6%	100.0%
	N	63.8%	16.7%	61.0%
		34	5	39
Total		87.2%	12.8%	100.0%
		36.2%	83.3%	39.0%
		94	6	100
		94.0%	6.0%	100.0%
		100.0%	100.0%	100.0%

According to the above table it is seen that 98.4% of the patients who were diagnosed to have appendicitis by USG truly had appendicitis by histopathology and 1.6% of the patients who were diagnosed to have appendicitis by USG were normal by histopathology. 87.2% of the patients who were said to have normal appendix by USG actually had appendicitis by histopathology while 12.8% of the patients who were said to have normal appendix by USG were really normal by histopathology. Thus the sensitivity, specificity and accuracy of ultrasound to diagnose acute appendicitis in our study is 63.8%, 83.3%, 65% respectively.

Table 8: Correlation of Modified Alvarado score, USG with per-operative and histopathological examination of the appendix

	Appendicitis	Normal	Total
MAS	43	57	100
USG	61	39	100
Per-op and HPE	94	6	100
Total	198	102	300

Table 9: Correlation of sensitivity, specificity and accuracy of MAS & USG in the diagnosis

	MAS	USG
Sensitivity	44.6%	63.8%
Specificity	83.3%	83.3%
Accuracy	47%	65%

From the above data, we can infer that abdominal ultrasound has higher sensitivity and accuracy when compared to modified Alvarado score in the diagnosis of acute appendicitis.

Discussion

The main aim of the clinical decision making process is to reach an accurate diagnosis in the fastest and cheapest way. Appendicitis still poses a diagnostic challenge and many methods have been investigated to try to reduce the removal of a normal appendix without an increase in the rate of perforation. In an attempt to increase the diagnostic accuracy several scoring systems were devised. The best-known scores are the Alvarado score, the modified Alvarado score, the Pediatric Appendicitis Score, the Appendicitis Inflammatory Response score, and the

RIPASA score. These tools not only can be used for diagnostic purposes but also for stratification, separating those patients who require observation and workup from those who can be assigned for certain specific treatment. The aim of these scores is to reduce the number of negative appendectomies without increasing the number of perforations.

The Alvarado score was described in 1986^[11] and since then has been evaluated and validated in many studies. It consists of three symptoms, three clinical signs, and two laboratory tests. This system uses a simple mnemonics (Mantrels) that is easy to remember and can be applied in many settings without the need of a computer. The symptoms are migration (one point), anorexia-acetonuria (one point), and nausea/vomiting (one point). The clinical signs are tenderness in the right lower quadrant (two points), rebound pain (one point), and elevation of oral temperature (37.3°C or more) (one Point). The basic laboratory tests are a complete blood count (CBC) to look for leukocytosis (>10,000 cells/mm³) and a differential white blood count (WBC) looking for left shift (increased stabs >5% or segmented neutrophils >75%).

In order of decreasing importance, the best predictive factors proved to be localized tenderness on the right lower quadrant, leukocytosis, migration of pain, shift to the left, temperature elevation, nausea or vomiting, anorexia or acetone in the urine, and direct rebound pain. Two points are assigned to the more important factors (tenderness and leukocytosis) and a value of 1 for each one of the others, for a possible total score of 10. A score of 4–5 is compatible with the diagnosis of acute appendicitis, a score of 7 or 8 indicates a probable appendicitis, and a score of 9 or 10 indicates a very probable appendicitis. To this score the clinician could subtract two points if the patient complains of headache because this symptom is very rare in cases of acute appendicitis. In this particular situation, the patient may need further investigation to rule out a different disorder.

Scores of 5 or 6 are in a gray area, and in this case, the clinician may want to observe the patient for a short time (reevaluate every 4–6 hours) for 12–24 hours, and if the score remains, the same consider other tests such as ultrasound or diagnostic laparoscopy. When the score is 3 or 4, the clinician has two options: the patient could be kept under observation and repeat the tests or, even more, order additional tests such as an US or a CT scan if they are available in that particular setting.

The modified Alvarado score (MAS)^[12] is a simplification of the Alvarado score by eliminating the neutrophil count because a differential WBC count is not available in certain facilities. The results are similar to the original score but with less capacity to detect the early stages of acute appendicitis.

The Pediatric Appendicitis Score (PAS), developed by Samuel in 2002^[13], is a modification of the Alvarado score in which the rebound sign has been replaced by cough/percussion/ hopping tenderness in the right lower quadrant, and the elevation of temperature has been increased to 38 °C. In this score the sign of tenderness in the right lower quadrant, the most relevant feature of the score, was given one point only.

In a recent study in India, Regar *et al.*^[14] found that the Alvarado score is more specific (80%) than the RIPASA score (60%). The PPV of the Alvarado score was 98.46% as compared to 97.83% of the RIPASA score.

In another recent study, Sinnet *et al.*^[15], in India, found that the RIPASA score has more sensitivity than the Alvarado score (95.5 vs. 65%) but has less specificity (65 vs. 90%). The PPV was 92.89% for the RIPASA score and 96.6% for the Alvarado score which indicates that the negative appendectomy rate is

higher for the RIPASA score than the Alvarado score (7.61 vs. 3.33%).

In a study to assess the reliability and practical application of the Alvarado, Eskelinen, Ohmann, and RIPASA scoring systems, Erdem *et al.*^[16] in Turkey, found that the Alvarado score had the best negative appendectomy rate (12%) than the RIPASA score (25%). The negative appendectomy rate for the Ohmann and the Eskelinen scores was 22 and 21%, respectively.

Diaz-Barrientos *et al.*^[17] in Mexico, found that the RIPASA score showed no advantage over the Modified Alvarado score taking into consideration that the ROC curve area was 0.59 for the RIPASA score vs.0.71 for the modified Alvarado score.

Using the clinical scoring system Alvarado with a low score of 1–4 only, some patients should be considered for imaging. Those with Alvarado score of 5–7 should have imaging performed. And those with scores more than 7, imaging can be added to increase the diagnostic accuracy.

In all patients who have clinical suspicion of appendicitis, we have various modalities of images to either confirm the diagnosis or rule out other causes of abdominal pain or reduce the rate of negative appendectomies such as ultrasound (US), computed tomography (CT), magnetic resonance, and conventional radiography in some cases.

Toprak *et al.*, in a study to investigate the integration of ultrasound (US) findings with the Alvarado score in diagnosing or excluding acute appendicitis, found that the diagnostic accuracy of US was as follows: sensitivity 93.1%, specificity 92.2%, positive predictive value 92.6%, negative predictive value 93.6%, and accuracy 92.6%. They also found that all patients with an Alvarado score greater than or equal to 7 had appendicitis proven by surgery and pathology. In the case of non-visualization of the appendix without a high Alvarado score, appendicitis can safely be ruled out.

CT scan may be useful with moderate scores and equivocal findings^[18]. The problem with ultrasound is that it was found to have an extremely variable accuracy in the diagnosis of acute appendicitis with a sensitivity range from 44 to 100% and a specificity range of 47 to 99%. Radiologist-operated ultrasound had inferior sensitivity and inferior positive predictive values when compared with a CT scan, though it was significant faster to perform and avoided the administration of contrast materials^[19]. For this reason, “a first pass” approach using US first and then CT, if US is not diagnostic, would be desirable in some institutions^[20-22].

In our study of 100 patients (55 males and 45 females), on histopathological examination 94 patients had acute appendicitis, among which 52 were females and 42 were males, with a negative appendectomy rate of only 6%. In similar studies done by Khan *et al.*^[23], Ohmann *et al.*^[24], and Arian *et al.*^[25], negative appendectomy rates of 14%, 14.3% and 16.1% respectively were observed.

According to our study, all the parameters in the MANTREL score were found to have a statistical significance. Migratory RIF pain had a p value of 0.0001, anorexia had a p value of 0.0001, leucocytosis had a p value of 0.0047, rebound tenderness had a p value of 0.0051, elevated temperature had a p value of 0.0047, vomiting had a p value of 0.0049 and tender RIF had a p value of 0.0001. According to a study done by Want *et al.*^[26], the sensitivity of leucocytosis count was 67% in the diagnosis of appendicitis.

In another study done by Cardall *et al.*^[27], the sensitivity of leucocytosis was 76% and elevated temperature was 47%. They considered this significant. In a study done by Andersson *et al.*^[28], elevated temperature, leucocytosis, tender RIF, and rebound

tenderness had individual statistical significance in the diagnosis of acute appendicitis.

In our study, 43 patients had a score of >7 of which 42 proved to have acute appendicitis on operative and histopathological examination, with a sensitivity of 44.6%.

The overall sensitivity of patients with a score of 5-6 was 92.5% with a negative appendectomy rate of 8% and the overall sensitivity of patients who had a score of 1-4 was 88.23% with a negative appendectomy rate of 11.8%.

According to our study, USG had a sensitivity of 63.8% and a specificity of 83.3% in the diagnosis of acute appendicitis. In other studies done by Skaane *et al.* [29] and Douglas *et al.* [2] the sensitivity and specificity were 78%, 92% and 94.7% and 88.9% respectively.

The accuracy of MAS in the diagnosis of acute appendicitis in our study was 47% and that of ultrasound was 65%. Even the sensitivity of Ultrasound to diagnose Acute Appendicitis in our study was higher than MAS. Patients with Modified Alvarado Score less than 7, need to be further evaluated to reduce the rates of negative appendectomies by repeated clinical examinations and Imaging studies.

In patients with Modified Alvarado Score >7, an Ultrasound of abdomen can be performed to strengthen the diagnosis before proceeding for surgery and to reduce the rates of negative appendectomy, and further imaging modalities like CT and MRI are usually not necessary in such cases.

Conclusion

According to the findings from our study, it is concluded that abdominal ultrasound has a higher sensitivity and accuracy when compared to modified Alvarado score in the diagnosis of acute appendicitis. However, the specificity to diagnose acute appendicitis by both modalities was similar.



Fig 1: Acute appendicitis

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