MODIFIED ALVARADO SCORE VERSUS ULTRASOUND EXAMINATION IN ACUTE APPENDICITIS

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ABSTRACT

BACKGROUND

Appendicitis, one of the most common causes of acute surgical abdomen, presents with a myriad of symptoms and signs resulting in a potential for delay in diagnosis or misdiagnosis. As a result, timely diagnosis is of paramount importance to avoid potential complications. However, appendicectomy based on mere clinical suspicion results in an increased incidence of negative appendicectomies. In this context, modified Alvarado score and ultrasound examination can aid in confirming suspected acute appendicitis. We conducted this study to find out the diagnostic accuracy of ultrasound examination and modified Alvarado scoring system.

MATERIALS AND METHODS

This prospective study of 150 patients was conducted in department of General Surgery, Govt. Medical College, Kottayam. Study involves application of modified Alvarado scoring system and performing ultrasound scan inside Kottayam Medical College Hospital in all cases. Modified Alvarado Score (MAS) is obtained by proper history taking, clinical examination and laboratory values. Following emergency appendicectomy of all cases the specimen was sent for histopathological diagnosis.

RESULTS

This study included 150 consecutive patients diagnosed with acute appendicitis undergoing emergency appendicectomy. There were 96 (64%) male patients and 54 (36%) female patients. As per the modified Alvarado scoring, 125 (83.3%) of the patients were diagnosed to have acute appendicitis. However, only 104 (69.3%) of the patients were diagnosed as acute appendicitis by sonological findings. This study showed rebound tenderness as the most common MAS factor, it was present in 147 cases (98%). It was followed by 'Migratory pain' which was present in 129 cases (86%). The area under the curve for the ROC for total modified Alvarado scoring was 0.77 (CI 0.62-0.92) figure-3. The sensitivity of USG was 73.4% whereas that of Modified Alvarado score was 86.3%. Specificity of USG was 81.8% and that of Modified Alvarado score was 54.5%. Positive predictive value was 98.1% and 96% respectively. The negative predictive value was 19.6% and 24% for USG and Alvarado scores.

CONCLUSION

From the present study, it can be concluded that modified Alvarado score is a better diagnostic tool than ultrasonography alone. However, neither modified Alvarado score nor ultrasonography is an absolute tool in reducing negative laparotomy. Both when used together have reduced negative appendicectomy rate by a large number.

KEYWORDS

Modified Alvarado Score, Ultrasound Abdomen, Appendicitis, Appendectomy, Abdominal Pain, Diagnostic Error, Laparotomy.

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BACKGROUND

Appendicitis continues to be the most common cause of an acute surgical abdomen diagnosed primarily based on clinical features.[1,2] Apart from the classical presentations, appendicitis may present with atypical clinical features, thus leading to either a delay in diagnosis or a misdiagnosis.[3,4]

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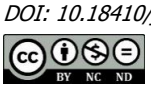

Acute appendicitis can present with atypical symptoms and signs, resulting in a diagnostic conundrum.[5] Non diagnosis or delay in diagnosis can result in life-threatening complications like perforation leading to much morbidity and mortality.[6] At the same time, faulty decision making based on experience will result in a negative laparotomy incidence of 15 to 30%.[7] However, timely diagnosis and intervention are the prognostic factors that result in less morbidity and mortality.[8] To improve diagnosis of acute appendicitis, we use various clinical and radiological methods. Modified Alvarado scoring system and ultrasonography have aided in confirming cases of suspected acute appendicitis.[9-13]

The purpose of the study was to find out diagnostic accuracy of Ultrasonological examination and modified Alvarado scoring system in the diagnosis of acute appendicitis.

MATERIALS AND METHODS

We conducted these prospective study among 150 patients undergoing appendicectomy for acute appendicitis in the Department of General Surgery, Government Medical College, Kottayam during a study period of one year. Before recruiting patients into the study, ethics committee clearance and informed consents were taken.

Patients admitted with a clinical diagnosis of appendicitis and undergoing emergency appendectomy constituted the study population. The diagnosis of the appendicitis was made by the operating surgeon based on the clinical features. The decision to operate or not was entirely taken by the medical officer in charge. We excluded patients with appendicular mass and those without sonological evaluation or with components of modified Alvarado score. We recruited all consecutive patients satisfying the inclusion criteria and exclusion criteria during the study period. A formal sample size calculation showed 150 cases as the sample size.

Study involved application of modified Alvarado scoring system and performing ultrasound scan inside Kottayam Medical College Hospital on all cases. Modified Alvarado score (MAS) was obtained by proper history taking, clinical examination and laboratory values. Following emergency appendicectomy of all cases the specimen was sent for histopathological diagnosis.

Statistical analysis was performed in R statistical software version 3.0 and stata IC15 software. Continuous data are summarized as median and interquartile range, and categorical variables reported with absolute frequencies and percentages. Diagnostic accuracy of ultrasound was compared with modified Alvarado scoring system and sensitivity, specificity, positive predictive value, and negative predictive values were calculated. ROC curve was drawn, and optimum cut off value arrived at.

RESULTS

This study included 150 consecutive patients diagnosed with acute appendicitis undergoing emergency appendicectomy. There were 96 (64%) male patients and 54 (36%) female patients. The median age with an interquartile range was 22.5 (17; 36). Migratory abdominal pain was present in 129 (86%) patients. One hundred and twelve patients (74.7%) reported anorexia and 127 (84.7%) nausea. Right iliac fossa tenderness was present in 147 (98%) patients and rebound tenderness in 116 (77.3%). Elevated temperature was present 84 (56%) patients and leukocytosis in 97 (64%) patients.

Ultrasonological examination showed dilated appendix in 87 (58%) of the patients. Feature suggestive of inflamed appendix was present in 43 (28.7%) of patients. A sausage-shaped structure was present in 67 (44.7%) patients. In 7 (4.6%) patients appendicoliths were reported. Preoperative findings showed peri appendiceal fluid in 50 (33.3%) patients and inflamed ileum and caecum in 29 (19.3%) patients. Appendix was found perforated in 14 (9.3%) of the patients.

As per the modified Alvarado scoring, 125 (83.3%) of the patients were diagnosed to have acute appendicitis (Table 1). However, only 104 (69.3%) of the patients were diagnosed as acute appendicitis by sonological findings. The final histopathology showed that 139 (92.7%) patients who underwent appendicectomy had appendicitis.

This study showed right iliac fossa tenderness as most common MAS factor, it was present in 147 cases (98%). It was followed by 'Migratory pain' which was present in 129 cases (86%). The least common MAS factor was 'elevated temperature' which was present only in 84 cases (56%). In In the study of 150 patient 2 MAS findings, that is 'migratory pain' (Chi-Square value =9.755, P value=0.002) and rebound tenderness (Chi-Square value = 16.971, P value < 0.001) were found to have significant relation in diagnosis of acute appendicitis (Figure 1).

In the study of 150 patients 2 USG findings, that are dilated appendix (Chi Square =11.657, P=0.001) and inflamed appendix (Chi-Square= 4.770, P=0.029) were found to have significant relation in diagnosis of acute appendicitis.

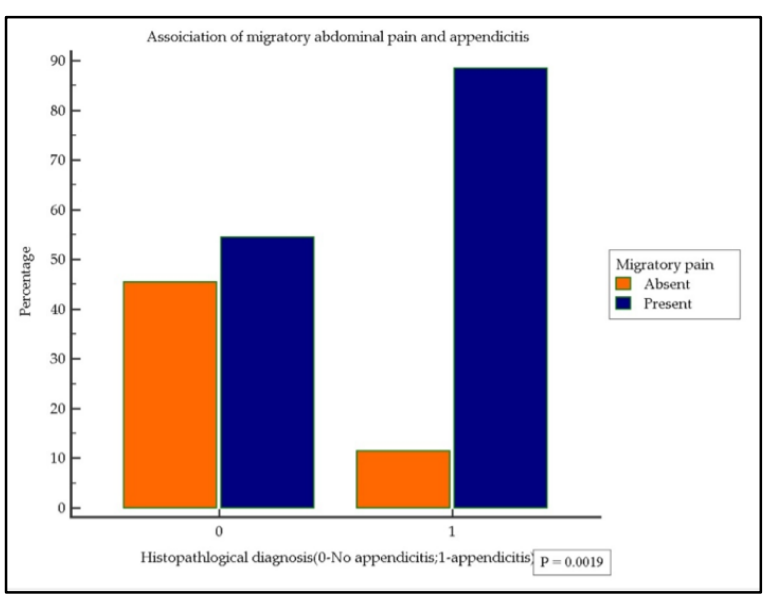

Figure 1

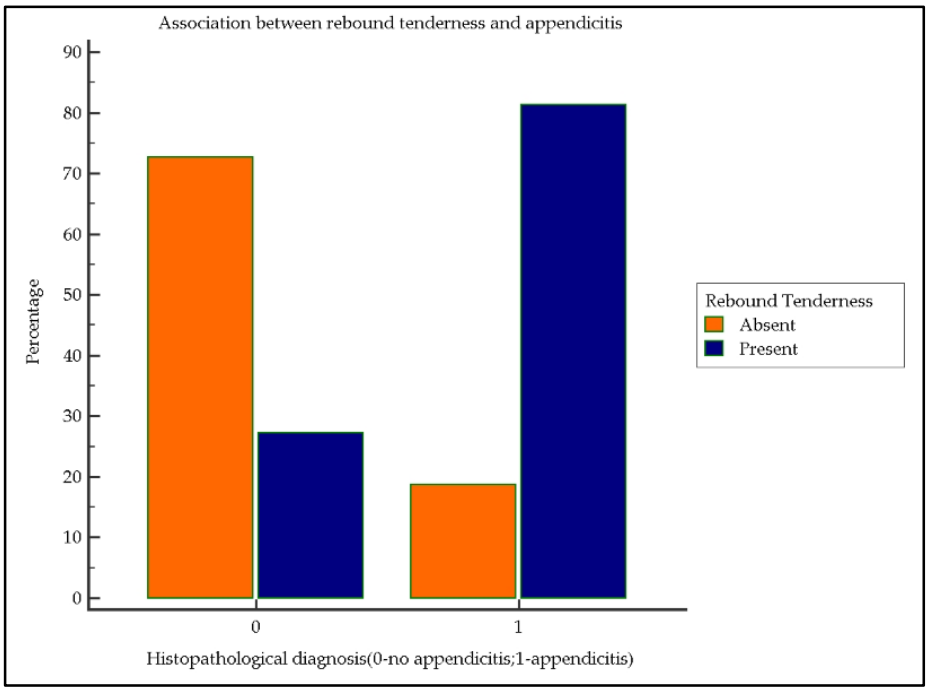

Figure 2

	(ALL) N=150	No Appendicitis N=25	Appendicitis N=125	P Overall
Age:	22.5 (17.0;36.0)	20.0 (17.0;39.0)	23.0 (17.0;34.0)	0.936
Sex:				0.494
Male	96 (64.0%)	14 (56.0%)	82 (65.6%)	
Female	54 (36.0%)	11 (44.0%)	43 (34.4%)	
History of abdominal pain:				0.711
Absent	62 (41.3%)	9 (36.0%)	53 (42.4%)	
Present	88 (58.7%)	16 (64.0%)	72 (57.6%)	
Migratory pain:				0.009
Absent	21 (14.0%)	8 (32.0%)	13 (10.4%)	
Present	129 (86.0%)	17 (68.0%)	112 (89.6%)	
Anorexia:				0.111
Absent	38 (25.3%)	10 (40.0%)	28 (22.4%)	
Present	112 (74.7%)	15 (60.0%)	97 (77.6%)	
Nausea:				<0.001
Absent	23 (15.3%)	11 (44.0%)	12 (9.60%)	
Present	127 (84.7%)	14 (56.0%)	113 (90.4%)	
Tenderness:				0.072
Absent	3 (2.00%)	2 (8.00%)	1 (0.80%)	
Present	147 (98.0%)	23 (92.0%)	124 (99.2%)	
Rebound Tenderness:				0.045
Absent	34 (22.7%)	10 (40.0%)	24 (19.2%)	
Present	116 (77.3%)	15 (60.0%)	101 (80.8%)	
Elevated Temperature:				<0.001
Absent	66 (44.0%)	20 (80.0%)	46 (36.8%)	
Present	84 (56.0%)	5 (20.0%)	79 (63.2%)	
Leukocytosis:				<0.001
Absent	53 (35.3%)	23 (92.0%)	30 (24.0%)	
Present	97 (64.7%)	2 (8.00%)	95 (76.0%)	
Dilated appendix:				0.183
Absent	63 (42.0%)	14 (56.0%)	49 (39.2%)	
Present	87 (58.0%)	11 (44.0%)	76 (60.8%)	
Inflamed appendix:				0.419
Absent	107 (71.3%)	20 (80.0%)	87 (69.6%)	
Present	43 (28.7%)	5 (20.0%)	38 (30.4%)	
Sausage shaped structure:				0.769
Absent	83 (55.3%)	15 (60.0%)	68 (54.4%)	
Present	67 (44.7%)	10 (40.0%)	57 (45.6%)	

Appendicolith:				1.000
Absent	143 (95.3%)	24 (96.0%)	119 (95.2%)	
Present	7 (4.67%)	1 (4.00%)	6 (4.80%)	
Periappendiceal fluid:				0.075
Absent	100 (66.7%)	21 (84.0%)	79 (63.2%)	
Present	50 (33.3%)	4 (16.0%)	46 (36.8%)	
Inflamed ileum and caecum:				0.412
Absent	121 (80.7%)	22 (88.0%)	99 (79.2%)	
Present	29 (19.3%)	3 (12.0%)	26 (20.8%)	
Gangrenous appendix:	150 (100%)	25 (100%)	125 (100%)	.
Perforated appendix:				0.467
Absent	136 (90.7%)	24 (96.0%)	112 (89.6%)	
Present	14 (9.33%)	1 (4.00%)	13 (10.4%)	
Other findings:				0.254
Absent	96 (64.0%)	13 (52.0%)	83 (66.4%)	
Present	54 (36.0%)	12 (48.0%)	42 (33.6%)	
Diagnosis from USG:				0.178
Absent	46 (30.7%)	11 (44.0%)	35 (28.0%)	
Total MAS	7.00 (6.00;8.00)	5.00 (4.00;5.00)	8.00 (7.00;8.00)	<0.001

Table 1. Clinical and Sonological Features in Patients Diagnosed with Modified Alvarado Scoring

The area under the curve for the ROC for total modified Alvarado scoring was 0.773 (CI 0.62-0.92)- Figure (3). The optimal cut off value for diagnosing appendicitis using modified Alvarado score was found to be a score of 5.5 and above with an area under ROC of 0.773. The sensitivity of USG was 73.4% whereas that of Alvarado score was 86.3%. Specificity of USG was 81.8% and that of Alvarado score was 54.5%. Positive predictive value was 98.1% and 96% respectively. The negative predictive value was 19.6% and 24% for USG and Alvarado scores. The diagnostic accuracy of modified Alvarado scoring was 84%, while that of USG was 74%.

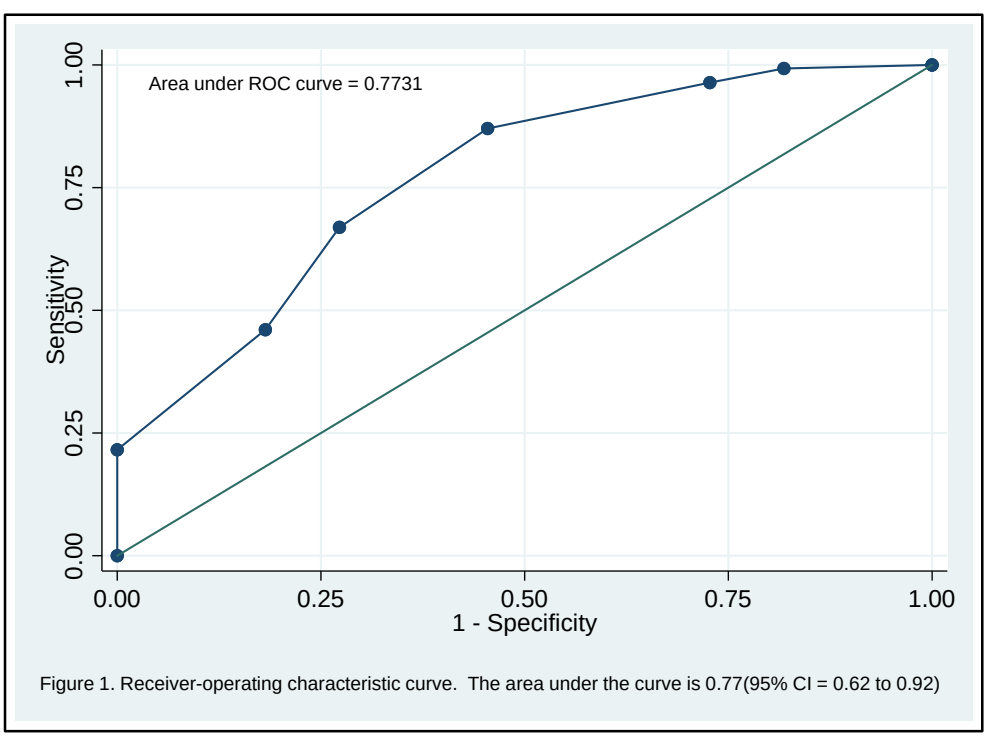

Figure 1. Receiver-operating characteristic curve. The area under the curve is 0.77(95% CI = 0.62 to 0.92)

Figure 3

DISCUSSION

This study aimed to assess the usefulness of sonological examination of abdomen versus modified Alvarado scoring system in the diagnosis of appendicitis admitted in our institution.

The most common age group affected by appendicitis in our study was from 15 to 30 yrs. age. More than 2 thirds of cases (68.7%) of appendicitis was below 30 yrs. of age. These results are similar to other studies like Brahmachari et al and Talukder.[14,15] The most common age group as per the western studies is between 10 to 20 years.[16,17,15] However, most of the Indian studies report similar age distribution as in our study.[18] This could suggest that in our population, appendicitis occurred at a later age group.

In our study, males were more affected. The male to female ratio was found to be 1.78:1. Our male to female

ratio was a little higher compared to Talukder DB et al[15] Most of the studies reported in literature showed a lower male to female like 1.4: 1 as in Addis et all, 0.86:1 in study by Lin et all in Taiwan, and 1.08 by Lee et al.[19,20,21] The increased male preponderance in our study may be due to sampling error.

Between 150, patient 139 histologically proved acute appendicitis. That is there was 11 negative appendicectomy (7.3%). This negative appendicectomy rate is far better than acceptable limits, because missed perforated appendix has dire consequences; surgeons have traditionally accepted a 20% rate of negative appendectomy. Study done by Lee et al in 766 patients showed negative appendicectomy rates of 15.7%.[22] This low rate of negative appendicectomy in our study may be due to combined use of MAS and USG in assessing patients with suspected appendicitis.

Among all MAS factors statistically significant relationship was only found for 'migratory pain' and rebound tenderness. This finding is in consistent with other studies like Sonawane et al[23] No significant relationship was established with other MAS factors probably due to low sample size.

In the study, the most common ultrasound finding was 'dilated appendix' seen in 87 patients (58%), followed by 'noncompressible, aperistaltic blind ended, sausage-shaped shaped structure' seen in 67 patients (44.7%). 'Gangrenous appendix' was not seen in any of the cases. But among all USG findings statistically significant relationship was only found for 'dilated appendix' (Chi-Square=11.657, P=0.001) and 'inflamed appendix' (Chi-Square=4.770, P=0.029). Other USG findings failed to find significant relationship probably due to low sample size.

In the study, the sensitivity of USG was found to be 73.4% and specificity was 81.8%. The positive predictive value was found to be 98.1%, whereas the negative predictive value was only 19.6%. Diagnostic accuracy was 74%.

In comparison study done by Nishikant Gujar et al Al Ameen medical college between 2010 and 2015 yielded following results.[24] The sensitivity of MAS is 98.44% and for USG is 98.33%. The specificity of MAS is 94.4% and USG is 90%.

Study by Satyajeet kumar singh et al with 55 patients showed the following results. The sensitivity and specificity of Modified Alvarado score was 82.05% and 81.25% with PPV 91.42% and NPV 65% and diagnostic accuracy of 81.82% respectively.[24] Ultrasonography study revealed 84.61% sensitivity and specificity of 56%, PPV PPV, and NPV were 80.48% and 57.14% and diagnostic accuracy was 70.91% respectively.[25] This minimal difference is sensitivity and specificity of MAS may be attributed to investigator bias in appreciating various clinical findings. The difference in sensitivity and specificity of USG may be due to operator bias as it is an operator dependent investigation.

In the study done by Harsha et al at Sri Devaraj Hospital, Kolar, Karnataka, 100 patients showed MAS to have a sensitivity of 98.8%, specificity of 93.3%. Positive predictive value 89.3%, negative predictive value 83.3%, while USG had a sensitivity of 88.8%, specificity of 93.4%, positive predictive value of 91.4%, negative predictive value of 84.4.7.

Comparing the diagnostic accuracy of MAS and USG, diagnostic accuracy of MAS was 84% compared to 74% 0f USG. MAS can be used as a screening tool in appendicitis suspected patient as it has got high sensitivity of 86.3%. However, for confirmation of diagnosis, it is better to have a USG abdomen which has got a better specificity of 81.8% compared to a low specificity of 54.5% of MAS.

So from present study, it is concluded that modified Alvarado score is better diagnostic tool than ultrasonography alone in diagnosis of acute appendicitis. But still, neither modified Alvarado score nor ultrasonography alone is absolute tool in reducing negative laparotomy in patients of suspected appendicitis.

The optimal cut off value for predicting appendicitis using Alvarado score was found to be a score > 5.5 with an area under the ROC of 0.773, with sensitivity of 87.05% and specificity of 55.55%. So rounding to nearest whole number a Modified Alvarado score of 6 can be kept as the cut off for diagnosis of appendicitis. A score of 6 or more gives an optimum sensitivity and specificity.

CONCLUSION

From present study, it can be concluded that modified Alvarado score is better diagnostic tool than ultrasonography alone in diagnosis of acute appendicitis. But still, neither modified Alvarado score nor ultrasonography is absolute tool in reducing negative laparotomy in patients of suspected appendicitis. Both when used together have reduced negative appendicectomy rate by a large number.

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