

A Hospital-Based Clinical Assessment of the Validity and Utility of Combining Ultrasonography with Different Clinical Scores in Diagnosis of Acute Appendicitis

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Abstract

Aim: This study was conducted to evaluate the diagnostic accuracy of the existent clinical scoring systems in combination with ultrasound imaging in the diagnosis of acute appendicitis in our patients.

Materials & Methods: All 100 patients with clinical diagnosis of acute appendicitis and who underwent emergency appendectomy in the Department of General Surgery, Bhagwan Mahavir Institute of Medical Science, Pawapuri, Nalanda, Bihar in between two years were included in the study. A detailed history of presenting illness was elicited and clinical examination, relevant blood investigations and abdominal ultrasonography were done. All patients were scored according to MAS, RIPASA and AIRS. Histopathology was taken as the gold standard.

Results: Out of the total 100 patients, 90 (90%) were found to have acute appendicitis on histopathology while 10 (10%) were normal on histopathology. This gave a negative appendectomy rate of 10%. RIF pain was the most consistent symptom present in 100% of the patients. Leucocytosis (Total leucocyte count >10000/mm³) was present in 88 patients (88%) and 12 patients (12%) had normal TLC. Elevated CRP in the range of 10–49 mg/l was seen in 90 patients (90%) while CRP was ≥ 50 mg/l in 10 patients (10%). The chi-square test shows that migratory pain ($p=0.003$), nausea ($p<0.001$), vomiting ($p<0.001$), guarding ($p<0.001$), rebound tenderness ($p<0.001$) and raised TLC >10000/mm³ ($p<0.001$) were statistically significant indicators of acute appendicitis. MAS was ≥ 7 in 78 patients (78%) and <7 in 22 patients (22%). On further analysis with histopathology; it was found that MAS could diagnose 77 patients out of 90 histopathologically positive acute appendicitis patients thereby yielding a sensitivity of 85.56%. RIPASA score was ≥ 7.5 in 84 patients (93.34%) and <7.5 in 6 patients (6.66%).

Conclusion: If ultrasonography is used in conjunction with current clinical scoring systems, then the diagnostic accuracy is enhanced. Therefore, USG should be done in all cases being evaluated for acute appendicitis; irrespective of the score being used.

Keywords: Appendicitis, Ultrasonography, Modified Alvarado scoring system, RIPASA, Appendicitis inflammatory response score.

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Introduction

Acute appendicitis is defined as the transmural inflammation of appendix. It has an incidence of about 1 in 400 or 0.25% in South India.[1] Acute appendicitis, the most frequently suspected acute abdominal disorder in the emergency department and the most common indication for emergency abdominal surgery, is still a difficult diagnosis based on clinical and laboratory data. In adult patients, appendicitis-mimicking conditions of gastrointestinal, urologic, or gynecologic origin make the diagnosis even more difficult. [2,3] Appendectomy is the gold standard treatment for AA.[4] It is thus necessary to make an accurate diagnosis to prevent unnecessary surgery. A successful outcome depends on an early diagnosis followed by appendectomy before development of any complication such as gangrene or perforation.[5,6] Several scoring systems have been used globally for early diagnosis of AA. To aid in the diagnosis, a number of clinical scores have been proposed such as the modified Alvarado scoring system (MAS), Raja Isteri Pengiran Anak Saleha appendicitis (RIPASA) and appendicitis inflammatory response score (AIRS).[7,8,9] RIPASA score is a new clinical diagnostic scoring system developed for diagnosis of acute appendicitis with significantly higher sensitivity, specificity and diagnostic accuracy particularly in an Asian population compared to Alvarado and modified Alvarado method.[9,10,11] Imaging modalities are another means to assist in the diagnosis of acute appendicitis and reduce the negative appendectomy rates. Due to its easier availability ultrasonography (USG), is the most commonly used imaging modality. Its drawback is variable sensitivity and specificity due to operator dependence.[12]

Therefore, we conducted a comparative study to evaluate the diagnostic accuracy of the existent clinical scoring systems in combination with ultrasound imaging in the diagnosis of acute appendicitis in patients.

Material & Methods

All 100 patients with clinical diagnosis of acute appendicitis and who underwent emergency appendectomy in the, Department of General Surgery, Bhagwan Mahavir institute of Medical science, Pawapuri, Nalanda, Bihar in between two years were included in the study. A detailed history of presenting illness was elicited and clinical examination, relevant blood investigations and abdominal ultrasonography were done. All patients were scored according to MAS, RIPASA and AIRS. Histopathology was taken as the gold standard.

Inclusion criteria

- All patients >18 years who undergo an emergency appendectomy.
- Exclusion criteria
- Age <18 years,
- Evidence of generalized peritonitis,
- Palpable mass in right iliac fossa (rif),
- Evidence of acute confusion state, dementia, septic shock and other associated abdominal diseases.

The patients were informed that the study is voluntary and the treatment would not be affected by participating or restraining from the study. No extra costs/visits of doctors were incurred as a part of the study.

A detailed history was taken in all cases with special reference to the relevant points- pain (onset, nature, site, duration and migration of pain), fever and associated symptoms such as anorexia, nausea, vomiting, diarrhoea, constipation and burning sensation in urine. Thorough

clinical examination was done in every patient with special attention to abdominal examination. The different signs of acute appendicitis i.e. tenderness in RIF, rebound tenderness, fever, rovsing sign were carefully looked for and findings were noted in the recording sheet by the duty doctor.

Examination of blood including TLC, DLC, the morphology of WBC (shift of neutrophils) and CRP were done. Ultrasonography was done by the radiologist of the rank of a senior resident or above only. Based on the findings the sonologist were asked to grade their result as- unlikely/negative, probable or definitive. The final diagnosis was made by the surgeon on his clinical judgment. Calculations of MAS, RIPASA, AIR scores were done.⁷

Statistical analysis

A computerized grouped database was constructed with study variables using SPSS-22 software. An indigenously designed scoring system combining clinical and sonographic scoring was used. Combined MAS, Combined RIPASA and Combined AIRS were obtained after combining ultrasonography findings with MAS, RIPASA score and AIRS respectively. A USG category score of 1, 2 or 3 was assigned to unlikely, probable or definite features of acute appendicitis respectively. Similarly, patients with MAS category score ≥ 7 were given MAS category score of 3; those with MAS score of 5-6 were given MAS category score of

2 and those with MAS score < 5 were given MAS category score of 1. Patients with RIPASA category score ≥ 7.5 were given RIPASA category score of 3; those with RIPASA score of 5-7 were given RIPASA category score of 2, and those with RIPASA score < 5 were given RIPASA category score of 1. Patients with AIRS category score ≥ 9 were given AIRS category score of 3; those with AIRS score of 5-8 were given AIRS category score of 2, and those with AIRS score < 5 were given AIRS category score of 1. Combined MAS category score, Combined RIPASA category score, Combined AIRS category score were each obtained by adding USG category score to MAS category score, RIPASA category score and AIRS category score respectively. Patients with Combined category score of 5-6 were considered as a definite probability of acute appendicitis; a combined category score of 3-4 was considered as probable acute appendicitis and a combined category score of 1-2 was taken as unlikely/low probability. Accordingly, patients with definite and probable appendicitis (score 3, 4, 5 or 6) were taken as test positives and those with unlikely/low probability (score 1 or 2) were taken as test negatives. Histopathological examination was done to confirm the diagnosis. Infiltration of the muscularis propria by neutrophils was considered diagnostic of acute appendicitis.¹² $p < 0.05$ was considered statistically significant.

Results

Table 1: Demographic details

Gender	N%
Male	65 (65)
Female	35 (35)
Age groups	
18-40 years	64 (64)
More than 40 years	36 (36)
Appendicitis on histopathology	
Acute appendicitis	90 (90)
Normal	10 (10)

We included 100 patients in our study. 64 (64%) patients were between the age of 18-40 and 36 patients (36%) were greater than 40 years of age. The mean age of subjects in the study was 32.40 ± 7.33 . Male patients composed 65% of our study population while 35% of patients were female. Histopathology was taken as the

reference gold standard for the diagnosis of acute appendicitis in our study. Out of the total 100 patients, 90 (90%) were found to have acute appendicitis on histopathology while 10 (10%) were normal on histopathology. This gave a negative appendectomy rate of 10%.

Table 2: Frequency and correlation of symptoms, signs and laboratory parameters with gold standard (histopathology)

Findings	Total (n=100) N (%)	Acute appendicitis (n=90) N (%)	Non-acute appendicitis (n=10) N (%)	P value
Symptoms				
Pain in RIF				
Present	100 (100)	90 (100)	10 (100)	-
Absent	0 (0)	0 (0)	0 (0)	
Migratory pain from umbilicus to RIF				
Present	55 (55)	54 (60)	1 (10)	0.002
Absent	45 (45)	36 (40)	9 (90)	
Anorexia				
Present	95 (95)	85 (94.45)	10 (10)	1.000
Absent	5 (5)	5 (5.5)	0 (0)	
Nausea				
Present	70 (70)	70 (77.78)	0 (0)	<0.001
Absent	30 (30)	20 (22.22)	10 (100)	
Vomiting				
Present	68 (68)	68 (75.55)	0 (0)	<0.001
Absent	32 (32)	26 (24.45)	10 (100)	
Constipation				
Present	14 (14)	12 (13.34)	2 (20)	0.615
Absent	86 (86)	78 (86.66)	8 (80)	
Diarrhoea				
Present	13 (13)	11 (12.22)	2 (20)	0.620
Absent	87 (87)	79 (87.78)	8 (80)	
Burning micturition				
Present	25 (25)	25 (27.78)	0 (0)	0.060
Absent	75 (75)	65 (72.22)	10 (100)	
Signs				
Tenderness RIF				
Present	100 (100)	90 (100)	10 (100)	-
Absent	0 (0)	0 (0)	0 (0)	
Guarding				
Present	70 (70)	79 (73.8)	2 (20)	<0.001
Absent	30 (30)	28 (26.2)	8 (80)	
Rebound tenderness				
Present	78 (78)	77 (85.55)	1 (10)	<0.001
Absent	22 (22)	13 (14.45)	9 (90)	

Fever(>37.5°C)				
Present	17 (17)	16 (17.77)	2 (20)	
Absent	83 (83)	74 (82.23)	8 (80)	1.000
Obturator sign				
Present	3 (3)	3 (3.34)	0 (0)	1.000
Absent	97 (97)	87 (96.66)	10 (100)	
Rovsing sign				
Present	25 (25)	25 (27.77)	0 (0)	0.060
Absent	75 (75)	78 (72.23)	10 (100)	
Psoas sign				
Present	5 (5)	4 (4.44)	1 (10)	0.444
Absent	95 (95)	86 (95.56)	9 (90)	
Laboratory				
Total leucocyte count				
10-14999/mm ³	18 (18)	17 (18.8)	1 (10)	<0.001
>15000/mm ³	70 (70)	81 (77.7)	0 (0)	
<10000/mm ³	12 (12)	5 (5.5)	9 (90)	
CRP levels				
≥50 mg/l	10 (10)	10 (11.11)	0 (0)	0.510
10-49 mg/l	90 (90)	97 (88.89)	10 (100)	
Urinalysis findings				
Negative	85 (85)	76 (84.44)	9 (90)	1.000
Positive	15 (15)	14 (15.56)	1 (10)	

RIF pain was the most consistent symptom present in 100% of the patients. Leucocytosis (Total leucocyte count >10000/mm³) was present in 88 patients (88%) and 12 patients (12%) had normal TLC. Elevated CRP in the range of 10–49 mg/l was seen in 90 patients (90%) while CRP was ≥50 mg/l in 10 patients (10%).

The chi-square test shows that migratory pain (p=0.003), nausea (p<0.001), vomiting (p<0.001), guarding (p<0.001), rebound tenderness (p<0.001) and raised TLC >10000/mm³ (p<0.001) were statistically significant indicators of acute appendicitis.

Table 3: Frequency and correlation of various scoring systems, USG and combined (with USG) clinical scores with gold standard (histopathology)

Scoring system	Total (n=100)	Acute appendicitis*(n=90)	Non-acute appendicitis*(n=10)	P value
	N (%)	N (%)	N (%)	
MAS score				
MAS ≥7	78 (78)	77 (85.56)	1 (10)	<0.001
MAS <7	22(22)	13 (14.44)	9 (90)	
RIPASA score				
RIPASA ≥7.5	88 (88)	84 (93.34)	4 (40)	<0.001
RIPASA <7.5	12 (12)	6 (6.66)	6 (60)	
AIRS score				
AIRS ≥9	60 (60)	60 (66.66)	0 (0)	<0.001
AIRS <9	40 (40)	30 (33.34)	10 (100)	
USG score				
Definitive or probable acute	88 (88)	85 (94.4)	3 (30)	

appendicitis on USG				<0.001
Acute appendicitis unlikely on USG	12 (12)	5 (5.6)	7 (70)	
Combined MAS score				
Combined MAS category 3	80 (80)	79 (87.78)	1 (10)	<0.001
Combined MAS category 2	12 (12)	10 (11.11)	2 (20)	
Combined MAS category 1	8 (8)	1 (1.11)	7 (70)	
Combined RIPASA score				
Combined RIPASA category 3	83 (83)	80 (88.8)	3 (30)	<0.001
Combined RIPASA category 2	10 (10)	9 (10)	1 (10)	
Combined RIPASA category 1	7 (7)	1 (1.11)	6 (60)	
Combined AIRS score				
Combined AIRS category 3	82 (82)	80 (88.8)	2 (20)	<0.001
Combined AIRS category 2	10 (10)	9 (10)	1 (10)	
Combined AIRS category 1	8 (8)	1 (1.11)	7 (70)	

MAS was ≥ 7 in 78 patients (78%) and < 7 in 22 patients (22%). On further analysis with histopathology; it was found that MAS could diagnose 77 patients out of 90 histopathologically positive acute

appendicitis patients thereby yielding a sensitivity of 85.56%. RIPASA score was ≥ 7.5 in 84 patients (93.34%) and < 7.5 in 6 patients (6.66%).

Table 4: Comparison of available scoring systems, USG and combined (with USG) clinical scoring systems based on the statistical and clinical performance of a test

	MAS (%)	RIPASA score (%)	AIRS (%)	USG (%)	Combined MAS (%)	Combined RIPASAScore (%)	Combine dAIRS (%)
Sensitivity	86.4	93.9	65.5	94.6	99.1	99.1	99.1
Specificity	90.5	63.2	100	71.9	70.8	64.6	73.7
PPV	98.2	96.8	100	98.2	96.2	95.5	95.2
NPV	41.6	50	24.3	56.4	87.3	85.5	87.3
Accuracy	87.8	90.2	68.2	92.8	96.4	95.2	95.5

It was found that MAS could diagnose 77 patients out of 90 histopathologically positive acute appendicitis patients thereby yielding a sensitivity of 86.4%. RIPASA score was ≥ 7.5 in 100 patients (93.5%) and < 7.5 in 7 patients (6.5%). RIPASA yields a sensitivity of 93.5%. AIRS yielded a sensitivity of 65.5%. In our study ultrasound achieved a diagnostic accuracy of 94.6% which is higher than any of the individual scoring systems. Combined MAS category score showed increased sensitivity (99.1%).

Discussion

Diagnosing appendicitis poses a lot of issues. There is no single sign, symptom, or available diagnostic tool to accurately confirm the diagnosis.[14] Clinical suspicion continues to be relied upon for taking the decision to operate. To aid in the diagnosis, a number of clinical scores have been proposed such as the modified Alvarado scoring system (MAS), Raja Isteri Pengiran Anak Saleha appendicitis (RIPASA) and appendicitis inflammatory response score (AIRS).[7,15,16] Among the scoring systems, the Alvarado score is

most commonly used. It has been observed to be less specific in Asian populations as compared to European/American populations.[15]

Out of the total 100 patients, 90 (90%) were found to have acute appendicitis on histopathology while 10 (10%) were normal on histopathology. This gave a negative appendectomy rate of 10%. In literature, a negative appendectomy rate varying from 6-20% has been reported.[17,18] The various scoring systems have included different clinical symptoms and signs in their scoring method. In our study right iliac fossa pain was present in 90 patients (100%) and nausea and vomiting in 78 patients (78%). Migratory pain, nausea and vomiting came out to be statistically significant. These findings are consistent with the study of Korner et al in which they found that history of nausea or vomiting and pain migration to RIF were significant predictors of acute appendicitis.[19] A study by Andersson et al also, showed that the migration of pain was statistically significant in cases of acute appendicitis.[20]

Kalan et al showed that this modified Alvarado score (MAS) had a sensitivity of 93% in males and 67% in females in diagnosing acute appendicitis.[7] In our study, MAS was able to exclude nine patients (90%) out of 10 histopathologically negative patients, thereby yielding a specificity of 90.9%. The positive predictive values and negative predictive values of MAS were 98.9% and 41.7% respectively; therefore, the overall accuracy of the score came out to be 87.3%. Our study correlates well with the study by Kanumba et al in terms of sensitivity, specificity, PPV and accuracy.[21] In the original Chong et al study using RIPASA score, they reported a sensitivity of 88%, specificity of 67%, PPV of 93%, NPV of 53% using a score ≥ 7.5 as the cutoff.3 Similar to their study, RIPASA was able to exclude only six

patients (60%) out of 10 patients who were histopathologically negative in our study, thereby yielding a specificity of 63.2%, PPV of 96.8%, NPV of 50% and diagnostic accuracy of 90.2%. Another scoring system, AIRS was able to exclude all 10 patients out of 10 histopathologically negative patients, thereby yielding a specificity of 100%. The PPV was 100%, NPV was 24.3%, accuracy was 68.2%. The study by Castro et al reported a high sensitivity (around 100%) while low specificity (100%) in diagnosis of acute appendicitis.[22]

USG was able to exclude only seven patients (70%) out of 10 histopathologically negative patients, thereby yielding a specificity of 71.9%. The PPV, NPV and accuracy were 98.2%, 56.4% and 92.8% respectively. Douglas et al reported similar sensitivity of 94.7% while specificity to be 88.9%.[23] Three patients were falsely diagnosed as acute appendicitis by combined MAS although histopathology showed them to be non-appendicitis. Thus, the negative appendectomy rate for Combined MAS comes out to be 3%. It reflects an improvement from the negative appendectomy rate of 10% obtained in our study where patients were operated on the basis of clinical suspicion alone without the use of scoring systems and/or USG. A study by Dsouza et al reported that additional information provided by ultrasound does improve the diagnostic accuracy of MAS.[24] A study by Alexander et al showed that using Alvarado score with ultrasonography increases the sensitivity and diagnostic reliability of this scoring system.[25]

RIPASA score was ≥ 7.5 in 100 patients (93.5%) and < 7.5 in 7 patients (6.5%). RIPASA yields a sensitivity of 93.5%. AIRS yielded a sensitivity of 65.5%. In our study ultrasound achieved a diagnostic accuracy of 94.6% which is higher than any of the individual scoring systems. Combined MAS category score showed

increased sensitivity (99.1%). A study by Gallego et al also reported that using USG with standard scoring systems increases diagnostic accuracy in patients with suspected acute appendicitis.[26] As USG raises the diagnostic accuracy of each of these scores, we infer that USG should be done in all cases being evaluated for acute appendicitis; irrespective of the score being used.

Conclusion

If ultrasonography is used in conjunction with current clinical scoring systems, then the diagnostic accuracy is enhanced. Therefore, USG should be done in all cases being evaluated for acute appendicitis; irrespective of the score being used. Among the clinical scoring systems, RIPASA has the highest diagnostic accuracy as compared to MAS and AIRS. However, ultrasonography has a higher diagnostic accuracy as compared to any of the individual scoring systems. Therefore, use of scoring systems and/or ultrasonography helps to reduce the negative appendectomy rate. There were no statistically significant differences between the accuracy of combined MAS, combined AIRS and combined RIPASA. Thus, all three scoring systems when combined with USG are similar in terms of diagnostic accuracy. Since AIRS uses C-reactive protein which may not be routinely available in developing countries and also further increases the cost incurred to the patient. Either MAS or RIPASA may be more appropriate to be used in combination with ultrasonography than AIRS.

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