

Modified Alvarado’s Score incorporating C-reactive protein for Acute Appendicitis

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ABSTRACT

Background: Acute appendicitis is one of the commonest surgical conditions requiring emergency appendectomy. The diagnosis is usually suspected clinically and confirmed on either ultrasound or Computed tomography. The aim of our study is to improve the diagnostic accuracy of acute appendicitis and reduce the rate of negative appendectomy. We have modified the Alvarado’s score by incorporating C- reactive protein and deleting two of its components (leukocyte shift to left and migration of pain from umbilical region to right iliac fossa). **Methods:** We successfully used this scoring system on a sample size of 100 patients. Out of 100 patients, diagnosis was confirmed on histopathological examination in 76 patients. Neutrophilic infiltration of the muscularis layer was considered as the diagnostic criteria for acute appendicitis. Ten patients were diagnosed only on CECT abdomen as Appendicular lump. These patients were not operated. Alternate diagnoses were made in twelve patients with MAS score of 5 or less and in two patients with MAS score of more than 6. **Results:** On statistical analysis, the result showed that the MAS is a very specific (85.7%) and highly sensitive (95.3%) in detecting Acute Appendicitis, taking Histopathology or CT as gold standard test. While, the positive predictive value is 97.6%, negative predictive value is only 75%. **Conclusions:** This means that it is difficult to rule out acute appendicitis in patients with lower scores. However, for such patients further investigations can be done to reach to a final diagnosis.

Key words: Acute appendicitis, Modified Alvarado’s Score, C-reactive protein

INTRODUCTION

Acute appendicitis is the most common acute surgical condition of the abdomen with peak incidence occurring between the age of 10 and 30 years.^[1,2] Appendicitis usually presents with pain and tenderness in the right iliac fossa, nausea and loss of appetite.^[3] The diagnostic sequence of colicky central abdominal pain followed by migration to the right iliac fossa was first described by Murphy but present in 50% of the patients only.^[4] Thus, in most cases not all signs and symptoms are manifested,

leading to inaccurate diagnosis of acute appendicitis or resulting in delay in the diagnosis. Also, symptoms of appendicitis overlap with a number of other acute abdominal conditions making its diagnosis a challenge, particularly at an early stage of presentation.^[5]

In 1880, Robert Lawson Tait performed the first appendectomy for appendicitis in England.^[6] Now, more than 135 years later, this most common of all surgical diseases can still be a diagnostic problem. This is demonstrated by the high negative laparotomy rates documented in the literature.

A negative appendectomy occurs when a normal appendix is removed following a medical workup for acute abdominal pain that indicates surgical intervention. Long thought to be a vestigial or unnecessary organ, it is now considered possible that the appendix is a repository for symbiotic gut bacteria which help to recolonize the microbiome following a disturbance to the intestinal ecosystem. Therefore, a negative appendectomy may have long-term consequences beyond those simply due to the surgical procedure. For example, negative appendectomy is higher in pregnant women, and increases the chances of losing the baby.^[7]

Access this article online	
Website: www.iabcr.org	Quick Response code
DOI: 10.21276/iabcr.2017.3.2.5	

Received:25.02.17| Revised:26.03.17| Accepted:05.04.17

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Over the past 2 decades, the use of dedicated ultrasonography (US) and computed tomographic (CT) techniques for the evaluation of patients clinically suspected of having acute appendicitis has led to improved diagnostic accuracy of 83%–98%.^[8] Though CT Scan is of high diagnostic accuracy, but in developing countries like ours, it is not affordable by a major section of the society and its facility is restricted to only a few hospitals.

Alvarado scoring allows selective use of CT in suspected appendicitis. Thus, Alvarado's scoring system is an economical, quick and easily accessible diagnostic tool that aids in the clinical assessment of patients with acute appendicitis. The Alvarado score is well known and best performing in validation studies, but not without limitations, it has some drawbacks. It is not consistent among children and it tends to over predict the probability of acute appendicitis among women.^[9] Its construction was based on a review of patients who had been operated with suspicion of appendicitis, whereas the score is supposed to be used on all patients with suspicion of appendicitis.^[10]

As a consequence, acute appendicitis is still a difficult diagnosis. However, arriving at the correct diagnosis is essential and any delay in the diagnosis may allow progression to perforation which will significantly affect the morbidity.

In our study, **Modified Alvarado's scoring system** is designed to overcome these drawbacks. This scoring system will incorporate the C-reactive protein (CRP) value which is an acute phase protein whose serum level rises in response to inflammation. Including serum CRP level as one of the elements of the scoring system is expected to increase the sensitivity and specificity of the test for the detection of acute appendicitis.

A study on malpractice lawsuits from North America found that appendicitis ranks third among lawsuits, even though appendicitis is the cause of acute abdominal pain only about 5% of the time or less.^[11] An objective validated scoring system with better diagnostic accuracy would legally strengthen decisions made in the emergency room and could avoid malpractice liability.

OBJECTIVES:

The objective of the study is

1. To increase the diagnostic accuracy of acute appendicitis through modification of Alvarodo's Score.
2. To decrease the rate of negative laparotomy of appendix.
3. To prevent any delay in the treatment by prompt diagnosis.

METHODS

This study was a prospective hospital based study comprising of patients presenting with pain right lower abdomen to surgery out-patient department or surgical emergency at a tertiary care hospital over a period of one year.

A total of 100 consecutive patients admitted with a suspicion of acute appendicitis were included in the study. Any patients in whom diagnosis could not be confirmed either on Contrast enhanced computerized scan or histopathological examination after appendectomy were excluded from our study.

Subsequent to the admission, clinical examination of the patients was done followed by the estimation of C- reactive protein and complete blood count. Estimation of the serum CRP was done by ELISA method in the central laboratory of the same hospital. Normal concentration in healthy human serum is between 5 and 10 mg/L. Anything more than 10 was taken as positive.

The original Alvarado's score was modified by deleting migration of pain and shift of white blood cell count to left and adding C-Reactive protein (Table 1).

Table 1: Alvarado and Modified Alvarado Score

Alvarado Score		Modified Alvarado Score	
Features	Score	Features	Score
Migration of pain	1		
Anorexia	1	Anorexia	1
Nausea	1	Nausea	1
Tenderness in Right lower quadrant	2	Pain in right lower quadrant	1
Rebound pain	1	Tenderness in Right iliac fossa	2
Elevated temperature	1	Elevated temperature	1
Leucocytosis	2	Leucocytosis of more than 11000/mm ³	2
Shift of white blood cell count to left	1	C-reactive Protein	2
Total	10		10

Modified Alvarado score of 6 or more was taken as positive for Acute appendicitis and appendectomy was planned. The score obtained was compared with the results of CECT abdomen or the histopathology of the appendix removed surgically.

The selected patients were grouped as:

1. Unlikely (score of 5 or less)
2. Probable (score 6 or more)

Having a normal CRP in the equivocal group of Alvarado 4-6, was further evaluated by advanced imaging before proceeding to appendectomy.

RESULTS

The present study included 100 consecutive patients with clinical suspicion of Acute appendicitis. There were 68 male patients and 32 female patients. The mean patient age was 24.6 years (males- 23 years while in females it was 34years). Age ranged from 5–65 years. All of these patients presented with pain in the right lower abdomen (Table 2). Clinical diagnosis of Acute appendicitis was made in 69 patients, appendicular lump in 15 patients, appendicular abscess in 2 patients, recurrent appendicitis in 7 patients and appendicular perforation peritonitis was diagnosed in 7 patients (Table 3).

Out of these 100 patients 84 were having score of more than 6 while 16 patients were having score of 5 or less. 72 patients with MAS score of more than 6 have been operated and diagnosis was confirmed on histopathological examination, 10 patients were diagnosed on CECT as appendicular lump and two as typhilitis. All these 12 patients were managed conservatively.

Table 2: General patient characteristics:

Patient parameters	Value
Mean age	24.6
Male/Female	68/32
Positive CRP	76
Diagnosis confirmed (Appendicular pathology)	(76 on Histopathology and 10 on CECT)
No. of patients underwent surgery	76
Negative appendectomy after surgery	None

Table 3: Clinical Diagnosis with MAS

Clinical Diagnosis (No. of patients=100)	Modified Alvarado score	No. of patients
Appendicular lump (3) Recurrent Appendicitis (7) Acute appendicitis (6)	5 or less (Unlikely)	16 (Score of 3 in two, 4 in five patients while score of 5 in nine patients)
Acute appendicitis (63) Appendicular lump (12) Appendicular abscess (2) Appendicular perforation (7)	6 or more (Probable)	84

Out of sixteen patients with score of less than 5, diagnosis of appendicitis was made in four patients on histopathological examination. One patient was diagnosed first on CECT and then underwent appendectomy. Three patients were admitted with history of recurrent appendicitis, underwent appendectomy and histopathology showed features of chronic appendicitis. Twelve patients were having alternate diagnosis. Three patients were diagnosed with Ureteric stones, five patients with mesenteric adenitis and two patients each with ileitis and ileocaecal tuberculosis)

Table 4: Validity of MAS as a screening test

MAS score	Confirmed Acute Appendicitis on the basis of Histopathology/CT		Total	
	Yes	No		
5 or less (Unlikely)	04	12	16	Sensitivity = 95.35 Specificity = 85.71 Positive Predictive value= 97.62 Negative Predictive value= 75
6 or more (Probable)	82	2	84	
Total	86	14	100	

Appendectomy was performed on total of 76 patients in both the groups. Of these, 72 patients underwent appendectomy based on the Modified scoring system, according to which they had a score of more than 6 while four patients having a score of less than 6 points underwent

appendectomy based on their CECT findings that were suggestive of appendicitis.

Out of 100 patients, diagnosis was confirmed on histopathological examination in 76 patients, ten patients were diagnosed only on CECT abdomen as Appendicular lump. These patients were not operated. Alternate diagnoses were made in twelve patients with MAS score of 5 or less and in two patients with MAS score of more than 6.

DISCUSSION

Appendicitis accounts for over 3% of the diseases that involve the digestive system, is the most common acute surgical problem of the abdomen, and appendectomy is the fifth most common surgical procedure performed on the gastrointestinal tract.^[12]

As per the study conducted by David R. Flum et al (2001)^[13] the frequency of misdiagnosis leading to unnecessary appendectomy has not changed with the introduction of computed tomography, ultrasonography, and laparoscopy, nor has the frequency of perforation decreased. These data suggest that on a population level, diagnosis of appendicitis has not improved with the availability of advanced diagnostic testing.

A study performed in 2005 in the Netherlands found that approximately 15% of the patients underwent a negative appendectomy, a number similar to another large Swedish study.^[14] The negative appendectomy rate was 13% in another large North American study.^[15]

The main aim of the clinical decision making process is to reach an accurate diagnosis in the fastest and cheapest way.^[16] History and clinical examination provide useful information regarding diagnosis but even then different possibilities are there. The choice that whether to operate or not, is very important.

Different diagnostic aids have appeared recently and among this laparoscopy and ultrasonography have shown good results but they also have limitations and drawbacks.^[17]

Over the past 2 decades, the use of dedicated ultrasonography (US) and computed tomographic (CT) techniques for the evaluation of patients clinically suspected of having acute appendicitis has led to improved diagnostic accuracy of 83%–98%.^[8] Though CT Scan is of high diagnostic accuracy, in developing countries like ours, it is not affordable by a major section of the society and also, its facility is restricted to only a few hospitals. Another concern about CT is the radiation exposure because of which it should be used selectively to minimize exposure to ionizing radiation.^[18] Moreover, false negative results may delay surgery and subsequently increase morbidity.^[19] Strategies to suggest which patients presenting to the emergency department (ED) should undergo computed tomography (CT) scan to confirm appendicitis have to be accurate.

A clinical scoring system estimates the probability of appendicitis in a patient and should aid in the decision-

making process for treatment because of its simple design and application. At present, many clinical scoring systems like Alvarado scoring are available and have proved useful in the management of acute appendicitis but the poor diagnostic accuracy has consequently resulted in an increase in the rate of negative appendectomy. Hence, there is a need for intervention to reduce the rate of negative appendectomy.

A study conducted by Ikramullah Khan and Ata ur Rehman^[20] on diagnostic accuracy of Alvarado's scoring system showed negative appendectomy frequency of 15.6% (male 12%, female 17.9%). The Perforation rate was 7.8%. Positive predictive value was 84.3% (males 88%, females 82.1%). The scoring system did not include C reactive protein. It is not consistent among children and it tends to over predict the probability of acute appendicitis among women.^[9] The study showed a very high negative appendectomy if only Alvarado scoring is used for the decision making. Therefore, there is a need for another scoring system with better diagnostic yield. We have modified the Alvarado Score by incorporating the CRP and removing the two components namely migration of pain and Shift of white blood cell count to left with the same maximum score of 10. This was done with the assumption that it may lead to better diagnostic yield.

A study by S. Eriksson et al^[21] suggests that repeated laboratory tests for CRP and WBC should be performed in patients with suspected acute appendicitis requested to stay for further observation. If these test results are normal, the surgeon should preferably refrain from operating but consider other differential diagnoses. But, repeated testing and long hospital stay may not be affordable and hence unacceptable to many patients. Therefore, it cannot be a reliable standard diagnostic method. However, it supports our consideration of incorporating CRP in the modified scoring system.

S.M.de Castro et al conducted a study to evaluate the appendicitis Inflammatory response (AIR)^[22] score for acute appendicitis with a similar objective of improving the diagnostic accuracy by incorporating CRP along with many other variables and showed a better specificity than Alvarado's score. However, its sensitivity in patients having more than 8 points in the scoring system is less than the Alvarado's score, though no specific reason has been mentioned. Moreover, the scoring system has included tenderness as 3 separate elements- light, medium and strong with allotted points of 1, 2 and 3 respectively which is too subjective to be discerned. This scoring system does not seem to establish any definite criteria for radiological investigation. There is not much advantage of subdividing the WBC count into less than or more than 15000 as counts are mostly less than 15000 in uncomplicated appendicitis. Any patient with appendicular abscess or appendicular perforation peritonitis doesn't pose much of a clinical challenge.

In our study, with the objective of improving the diagnostic accuracy of acute appendicitis, we have modified the Alvarado's score by incorporating C- reactive protein and

deleting two of its components (leucocyte shift to left and migration of pain from umbilical region to right iliac fossa). We successfully used this scoring system on a sample size of 100 patients. Out of 100 patients, diagnosis was confirmed on histopathological examination in 76 patients. Neutrophilic infiltration of the muscularis layer was considered as the diagnostic criteria for acute appendicitis. Ten patients were diagnosed only on CECT abdomen as Appendicular lump. These patients were not operated. Alternate diagnoses were made in twelve patients with MAS score of 5 or less and in two patients with MAS score of more than 6.

On statistical analysis, the result showed that the MAS is a very specific (85.7%) and highly sensitive (95.3%) in detecting Acute Appendicitis, taking Histopathology or CT as gold standard test.

While, the positive predictive value is 97.6%, negative predictive value is only 75%. This means that it is difficult to rule out acute appendicitis in patients with lower scores. Modified Alvarado score which we have used is very specific and highly sensitive for the diagnosis of acute appendicitis and its complications. The patients with a low score may be investigated further for the final diagnosis.

CONCLUSION

Modified Alvarado score can be used effectively to diagnose patients with Acute appendicitis. The disadvantage is that the low scores cannot rule out the disease and may require further work up for the patients with high suspicion or in whom an alternate diagnosis could not be made on Ultrasonography.

Acknowledgement: ICMR

Ethical Committee Approval: Obtained

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How to cite this article: Husain M, Islam H, Khan S, Nadeem R. Modified Alvarado's Score incorporating C-reactive protein for Acute Appendicitis. *Int Arch BioMed Clin Res.* 2017;3(2):20-24.DOI:10.21276/iabcr.2017.3.2.5

Source of Support: partly ICMR, **Conflict of Interest:** None