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ORIGINAL ARTICLE

A STUDY OF PRE-OPERATIVE DIAGNOSIS OF ACUTE APPENDICITIS USING ALVARADO SCORE IN RURAL POPULATION

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ABSTRACT: BACKGROUND AND OBJECTIVES: The diagnosis of the acute appendicitis is essentially clinical; but the negative appendectomy rates are still high (15-30%). APACHE scoring, RANSON scoring, GLASGOW scale, and GOLDMAN'S cardiac index have all proven their importance in surgical practice. ALVARADO SCORE is a new scoring system introduced in 1986 and modified in 1994, used for the diagnosis of acute appendicitis. The objective of this study is to evaluate the sensitivity and specificity of Modified Alvarado score in pre-operative diagnosis of acute appendicitis. **METHODS:** 50 patients who presented with RIF pain and admitted in our rural hospital were included in the study. Pre-operative evaluation with application of the Modified Alvarado score was done. Per-operative findings were noted and HPE reports were followed up. The collected data was analyzed with regard to various parameters like sensitivity, specificity, predictive values and accuracy. **RESULTS:** In our study, out of 50 patients presented with RIF pain, histopathology proved 35 patients to have features suggestive of acute appendicitis. The sensitivity and specificity for MAS>7 were 42% and 93% respectively. And the accuracy of the test for score >7 was 58%, for score 5-6 and <4, it was 44% and 28% respectively. **CONCLUSION:** A strong clinical suspicion (MAS>7) aided by laboratory tests is a valuable tool for early diagnosis and definitive treatment of appendicitis.

KEYWORDS: Appendicitis; Appendectomy; RIF pain; Modified Alvarado Score.

INTRODUCTION: Appendix previously considered as a vestigial organ of human body, has gained its importance presenting as an acute surgical emergency.

Clinically acute appendicitis presents with varied combination of clinical symptoms and signs that includes abdominal pain, vomiting, anorexia, fever, constipation/diarrhea, dysuria etc. This wide spectrum of clinical features makes clinical diagnosis of acute appendicitis difficult. Added to the above confusion, conditions like gastroenteritis, Meckle's diverticulitis, renal/ureteric stones, ectopic pregnancy, ovarian cyst and others, frequently presents with clinical syndrome similar to acute appendicitis.

A clinical suspicion of acute appendicitis tempts a surgeon in training or sometimes an experienced surgeon to err on the side of negative appendectomy rather than allowing the acute condition to complicate.

Many diagnostic methods have shown their capability in diagnosing acute appendicitis but clinical suspicion and appropriate decision by the surgeon still stands gold standard diagnostic tool. The diagnosis of the acute appendicitis is essentially clinical; but the negative appendectomy rates are still high (15-30%).[1]

Many scoring systems have helped the surgeon in clinical diagnosis and management of many surgical conditions. Alvarado scoring system is one such scoring system introduced in 1986 and modified in 1994, since then many studies have been done to prove its importance in diagnosis of acute appendicitis.[2]

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In this study, an earnest endeavor has been made to study the importance of Modified Alvarado score in clinical diagnosis of acute appendicitis in rural population.

AIM OF THE STUDY: The objective of the present study is to evaluate the sensitivity and specificity of Modified Alvarado score (MAS) in pre-operative diagnosis of acute appendicitis in rural population

MATERIALS & METHODS: Source of Data: The material for the present study is proposed to be collected from the patients who presents with RIF pain with/without fever and vomiting, admitted to the department of surgery at Sri Adichunchanagiri Hospital and Research Centre, B. G. Nagara for a duration of 2 years. 50 patients fulfilling the inclusion criteria were included in the study.

Method of Collection of Data:

- Detailed history taking.
- Complete clinical examination of the patient.
- Routine and special Investigations.
- Application of the Modified Alvarado scoring system.
- Performing surgery for the selected cases, noting per-operative findings and follow-up of histopathological reports.

Inclusion Criteria: Patients aged between 12-60 years of age of both gender admitted with the provisional diagnosis of acute appendicitis.

Exclusion Criteria:

- Patient aged below 12 years or above 60 years.
- Patients managed conservatively.
- Patients who underwent interval appendectomy.
- Patients with RIF mass.
- Patients with presentation of urological, gynecological or surgical problems other than appendicitis.

Investigations: Routine:

- Haemoglobin percentage
- Total & differential WBC count
- ESR
- Bleeding & clotting time
- Urine Routine
- Blood sugar
- Blood urea and
- Serum creatinine

Specific:

- Ultrasound abdomen
- CT Scan abdomen

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- Chest x-ray
- Erect x-ray abdomen
- ECG

Appendectomy was done in all selected cases and the decision to operate was taken by the surgeon. The per-operative and histopathological findings were compared with the pre-operative diagnoses.

The collected data was analyzed with regard to various parameters like sensitivity, specificity, predictive values and accuracy.

Criteria for acute appendicitis by Modified Alvarado Score:

ALVARADO SCORE.[1]	
SYMPTOMS:	
Migratory RIF pain	1
Anorexia	1
Nausea and Vomiting	1
SIGNS:	
Tenderness RIF	2
Rebound tenderness	1
Elevated body temperature	1
LABORATORY:	
Leucocytosis	2
Shift to left	1
Total score	**10**
Note: Modified Alvarado score does not include shift to left of neutrophil maturation.[3] Hence total score becomes 9 in Modified Alvarado Score.	

Table 1: Alvarado Scoring

SCORE 7–9: Diagnostic of acute appendicitis.
SCORE 5–6: Compatible with acute appendicitis but not convincing.
SCORE 1–4: Unlikely to have acute appendicitis.

Histopathological Criteria: Presence of significant numbers of neutrophils in the muscularis propria of the vermiform appendix was considered as the main criterion for the histopathological diagnosis of acute appendicitis.

Statistical Analysis: The collected data were incorporated in a redesigned clinical proforma and then tabulated in a master chart of 50 patients.

The collected data was analyzed with regard to various parameters like:

- Age incidence.
- Sex incidence.
- MANTREL distribution.
- Sensitivity.

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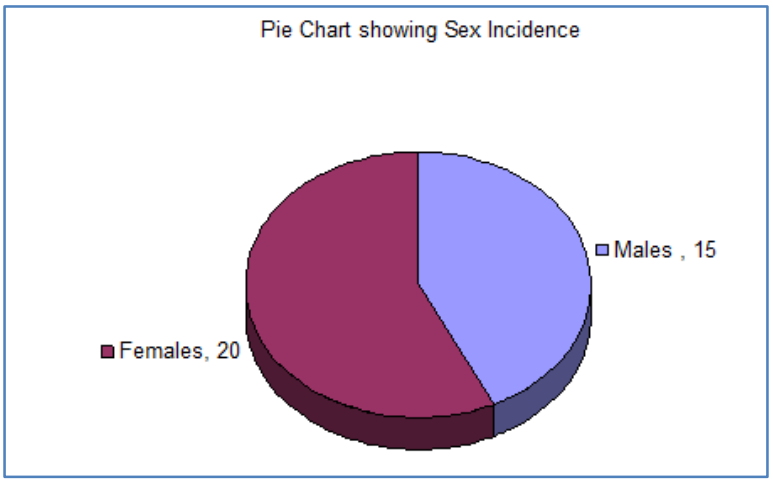
- Specificity.
- Predictive values and
- Accuracy.

RESULTS:

1. **Sex Incidence:** 50 patients with clinical suspicion of acute appendicitis were studied during a period of two year, out of which 15 males, 20 females and a total of 35 patients were proved to be having appendicitis by histopathplogical examination of appendectomy specimens.

	NO.OF CASES	INCIDENCE
Males	15	42.85%
Females	20	57.15%
Total	**35**	**100%**
Male: Female Ratio was 3: 4		

Table 2: Sex Incidence of acute appendicitis in our study



Graph 1: Pie chart showing Sex incidence in our study

2. **Age Incidence:** 50 patients with clinical suspicion of acute appendicitis were studied during a period of two year, age wise distribution of acute appendicitis were as follows.

Age group	No.of Cases studied	Histopathology positive	Age incidence
12-20 yrs	25	20	57.14%
21-30 yrs	12	08	22.86%
31-40 yrs	04	02	05.71%
40-50 yrs	05	03	08.58%
50-60 yrs	04	02	05.71%
Total	50	35	100%

Table 3: Age Incidence of acute appendicitis in our study

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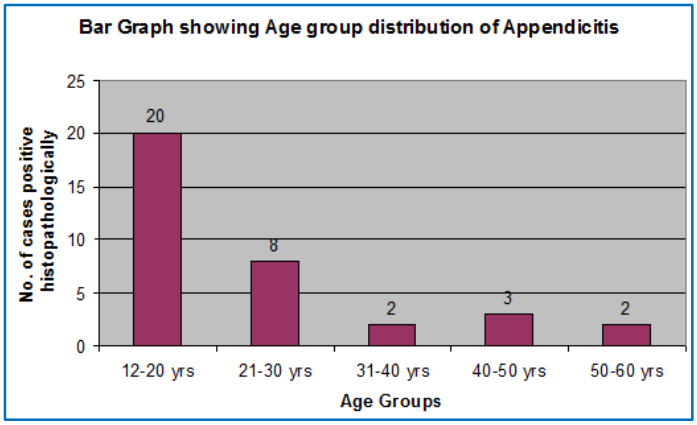
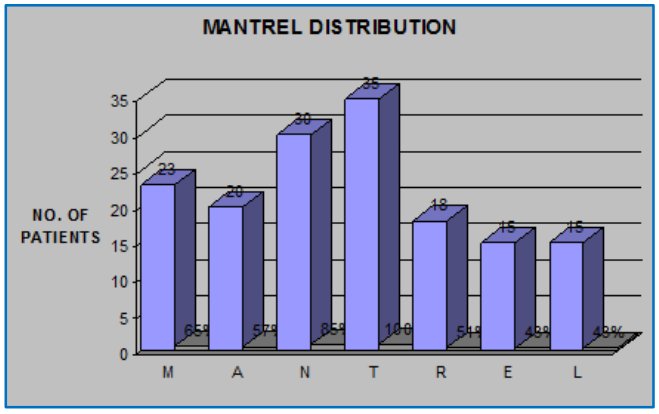


Graph 2: Bar Graph showing Age Group distribution of Appendicitis in our study

3. MANTREL Distribution among Appendicitis Patients:

	MANTREL CRITERIA	No. patient studied	No. cases with Histopatology positive	MANTREL distribution
M	Migratory RIF pain	23	23	65%
A	Anorexia	27	20	57%
N	Nausea/ Vomiting	40	30	85%
T	Tenderness in the right iliac fossa	50	35	100%
R	Rebound tenderness	22	18	51%
E	Elevated body temperature	21	15	43%
L	Leucocytosis	19	15	43%
	TOTAL	**50**	**35**	

Table 4: MANTREL distribution among Appendicitis patients in our study



Graph 3: Bar Graph showing MANTREL distribution among Appendicitis patients in our study

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FOR MODIFIED ALVARADO SCORE FOR > 7:

ALVARADO SCORE	HPE POSITIVE	HPE NEGATIVE	TOTAL
POSITIVE	a = 15	b = 1	**16**
NEGATIVE	c = 20	d = 14	**34**
TOTAL	35	15	**50**

Table 5: Tabulations for Modified Alvarado score >7

SENSITIVITY:

= a / (a+c) = 42%.

SPECIFICITY:

= d / (b+d) = 93%.

POSITIVE PREDICTIVE VALUE:

= a / (a+b) = 93%.

NEGATIVE PREDICTIVE VALUE:

= d / (c+d) = 41%.

Accuracy = (true positive + true negative) /total = (a+d) /total = 58%.

Kappa = (Io–Ie) / (I–Ie) = 0.19, where Io = Observed aggregate and Ie = Expected aggregate.

FOR MODIFIED ALVARADO SCORE FOR > 5-6:

ALVARADO SCORE	HPE POSITIVE	HPE NEGATIVE	TOTAL
POSITIVE	a = 13	b = 6	**19**
NEGATIVE	c = 22	d = 9	**31**
TOTAL	35	15	**50**

Table 6: Tabulations for Modified Alvarado score 5-6

SENSITIVITY:

= a / (a+c) = 37%.

SPECIFICITY:

= d / (b+d) = 60%.

POSITIVE PREDICTIVE VALUE:

= a / (a+b) = 68%.

NEGATIVE PREDICTIVE VALUE:

= d / (c+d) = 29%.

Accuracy = (true positive + true negative) /total = (a+d) /total = 44%.

Kappa = (Io–Ie) / (I–Ie) = 0.018, where Io = Observed aggregate and Ie = Expected aggregate.

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FOR MODIFIED ALVARADO SCORE FOR <4:

ALVARADO SCORE	HPE POSITIVE	HPE NEGATIVE	TOTAL
POSITIVE	a = 7	b = 8	15
NEGATIVE	c = 28	d = 7	35
TOTAL	35	15	50

Table 7: Tabulations for Modified Alvarado score <4

SENSITIVITY:

= a / (a+c) = 20%.

SPECIFICITY:

= d / (b+d) = 46%.

POSITIVE PREDICTIVE VALUE:

= a / (a+b) = 46%.

NEGATIVE PREDICTIVE VALUE:

= d / (c+d) = 20%.

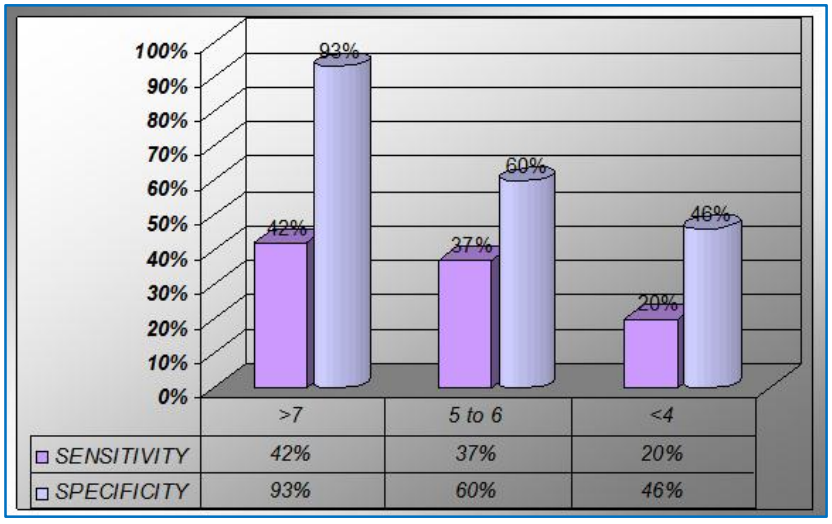
Accuracy = (true positive + true negative) /total = (a+d) /total = 28%.

Kappa = (Io–Ie) / (I–Ie) = 0.24, where Io = Observed aggregate and Ie = Expected aggregate.

OVERALL SENSITIVITY AND SPECIFICITY OF MODIFIED ALVARADO SCORE:

SCORE	SENSITIVITY	SPECIFICITY
>7	42%	93%
5-6	37%	60%
<4	20%	46%

Table 8: Sensitivity and Specificity for various scores in our study



Graph 4: Bar Graph showing Sensitivity and Specificity for various scores in our study

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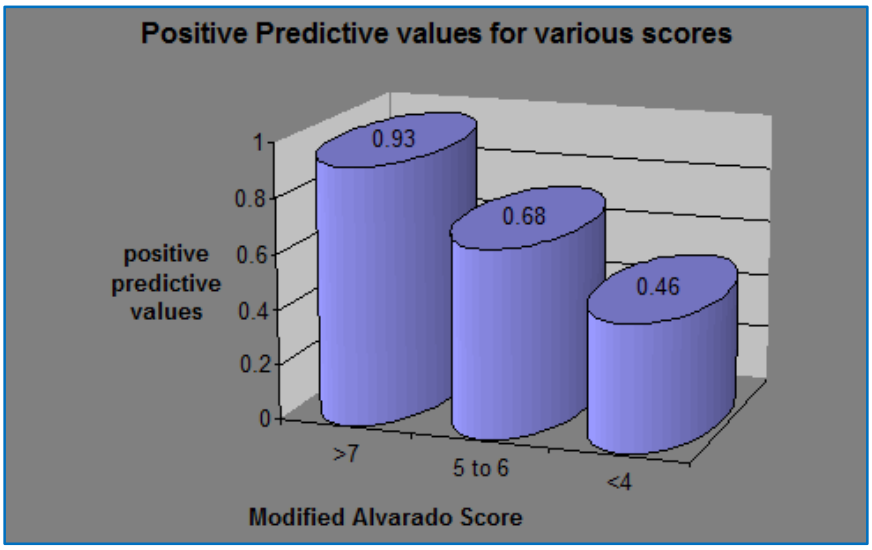
OVERALL POSITIVE PREDICTIVE VALUES OF MODIFIED ALVARADO SCORE:

	SCORE	NO. OF PATIENTS	ACUTE APPENDICITIS	NORMAL	POSITIVE PREDICTIVE VALUE
1.	7-9	16	15	01	0.93
2.	5-6	19	13	06	0.68
3.	1-4	15	07	08	0.46
Total		**50**	**35**	**15**	

Table 9: Positive predictive values for various scores in our study



Graph 5: Bar Graph showing Positive predictive values for various scores in our study

OVERALL ACCURACY OF MODIFIED ALVARADO SCORE:

	SCORE	ACCURACY
1.	7-9	58%
2.	5-6	44%
3.	1-4	28%
Total		50

Table 10: Accuracy for various scores in our study

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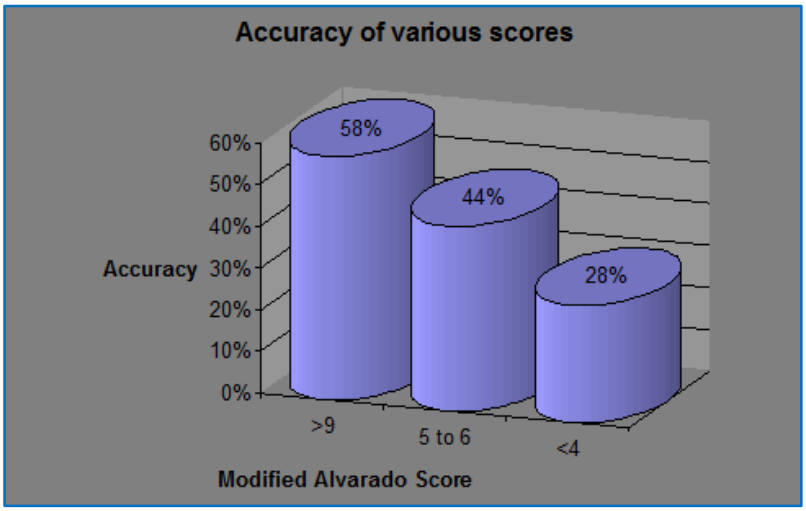

Graph 6: Bar Graph showing Accuracy for various scores in our study

DISCUSSION: The diagnosis of acute appendicitis continues to be difficult due to the variable presentation of the disease and the lack of reliable diagnostic test. Although there has been some improvement in the diagnosis of acute appendicitis over the past several decades, the percentage of normal appendices being removed, reported in various series varies from 8 to 33%.[4,5,6]

Clinical scoring systems have proved useful in the management of number of surgical conditions. In the past few years various scores have been developed to aid the diagnosis of acute appendicitis.[7] Although many diagnostic scores have been advocated, most are complex and difficult to implement in the clinical situation.[7] The Alvarado score, is a simple scoring system that can be instituted easily.[2]

In a prospective study of 215 adults and children in Cardiff, use of the Alvarado score decreased an unusually high false-positive appendicectomy rate of 44% to14%.[8]

Fenyo,[9] reported in one study a sensitivity of 90.2% and specificity of 91.4% and others reported a sensitivity of 73%, specificity of 87% with negative laparotomy rate of 17.5%.[10]

A study was done by Mohd. Saleem and Ahemed M using Modified Alvarado score on 125 patients between the ages of 16 to 76 years with the provisional diagnosis of acute appendicitis, showed a sensitivity of 53.8% and specificity of 80%.[11]

Siddique K., reported a sensitivity of 57.8% and specificity of 78% in a prospective study done on Modified Alvarado score among 267 patients during 2006 in Holy family hospital, Rawalpindi.[12]

To be useful, a scoring system must be both sensitive and specific. The Modified Alvarado score proved to be effective in one study in adult patients with acute appendicitis[13] but in another study was not successful in paediatric age group.[14]

Modified Alvarado score is an objective assessment of right lower quadrant pain. The score >7 indicates high probability of acute appendicitis. Practically speaking, it is equivalent to one's degree of clinical suspicion.

Ultrasound has no place as a screening tool but may help in cases of doubtful diagnosis.

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In our study of 50 patients presenting with RIF pain, histopathology proved 35 patients to have features suggestive of acute appendicitis.

Among the patients presenting to us, 65% had migrating abdominal pain, 57% had anorexia and 85% had nausea, while a study done by Gulzars et al,[15] showed that 48% patients had migratory pain, 90% had anorexia and 75% presented with nausea.

Leucocytosis is present in most of the patients with appendicitis but it is also elevated in many other inflammatory conditions. Differential count shows neutrophilia in most cases of appendicitis. The comparison of WBC count in our study with that done by Dorraiswamy[16] is shown in the table.

Study group	Number	Leucocytosis
Dorraiswamy	225	42%
Our study	35	43%

Table 11: Comparison of incidence of leucocytosis

In our present study, 16 patients had a Modified Alvarado score of > 7 with a positive predictive value of 93% and negative predictive value of 41%.

Sensitivity and specificity of our test were as follows:

Score	Sensitivity	Specificity
>7	42%	93%
5-6	37%	60%
<4	20%	46%

Table 12: Sensitivity and Specificity for various scores in our study

The accuracy of the test for score >7 was 58%, for score 5-6 and <4, it was 44% and 28% respectively.

The efficiency of the test for score>7 was very good. For a score 5-6, patients needed further collaborative investigations like USG to reduce negative appendectomy rates. And for score <4, negative appendectomy rate was very high.

This study done in Sri Adichunchanagiri Hospital and Research Centre, B. G. Nagara, showed very good efficiency of Modified Alvarado Scoring. The results as compared to those of previous studies were as follows:

	Sensitivity	Specificity
Mohd. Saleem and Ahemed M[11]	53.8%	80%
Khurram Siddique [12]	57.8%	78%
Our study	42%	93%

Table 13: Comparison of Sensitivity and Specificity of our study with previous studies

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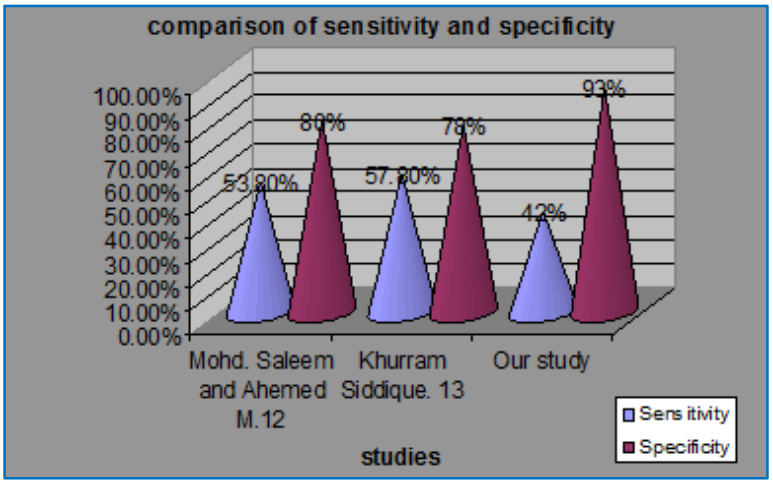

Graph 7: Graph showing comparison of sensitivity and specificity of our study with previous studies

It was observed that the sensitivity and specificity in our study were almost comparable with those of standard studies.

CONCLUSION: The clinical suspicion and presence of high score was found to be a dependable aid in the pre-operative diagnosis of acute appendicitis. Diagnosis of acute appendicitis is virtually confirmed with a score of 7-9 especially in males and should undergo appendectomy. Patients with score 5-6 must be admitted and scored frequently. These patients should undergo graded compression ultrasonography in order to confirm the diagnosis. Score 1-4 can be discharged unless otherwise indicated.

Clinical judgment still has a place, especially if an experienced clinician is prepared to re-evaluate doubtful cases at regular intervals: rapid, unexpected perforation is uncommon, and there is no case for rushing to operate in marginal cases. Scoring systems may help, if only by formalizing assessment and ensuring attention to detail.

There is no advantage of ultrasound over the Modified Alvarado score for the diagnosis of acute appendicitis. Ultrasound is unnecessary when one's degree of clinical suspicion is high. However, the additional information provided by ultrasound does improve diagnostic accuracy in the case of a negative or equivocal Alvarado score.

'Thus clinical suspicion aided by laboratory tests is a valuable tool for early diagnosis and definitive treatment of appendicitis'

BIBLIOGRAPHY:

1. Connell pr. The vermiform appendix. In: bailey and love's short text book of surgery. 24th ed. London: arnold, 2004; 1203-1218.
2. Alvarado a., et al 1986 "a practical score for the early diagnosis of acute appendicitis". Ann emerg med, 15: 557-564.
3. Kalan m., et al 1994 "evaluation of the modified alvarado score in the diagnosis of acute appendicitis": a prospective study. Ann r. Coll. Surg. Engl 76: 418-419.
4. Chan m. Y. P., et al 2003 "Alvarado score: an admission criterion in patients with right iliac fossa pain". Surg j r coll surg edinb irel, 1 February 2003: 39-41.

DOI: 10.14260/jemds/2015/955

5. Bell m. J., bower r. J., Ternberg j. L.: Appendicectomy in childhood. Analysis of 105 negative appendix. Am. J. Surg. 1982; 144: 335-337.
6. Deutch a. A., Shani n., Reiss r.: are some appendectomies unnecessary? J. R. Coll. Surg. Edinb. 1983; 28: 35-40.
7. Ohmann c., et al 1995 "diagnostic scores for acute appendicitis, abdominal pain study group". Eur j surg 161: 273-281.
8. Owen t. D., et al 1992 "evaluation of the Alvarado score in acute appendicitis". J r Soc med 85: 87-88.
9. Fenyö g.: routine use of a scoring system for decision-making in suspected acute appendicitis in adults. Acta Chir Scand 1987; 153: 545-551.
10. Fenyo g., et al 1997 "diagnostic decision support in suspected acute appendicitis: validation of a simplified scoring system". Eur j surg 163 (11): 831-838.
11. Saleem m. I., et al "appraisal of the modified alvarado score for acute appendicitis in the adults". Lecture, royal coll. Surg: http: //www. Edu. Rcsed. Ac. Uk/lectures/lt22. Htm.
12. A siddique k, jamil a, ali q, ehsan a, anwar i, zafar a.: evaluation of modified alvarado score and ultrasonography in acute appendicitis: international journal of surgery. Friday 1, June 2007.
13. Harrold ellis, keith nathanson l zinner mj, shwartz si, harold ellis. Appendix and appendectomy. In: maingot's abdominal operations. 10th ed. Connecticut: Appleton and lange, 1997; 1191-1227.
14. Macklin. , et al 1997 "alvarado score for acute appendicitis in children. Ann r. Coll. Surg. Engl 79: 203-205.
15. Gulzar s, umar s, dar gm and rasheed. Acute appendicitis –importance of clinical examination in making a confident diagnosis. Pak j med sci 2005: 21 (2): 125-132.
16. Doraiswamy n v. Leucocyte counts in the diagnosis and prognosis of acute appendicitis in children. Br j surg. 1979; 66: 782.

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