EVALUATION OF MODIFIED ALVARADO SCORE IN DIAGNOSIS OF ACUTE APPENDICITIS- A PROSPECTIVE STUDY COMPARING THE SCORE WITH HISTOPATHOLOGY

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ABSTRACT

BACKGROUND

Objectives- Acute appendicitis is one of the common causes of acute abdomen, especially in the younger population. Failure of early diagnosis and appropriate treatment can lead to progression of the disease and fatal complications. Definitive treatment in majority of cases is appendicectomy, but the decision to do appendicectomy based on clinical suspicion alone can lead to removal of normal appendix in 15 to 30% of cases.

The aim of this study is to assess the efficacy of Modified Alvarado score in decision making and thereby reducing the incidence of negative appendicectomy.

MATERIALS AND METHODS

A total of 100 patients were analysed for this prospective study conducted from January 2014 to June 2015, at a tertiary centre in south India. All patients clinically diagnosed as acute appendicitis were evaluated using modified Alvarado scoring system and the score obtained in each case recorded in the proforma. Patients with high suspicion of acute appendicitis by the surgeon irrespective of the score were taken up for surgery, following surgery all appendix specimens were sent for histopathologic examination. The scoring system is then correlated with the histopathology reports.

RESULTS

The negative appendectomy rate was 3.79% (males 5%, females 15.38%). Sensitivity of the scoring system was 90.47% (males 98.48%, females 78.57%). Specificity was 81.25% (males 75%, females 83.3%). Positive predictive value was 96.20% (male patients 98.48%, female patients 84.6%). Negative predictive value was 61.9% (male patients was 75% and female patients was 76.9%).

CONCLUSION

Modified Alvarado score increases the diagnostic certainty of clinical examination in acute appendicitis, reducing the progression of the disease to perforation and other complications. Misdiagnosis leading to negative appendectomy can also be reduced, thus avoiding the morbidity of the procedure.

KEYWORDS

Acute Appendicitis, Appendectomy, Modified Alvarado Score, Histopathology, Negative Appendicectomy.

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BACKGROUND

Acute appendicitis is the most common surgical emergency we encounter in our day-to-day practice. The lifetime risk of acute appendicitis was estimated to be 8.6% for men and 6.7% for women.[1] Highest incidence is in the second and third decades of life.[1] Diagnosis of acute appendicitis may be straight forward in established cases and is often made by signs and symptoms of migratory abdominal pain, fever, vomiting, tenderness, rebound tenderness with or without rigidity in the right iliac fossa and laboratory finding of leucocytosis.[2] Diagnosis is not always an easy task, especially in early stages of the disease and in atypical presentation. Moreover, acute catarrhal or non-perforated appendix behaves differently from acute obstructed and perforated appendix.[1] Failure of early diagnosis can lead to progression of the disease and fatal complication. Worldwide, perforated appendicitis is the leading general surgical cause of death.[3]

Even though the rate of appendicectomy for appendicitis have been decreasing since 1950's,[4,5] surgery for acute appendicitis constitute 12% of all abdominal operations.[6] The percentage of misdiagnosed cases of acute appendicitis is significantly higher among women than men (22.3% - 9.3%).[4] A decision to operate based on clinical suspicion alone can lead to removal of a normal appendix in 15% to 30% of cases.[7] Since the introduction of preoperative ultrasound and Computed Tomography (CT), the rate of negative appendectomy has decreased.[8,9,10] Although, they decrease the proportion of negative appendectomies, ultrasonography and CT have their own limitations, which preclude every patient from routinely undergoing imaging studies prior to surgery. Diagnosis can only be confirmed at surgery and after

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histopathological examination of surgical specimen (Gold standard).

For many years, the appendix was considered as a vestigial organ with no known function. It is now well recognised that the appendix is an immunologic organ that participate in the secretion of immunoglobulins, particularly immunoglobulin A. Data published from Australia suggest that appendicectomy may protect against the subsequent development of inflammatory bowel disease,[11] only beneficial effect of appendicectomy reported; however, the exact mechanism is unclear. Even though appendicectomy is a common surgical procedure and considered safe emergency procedure, a recent meta-analysis evaluating worldwide mortality data following emergency abdominal surgery from 357 centres in 58 countries suggest that surgical mortality is three times higher in emergency surgery done in low income countries compared with high income (HDI- Human Development Index)[12] countries even when adjusted for prognostic factors.[13] Appendix is sometimes used in reconstructive urological surgery as a conduit.[14] Negative appendicectomy therefore robs the patient of a useful asset and also has a morbidity of 13%.

The clinical diagnosis of appendicitis is a subjective estimate based on multiple variables. This process can be made more objective by use of clinical scoring system based on multiple variables with proven discriminatory power. Alvarado score introduced in 1985[15,16] and its modified version[17] is the most widely used scoring system. Its main application is to rule out appendicitis. Recently introduced 'Appendicitis inflammatory response score,'[18] resembles Alvarado score with more graded variables and includes C-reactive protein, but has not gained widespread acceptance.

The present study is to evaluate the efficacy of the Modified Alvarado score in a tertiary hospital in South India, in facilitating more accurate diagnosis of Acute Appendicitis and thereby decreasing the rate of negative appendicectomy.

MATERIALS AND METHODS

A total of 100 patients were analysed for this prospective study conducted from January 2014 to June 2015 over a period of 18 months at Government T.D. Medical College Alappuzha, a tertiary hospital in South India catering mainly rural population.

Sample size was calculated using the Burderer's formula

$N (Sn) = [z^2 x Sn x (1-Sn)]/W2x P$

$N (Sp) = [z^2 x Sp x (1-Sp)]/W2 x (1-P)$

Sn=Sensitivity, Sp= Specificity, z= 1.96 (for 95% CI), W= precision, P= prevalence

Sensitivity and specificity used in computing were 88% and 94%, taken from literature.

Prevalence of acute appendicitis in hospital is 24%. The sample size thus calculated is 64.

We could include 100 patients in the study.

Study Group

All patients admitted in the hospital with acute abdomen and diagnosed provisionally as acute appendicitis and prepared for appendicectomy in different surgical units were included in the study.

Study Procedure

As per the modified Alvarado scoring system and their individual presentation, a score was calculated independently by the evaluator and data were entered in the predesigned proforma.

Modified Alvarado Score	
Symptoms	**Score**
Migratory Right Iliac Fossa Pain	1
Anorexia	1
Nausea/Vomiting	1
Signs	
Tenderness at Right Iliac Fossa	2
Rebound Tenderness Right Iliac Fossa	1
Elevated Temperature	1
Extra Sign (Cough test and/or Rovsing's sign and/or rectal tenderness)	1
Laboratory	
Leucocytosis	2
Total Score	**10**

Statistical Analysis

Data was entered in MS Excel data sheet and analysed using SPSS version 16 software.

Analysis was done to assess Sensitivity, Specificity, Positive predictive value when score is > 7.

Negative predictive value when score is < 7 and the negative appendectomy rate.

Sensitivity of Test

(Probability that a test result will be positive when the disease is present).

$$\frac{\text{True positive}}{\text{True positive + false negative}} \times 100$$

Specificity of Test

Specificity: (Probability that a test result will be negative when the disease is not present).

$$\frac{\text{True negative}}{\text{True negative + false positive}} \times 100$$

Positive Predictive Value

(Probability that the disease is present when the test is positive).

$$\frac{\text{True positive}}{\text{True positive + false positive}} \times 100$$

Negative Predictive Value

(Probability that the disease is not present when the test is negative).

$$\frac{\text{True negative}}{\text{True negative + false negative}} \times 100$$

RESULTS

This study includes both male and female patients of age group 13 to 80 years.

In our analysis, majority of the patients who were affected with acute appendicitis belong to the age group 21 to 30 years, followed by 13 to 20 years. The youngest patient is 14 years and oldest one 76 years. The mean age of the patient affected is 28.45 years (Table I, Figure I).

We observe that in patients with Acute Appendicitis male's-to-female's ratio is 74: 26 (Table II).

In the parameters of Modified Alvarado Score (M.A.S.S), tenderness in right iliac fossa is having maximum sensitivity (100%) followed by Nausea or vomiting (90%), rebound tenderness in right lower quadrant (80%) and raised temperature (68%). Anorexia and Leucocytosis have low sensitive values (59% and 60%) (Table II, Fig. URE III, IV).

79% of the patients presented with modified Alvarado score of ≥ 7 and 21% presented with score of < 7 (Table IV) 84% of the patients had histopathologically confirmed appendicitis and 16% had normal appendix on histopathological examination. (Table IV) Sensitivity of the test is 90.4%, Specificity of test is 81.25%, Positive Predictive value is 96.20%, Negative predictive value is 61.9%, Disease prevalence 84% and Negative Appendectomy rate 3.79% respectively (Table V).

When we compare the gender, Sensitivity value in male patients is 98.48%, Specificity is 75%, Positive predictive value 98.48%, Negative predictive value 75%, Negative appendectomy rate 5% (Table VI, Fig. V, VI), whereas in female patients Sensitivity, Specificity, Positive predictive value, Negative predictive value, Negative appendectomy rate are 78.57%, 83.33%, 84.6%, 76.9% and 15.38% respectively (Table VII, Fig. V, VI).

Age Group in Years	Male	Female	No. of Patients
13 to 20	16	6	22
21 to 30	39	13	52
31 to 40	12	2	14
41 to 50	3	3	6
51 to 60	2	2	4
61 to 70	1	0	1
71 to 80	1	0	1
Total Number of Patients	**74**	**26**	**100**

Table I. Age and Sex Distribution of Study Group

Parameters of M.A.S.S*	No. of Patients	HPE** Positive Cases	Sensitivity
Migratory right iliac fossa pain	62	58	64.3%
Anorexia	60	50	61.45%
Nausea/vomiting	93	78	90.8%
Tenderness RIF	100	92	100%
Rebound tenderness	78	73	85.06%
Elevated temperature	70	60	67.82%
Extra Sign	60	55	64.37%
Leucocytosis	59	58	65.91%

Table II. Correlation of Parameters of Alvarado Score System with Histopathology

*Modified Alvarado Score System

**Histopathology Examination

Modified Alvarado Score	Appendicitis (HPE +ve)	Normal Appendix (HPE -ve)	Total
10	6	0	6
9	17	0	17
8	22	1	23
7	31	2	33
6	7	5	12
5	1	6	7
4	0	2	2

Table III. Correlation of Alvarado Score of Study Group with Histopathology

	Score > 7		Score < 7		Total
	Male	Female	Male	Female	
HPE Positive Cases	65	11	5	3	84
HPE Negative Cases	1	2	3	10	16
Total	**66**	**13**	**8**	**13**	**100**

Table IV. Distribution of Modified Alvarado Score of 7 as Cut-Off Point with Histopathology in Male and Female Patient Groups

Sensitivity	90.4%
Specificity	81.25%
Positive Predictive Value	96.20%
Negative Predictive Value	61.9%
Disease Prevalence	84%
Negative Appendectomy Rate	3.79%

Table V. Prediction of Appendicitis by Modified Alvarado Score in Study Group if Score is ≥ 7

Sensitivity	98.48%
Specificity	75%
Positive Predictive Value	98.48%
Negative Predictive Value	75%
Negative Appendectomy Rate	5%

Table VI. Prediction of Appendicitis in Males by Modified Alvarado Score if Score is ≥ 7

Sensitivity	78.57%
Specificity	83.33%
Positive Predictive Value	54.6%
Negative Predictive Value	76.9%
Negative Appendectomy Rate	15.38%

Table VII. Prediction of Appendicitis in Females by Modified Alvarado Score if Score is ≥ 7

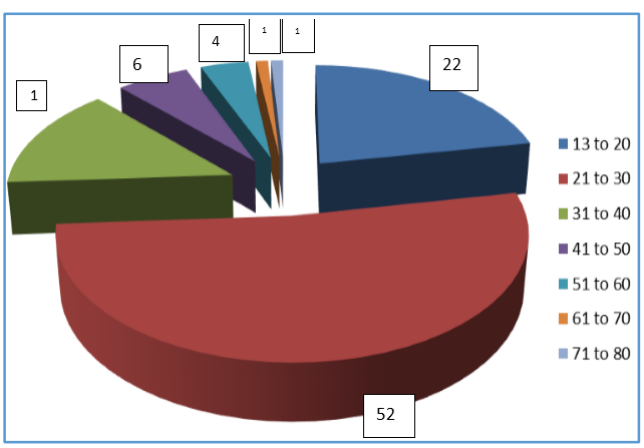

Figure I. Age Distribution of the Study Group

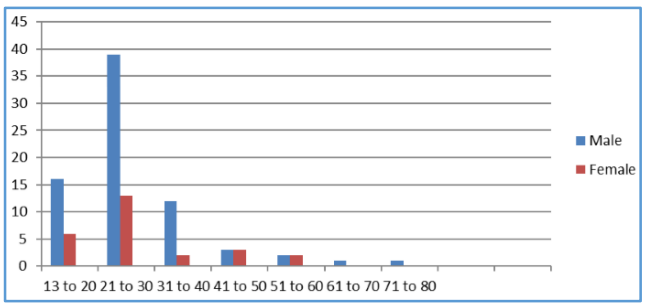

Figure II. Age and Sex Correlation of the Study Group

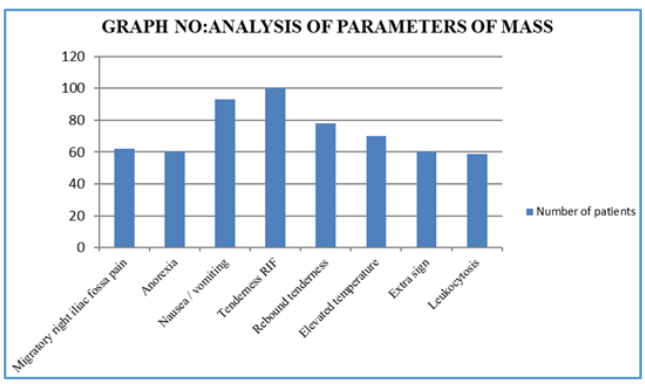

Figure III. Correlation of Parameters of Alvarado Score System with Histopathology

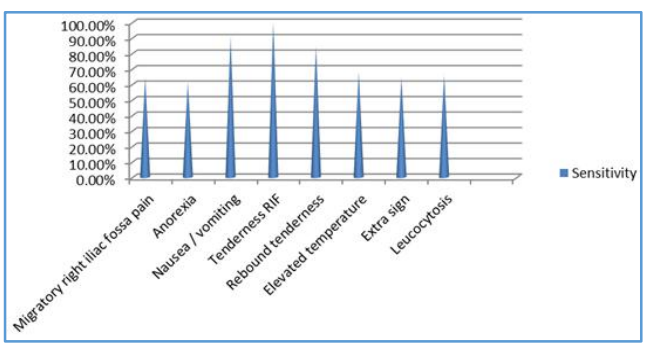

Figure IV. Sensitivity of Individual Parameters of Alvarado Score System

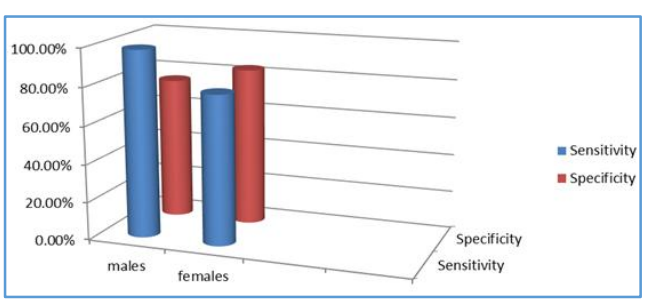

Figure V. Sensitivity and Specificity of Modified Alvarado Score in Male and Female Groups

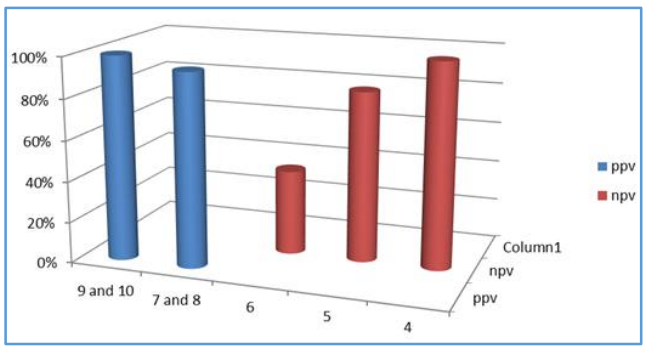

Figure VI. Predictive Value of Individual Score in Alvarado Score System

DISCUSSION

Acute appendicitis is the most common surgical abdominal emergency. It is common in second and third decades of life. The clinical diagnosis of appendicitis is not easy in all cases. There are several scoring systems in use to help the clinician to make the diagnosis with certainty. Of which Modified Alvarado scoring system is an easy, simple, cheap, non-invasive, safe diagnostic tool for pre-operative diagnosis of acute appendicitis. When we evaluated 100 patients with this scoring system, right iliac fossa pain is the most common presenting symptom followed by nausea/vomiting. In diagnosis of acute appendicitis, modified Alvarado score has a high diagnostic value. The sensitivity of the test is more in male population compared with the females. This can easily be attributed to the pelvic pathological conditions in females, which mimic appendicitis and require more diagnostic aids like ultrasound and laparoscopy for differentiating the disease process from appendicitis. Predictive value of Modified Alvarado score is low in obese patients and immune compromised subjects. Hence, a low score in this subset of patients should also be considered as indicator of appendicitis.

CONCLUSION

Modified Alvarado score increases the diagnostic certainty of clinical examination in acute appendicitis, reducing the progression of the disease to perforation and other complications. Misdiagnosis leading to negative appendectomy can also be reduced, thus avoiding the morbidity of the procedure.

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