

**ORIGINAL ARTICLE****Determination of Sensitivity and Specificity of Modified Alvarado Score and Ultrasonography in Patients with Acute Appendicitis***Nishikant Gujar<sup>1\*</sup>, Sajid Mudhol<sup>1</sup>, Ravi Kumar Choudhari<sup>1</sup>, Sachin D.M.<sup>1</sup>*<sup>1</sup>*Department of General Surgery, Al-Ameen Medical College, Vijayapur-586108 (Karnataka), India***Abstract:**

*Background:* In spite of improvement in modern diagnostic technology, diagnosis of appendicitis based on clinical suspicion, leads to removal of normal appendix. Sometimes, Modified Alvarado Score system is helpful in minimizing the same. *Aim:* To evaluate the sensitivity and specificity of Modified Alvarado Score (MAS) and Ultrasonography (USG). *Material and Methods:* 350 patients suspected of acute appendicitis were admitted, investigated and treated. They were evaluated using Modified Alvarado Scoring and all cases were subjected to ultrasonography. The sensitivity and specificity of Modified Alvarado Score and Ultrasonography were correlated with histopathological findings. *Results:* Modified Alvarado score  $\geq 7$  was seen in 158 patients in whom 151 (95.60%) had histopathologically proved acute appendicitis and 7 (4.43%) patients were histopathologically negative. Modified Alvarado score  $< 7$  was observed in 192 patients among whom 81 (42.19%) were histopathologically proved acute appendicitis and 111 (57.81%) patients were histopathologically negative. Among 158 with Modified Alvarado Score  $\geq 7$ , 152 (96.2%) were ultrasonographically diagnosed as acute appendicitis and 6 (3.8%) patients were ultrasonography negative. Among 192 patients those with Modified Alvarado Score  $< 7$ , 97 (50.52%) were ultrasonographically diagnosed as acute appendicitis and 111 (57.8%) patients were histopathologically negative.

*Conclusion:* An application of Modified Alvarado Scoring system and USG preoperatively as a protocol in patients with suspected appendicitis, the sensitivity is 98.44% for MAS and 98.33% for USG and specificity is 94.4% for Modified Alvarado Scoring and 90% for USG. In acute appendicitis, MAS is a good diagnostic indicator, and it is highly sensitive in diagnosis of appendicitis. Combined use of MAS and USG is very effective in diagnosis of appendicitis and it helps in reducing number of negative appendicectomy.

**Keywords:** Acute appendicitis, Modified Alvarado Score, Ultrasonography

**Introduction:**

There are many pathological conditions involving appendix among which acute appendicitis is commonest [1], it is one of the commonest surgical emergencies worldwide, with an incidence of 1.17 per 1000 and life time risk of 8.6% among males and 6.7% in females [2]. The incidence is highest in adolescents and young adults but incidence of complicated acute appendicitis shows little variation between age groups [3]. In 1886 Reginald Heber Fitz described the classical signs and symptoms of acute appendicitis as the disease entity [4]. Typical cases present classically with para-umbilical pain migrating to right lower quadrant of abdomen. Pain usually is

associated with nausea, vomiting, and low grade fever. Variation in position of appendix, age of the patient, degree of inflammation makes the clinical presentation of appendicitis inconsistent [1], despite extra-ordinary advances in modern radiography imaging and diagnostic laboratory investigations. The accurate pre-operative diagnosis of acute appendicitis remains an enigmatic challenge [5]. Nowadays commonly used diagnostic aids for appendicitis are CECT abdomen, laparoscopy, diagnostic scores and ultrasonography [5]. It has been claimed that ultrasonography dramatically reduces the number of appendicectomies in patients without appendicitis. It is especially useful in children and young thin adults and in females it will allow exclusion of gynecological causes mimicking appendicitis leading to diagnostic accuracy in excess of 90% [6]. A scoring system for early diagnosis of acute appendicitis was developed by Alvarado in 1986, based on clinical signs, symptoms and differential leucocyte count with left shift of neutrophil maturation yielding a score of 10, is known as Alvarado Score. Kalan *et al* omitted left shift of neutrophil maturation parameter and produced Modified Alvarado Score, it is 9 point scoring system that helps in increasing accuracy of preoperative diagnosis and thus reducing negative appendicectomy rate. Score of 7 or more has been recommended for surgery [7]. The aim of present study has been to evaluate sensitivity and specificity of Modified Alvarado Scoring system and Ultrasonography.

### Material and Methods:

This prospective study was carried out in Al-Ameen Medical College and Hospital, Bijapur, during January 2010 to January 2015, on admitted patients of right lower quadrant abdominal pain suspected of appendicitis. Evaluation of patient was done by comprehensive history, clinico-pathological examination, investigations and Modified Alvarado Score.

**Inclusion Criteria:** All patients of age more than 15 years and less than 50 years with acute abdominal pain in right iliac fossa were presumed to be of appendicular origin. **Exclusion Criteria:** Patients with age less than 15 years or more than 50 years with palpable mass on abdominal examination or with signs of generalized peritonitis, patients who are not willing for appendicectomy.

Informed consent was taken from all enrolled patients after detailed counseling. The contents of the consent were read out to the patient in his/her language.

Patients with a score of 1-4 who were not considered likely to have acute appendicitis and were observed and not operated unless for compelling reasons, they had to be operated. Those with scores between 5-6 who would be considered to have possible diagnosis of acute appendicitis, but not convincing enough to warrant immediate surgery. These patients were monitored at 4 hourly intervals and if within 24 hours of observation their score become >7 or their clinical features were convincing enough to warrant surgery, and then irrespective of their scores, appendicectomy would be performed.

**Modified Alvarado Score**

Symptoms/ Signs/ Investigations	Score	
	Yes	No
<b>Symptoms</b>		
Migration of pain to right iliac fossa	1	0
Anorexia	1	0
Nausea/ vomiting	1	0
<b>Signs</b>		
Tenderness over right iliac fossa	2	0
Rebound tenderness over right iliac fossa	1	0
Temperature > 37.3°C	1	0
<b>Investigations</b>		
Leucocytosis > 10 x 10 <sup>9</sup> /L	2	0
<b>Total score</b>	9	0

*Scoring system: 1-4: Appendicitis unlikely, 5-6: Appendicitis possible, 7-9 Appendicitis definitive*

All patients with scores 7 to 9 were considered to have either probable or definite diagnosis of acute appendicitis and were considered for appendicectomy in the first instance [5].

Ultrasonography of every patient was performed with 5 MHZ or 7.5 MHZ linear array transducer to diagnose appendicitis and with 3.5 MHZ convex transducer to rule out any other abdominal pathology. An ultrasonography criterion for diagnosis of acute appendicitis was maximum diameter of 6 mm or more or wall thickness of 3 mm or more or increased peri-appendicular echogenecity [5]. Confirmation of diagnosis of acute appendicitis was done by histopathological examination of appendix in all operated cases.

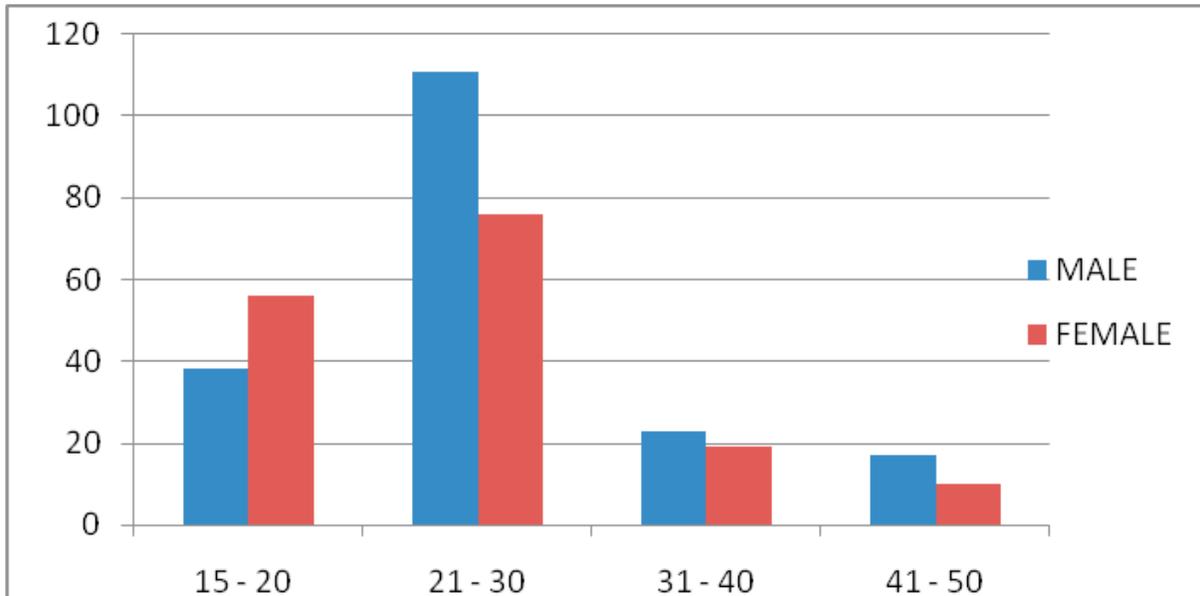
**Statistical Method:**

Data was collected using a pre-tested coded questionnaire and analyzed using SPSS satiated computer software.

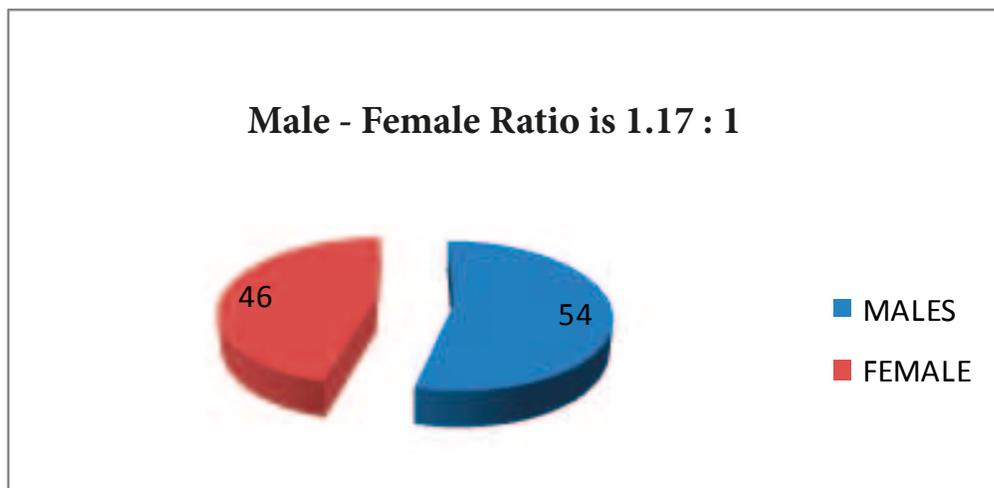
**Results:**

In our study, patients ranged in age from 15-50 years (The mean age being 17.5years).The highest occurrence was seen in 187(53%) of the patients as seen in age group of 21-30 years

In our study the total number of male patients were 189 (54%) and female patients were 161 (46%) and M:F Ratio was 1.17:1. Maximum patients were in the range of 7-9 years i.e. 158.



Graph 1: Age and Sex Distribution of Study Population



Graph 2. Gender distribution of Modified Alvarado Scoring

**Table 1: Symptoms and Signs Distribution with Sensitivity and Specificity of Modified Alvarado Scoring**

Symptoms and signs	No of cases with score (1-4)	No of cases with score (5-6)	No of cases with score (7-9)	Total.	Percentage	Sensitivity	Specificity
Migration of pain to right iliac fossa	82	75	149	306	87	64.2%	98.4%
Anorexia	2	44	108	154	44	79%	79%
Nausea and vomiting	33	101	119	253	72	54%	71%
Tenderness in right iliac fossa	73	119	158	350	100	100%	0.00%
Rebound tenderness	12	54	96	162	46	60%	69%
Elevated temperature >37deg C	20	72	110	202	58	57%	70%
Leukocytosis	9	64	157	230	66	76%	95%

In males, 34 patients were in the range of 1-4, 83 patients were in the range of 5-6, and 72 patients were in the range of 7-9, and the total was 189. In females, 39 patients were in the range of 1-4, and 36 patients were in the range of 5-6 years, and 86 patients were in the range of 7-9 years, and the total was 161. Maximum patients were in the range of 7-9 years i.e. 158.

In our study score  $\geq 7$  (158) patients, there were

(151) (95.60%) patients were histopathologically positive, 7 patients were having normal appendix so negative appendicectomy rate was (4.43%). In our study score  $< 7$  (192) patients whom histopathologically positive were 81 (42.19%), while 111 patients were having normal appendix (57.81%). So, overall negative appendicectomy rate in our study regardless of Modified Alvarado Score was 33.71%.

**Table 2: Gender Distribution of Results of Histopathology for Patients with Modified Alvarado Score**

Gender	Positive HPR	Percentage	Negative HPR	Percentage
<b>Modified Alvarado score <math>\geq 7</math></b>				
<b>Female N=88</b>	85	56.29	3	42.86
<b>Male N=70</b>	66	43.71	4	57.14
<b>Total N=158</b>	151	95.60	7	4.43
<b>Modified Alvarado score &lt; 7</b>				
<b>Female N=85</b>	33	40.74	52	46.85
<b>Male N=107</b>	48	59.26	59	53.15
<b>Total N=192</b>	81	42.19	111	57.81
<b>For all Patients</b>				
<b>Female N=173</b>	118	40.86	55	46.61
<b>Male N=177</b>	114	49.14	63	53.39
<b>Total N=350</b>	232	66.29	118	33.71

In our study, 158 patients with score  $\geq 7$  range, males with positive histopathology reporting were 66 (43.71%) and negative histopathology reporting were 4 (5.71%), females with positive histopathology reporting were 85 (56.29%) and negative histopathology reporting

were 3 (42.86%). Out of the 192 patients with Modified Alvarado Score <7, 81 patients had histopathologically positive acute appendicitis while 111 patients had histopathologically normal appendix. Out of 107 male patients, 48 (59.26%) patients were histopathologically

positive; while out of 85 female 33 (40.74%) patients were histopathologically positive. In our study 81 patients with confirmed appendicitis by histopathology, 33 (40.74%) were females and 48 (59.26%) were male. On other hand 111 patients with non-appendicitis, 52 (46.85%) were females and 59 (53.15%) were males. In our study, number of males in the Modified Alvarado Score range of  $\geq 7$  were 70 patients in which, number

of ultrasonography positive were 68 (97.14%) and number of confirmed appendicitis were 70 (100%).

In our study the over all, sensitivity and specificity of histopathology were 98.44% and 94.44% respectively. Ultrasonography sensitivity = 98.33%, Specificity = 90.0% and Modified Alvarado score Sensitivity = 65.62% Specificity = 91.67%.

**Table 3: Comparison of Findings of Modified Alvarado Score, USG and Histopathology**

Sex	No. of Cases	USG Positive	Confirmed by histopathology
<b>Modified Alvarado Score <math>\geq 7</math></b>			
Male	70	68 (97.14%)	70 (100%)
Female	88	84 (95.45%)	85 (96.59%)
Total	158	152	155
<b>Modified Alvarado Score <math>&lt; 7</math></b>			
Male	112	61 (54.46%)	64 (57.14%)
Female	80	36 (45%)	38 (47.50%)
Total	192	97	102

**Table 4: Overall Sensitivity and Specificity of Histopathology Ultrasonography and Modified Alvarado Score**

Histopathology	Diagnosis		
	Appendicitis	Non appendicitis	Total
Positive	True positive (228)	False positive (8)	236
Negative	False negative (4)	True negative (110)	114
Total	232	118	350
<b>Ultrasonography</b>			
Positive	True positive (207)	False positive (14)	221
Negative	False negative (4)	True negative (125)	129
Total	211	139	350
<b>Modified Alvarado score</b>			
	Diagnosis		
	Appendicitis	Non appendicitis	Total
Score 7	True +ve (155 )	False +ve (3)	158
Score <7	False-ve (76)	True -ve (116)	192
Total	231	119	350
<b>Sensitivity and Specificity of All the Three Modalities of Modified Alvarado Score, Ultrasonography and Histopathology</b>			
	Modified Alvarado Score	Ultrasonography	Histopathology
Sensitivity	65.62%	98.33%	98.44%
Specificity	91.67%	90.0%	94.44%

**Discussion:**

This study involved 350 patients suspected to have appendicitis admitted to Al-Ameen Medical College and Hospital, Bijapur, for a period of 2010 to 2015. At the end of the study, it was found that age group of patients in which maximum number

of cases presented was from 21-30 years. Male patients outnumbered female patients.

Similar study has been done by Harsha *et al.* In their study maximum incidence of acute appendicitis was found in the age group of 21 to

30 years [7], while Talukder *et al* showed high incidence in third decade [8]. In our study the total number of male patients was 89 (54%) and number of female patients was 161 (46%) and M: F Ratio was 1.17:1. Male: female ratio was 3:2 [7], while Thabit *et al* showed high incidence in females about (57%) [9]. In males the patients in the range of 1-4 was 34, in 5-6 range was 83 and in 7-9 range was 72 patients and total was 189. In females, the patients in the range of 1-4 was 39, in 5-6 range was 36 and in 7-9 range was 86 patients and total was 161. Maximum patients were in the age range of 7-9 years i.e. 158. In our study the distribution of patients according to Modified Alvarado Score in  $\geq 7$  range was 158 and  $< 7$  was 192. Migration pain to right iliac fossa was present in 306 (87%) patients with sensitivity of 64.2% and specificity of 98.4%.

In our study for Modified Alvarado Score  $\geq 7$  (158) patients in which histopathologically positive were (151) patients (95.60%), 7 patients were having normal appendix so negative appendectomy rate was (4.43%).

In our study, 158 patients with score  $\geq 7$  range, males with positive histopathology reporting were 66 (43.71%) and negative histopathology reporting present in 4 (57.14%), females with positive histopathology reporting were 85 (56.29%) and negative histopathology reporting were are 3 (42.86%). Similar study was done by Thabit *et al* [9]. In his study out of these (87) patients with score  $\geq 7$ , (80) patients had histopathologically proven acute appendicitis, while (7) patients had histopathologically normal

appendix. Patients with positive histopathology, (45) of them (56.25%) were females, while (35) patients (43.75%) were males. Patients having negative histopathology, (5) of them (71.5%) were females while (2) patients (28.5%) were males, Negative appendectomy rate for patients with Modified Alvarado Score  $\geq 7$  were 8.1%.

Similar study was done by Thabit *et al* [9], out of (86) patients, regardless of their Modified Alvarado Score, with confirmed appendicitis by histopathology, (52.4%) were females, and (47.6%) were males. On the other hand, out of (14) patients with non-appendicitis, (85.7%) were females and (14.3%) were males. Accordingly, the negative appendectomy rate in female patients was (21.05%) while in male patients was (4.65%). In our study, number of males in the Modified Alvarado Score range of  $\geq 7$  were 70 patients in which, number of ultrasonography positive were 68 (97.14%) and number of confirmed appendicitis were 70 (100%), number of females in the Modified Alvarado Score range  $\geq 7$  were 88 patients in which ultrasonography positive were 84 (95.45%) and number of confirmed appendicitis were 85 (96.59%). In our study, number of males in the Modified Alvarado Score range of  $< 7$  were 112 patients which, number of ultrasonography positive were 61 (54.46%) and number of confirmed appendicitis were 64 (57.14%), Number of females in the Modified Alvarado Score range  $< 7$  were 80 patients in which ultrasonography positive were 36 (45%) and number of confirmed appendicitis are 38 (47.50%). In our study, in

the diagnosis of appendicitis, true positive cases were 228 and false negative case were 4 and in non-appendicitis, false positive cases were 8 and true negative cases were 110. In our study the diagnostic approach for over all, Sensitivity = 98.44%, Specificity = 94.44%

Sensitivity and Specificity of Modified Alvarado Score in our study was 98.44 and 94.44% respectively which is more as compared to Nautiyal *et al* [5]; while Tiecher *et al* study showed sensitivity 48-77% and specificity 73-87% [11]. In another study conducted by Gurav *et al* showed 20.00% and 80.00% sensitivity and specificity in case of acute appendicitis while 28.57% and 78.83% sensitivity and specificity in case of non-acute appendicitis [12]. In our study, in the diagnosis of appendicitis, true positive cases were 207 and false negative cases were 4 and in non-appendicitis, false positive cases were 14 and true negative cases were 125. In our study the diagnostic approach for ultrasonography, Sensitivity = 98.44%, Specificity = 94.44%. In our study, in the diagnosis of appendicitis, true positive cases were 155 and false negative cases were 76 and in non-appendicitis, false positive cases were 3 and true negative cases were 116. In our study the diagnostic approach for Modified

Alvarado Score, Sensitivity = 65.62%, Specificity = 91.67%

Nautiyal *et al* diagnostic sensitivity was 97.14% and 88.57%. in ultrasonography. It can only complement clinical scores or clinical judgment because in few cases inflamed appendix could not be visualized due to bowel gases.

#### **Conclusion:**

Thus applying Modified Alvarado Scoring system preoperatively as a protocol in patients with suspected appendicitis the sensitivity is 98.44% for MAS and 98.33% for USG and specificity is 94.4% for MAS and 90% for USG. In acute appendicitis, MAS is a good diagnostic indicator, and it is highly sensitive in diagnosis of appendicitis and when combined with USG, is very effective in diagnosis of appendicitis and it helps in reducing number of negative appendicectomy.

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**\*Author for Correspondence:** Dr. Nishikant N Gujar, Professor department of General Surgery,  
Al-Ameen Medical College, Vijayapur- 586108(Karnataka), India.  
Cell: 09902384271, Email: drnishikantgujar7@gmail.com.