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Evaluation of Alvarado Score in Acute Appendicitis: Prospective Study

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Abstract: ***Background and Objectives: Decision making in case of acute appendicitis may be difficult, especially for junior surgeon. Radiological investigations do not appear to be helpful sometime. A decision to operate based on clinical suspicion alone can lead to removal of normal appendix in 15-30% cases. In some studies Alvarado Scoring System was helpful in minimizing unnecessary appendectomies. The present study aims to evaluate the efficiency of Alvarado scoring in preoperative diagnosis of acute appendicitis. Methods: A 100 consecutive patients suspected of acute appendicitis who were admitted, investigated and treated were taken for the study. They were prospectively evaluated using the Alvarado scoring to determine whether or not they had acute appendicitis they were assigned in three groups they were treated accordingly. The AS was correlated with operative and histopathological findings. Results: The results of the study showed that high score in men and children (7-9) had a sensitivity of 95.45% and 87.50& respectively, where in females it had a sensitivity of 76%. The score (5-6) in men and females had a sensitivity of 57.14% and 75% respectively. Interpretation and Conclusion: The high score in Alvarado Score Is dependable aid in the early diagnosis of acute appendicitis in men and children but is a less dependable aid as far as women are concerned.***

Keywords: Acute appendicitis-AA, Alvarado Score-AS

1. Introduction

One of the commonest clinical presentation that requires emergency surgery is acute appendicitis[1,2]. It is rare in infancy and amongst the elderly, but is common in children, teenagers and young adults[3]. Much efforts have been directed towards early diagnosis and intervention as approximately 6% of the population will suffer from this disease during their life time[4]. Delay in diagnosis leads to increase morbidity and costs.

Despite attempts to increase the diagnostic accuracy in cases of acute appendicitis, the rate of misdiagnosis in developed countries has remained constant at 15.3%[5].

The classical signs and symptoms of acute appendicitis were first reported by Fitz in 1886. Since then it has remained the most common diagnosis for hospital admission requiring laparatomy[1,2].

A negative appendicectomy rate of 20% has been described in the surgical literature.

The diagnosis of appendicitis can be difficult, occasionally taxing the diagnostic skills of even the most experienced surgeon. Attempts to increase the diagnostic accuracy of acute appendicitis have included computer aided diagnosis, imaging by ultrasonography, laparoscopy and even radioactive isotope imaging[6,7,8,9]. Various scoring systems have been devised to aid diagnosis. The Alvarado score was described in 1986[10] and has been validated in adult surgical practice.

2. Methodology

In this study, over a period of 20 months (November 2015 to June 2017) 100 patients presenting with pain in the right lower quadrant of abdomen, lasting fewer than 7 days who after clinical examination were provisionally diagnosed to have acute appendicitis and warranting surgery for the same were evaluated using the scoring system – Alvarado Score.

The study was conducted on the patients presenting with clinical features suggestive of acute appendicitis admitted in surgical wards.

Inclusion Criteria: Patients with provisional clinical diagnosis of acute appendicitis.

Exclusion Criteria:

a) Patients with generalized peritonitis due to appendicular perforation.
b) Patients with appendicular mass or abscess.

Collection of Data

A total of 100 consecutive cases of suspected acute appendicitis who were admitted, investigated and treated were taken for the study. After detailed examination and investigations a Alvarado score was applied to each case.

The diagnostic scoring systems have been developed in an attempt to improve the diagnostic accuracy of acute appendicitis[39]. The most prominent of those scores is Alvarado score.

Alvarado Score: This consists of 3-symptoms, 3 signs and a laboratory finding.

Table 1: Symptoms/ Signs/ Investigation

Symptoms/ Signs/ Investigations	Score	
	Yes	No
Symptoms		
Migration of paint to right iliac fossa	1	--
Anorexia	1	--
Nausea/ vomiting	1	--
Signs		
Tenderness over right iliac fossa	2	--
Rebound tenderness over right iliac fossa	1	--
Temperature >37.3ºC	1	--
Investigations		
Leucocytosis>10 x $10^{9/L}$	2	--
Left shift in leukocyte count	1	--
Total Score	10	--

Following decisions were taken:
Cases with score of 1-4 were observed and not operated and were followed up after discharge for next 6 months for development of acute appendicitis.

Cases with score of 5-6 were observed for next 24 hours for revision of scoring. If scores become ≥ 7 or their clinical condition was highly suspicious of acute appendicitis as decided by treating surgeon they were subjected for appendicectomy.

All patients who were considered for appendicectomy underwent ultrasonography of abdomen primarily to rule out other conditions mimicking acute appendicitis.

Patients with score of 7-9 who were considered candidates for appendicectomy were assessed again after ultrasonography. If any other conditions mimicking acute appendicitis were found in them. They were not operated and were considered as false positive cases.

All the specimens of appendix were sent for histopathological confirmation of acute appendicitis. Final correlation between the scoring system and final diagnosis was made.

3. Results

The various features of the study which included age and sex of patient, clinical presentation, operative findings, histopathological examination were observed and analyzed. Statistical analysis of these observations and results of the study was done and presented in tabular form.

1) Sex Distribution:

Table 2: Sex Distribution

SEX	No. of patients	Percentage (%)
Male	64	64%
Female	36	36%
Total	100	100%

In this study number of male patients (64) were more than the number of female patients (36).

2) Age Distribution

Table 3: Age Distribution

Age group (years)	No. of patients	Percentage
0 – 10	07	07
11 – 20	39	39
21 – 30	32	32
31 – 40	15	15
41 – 50	04	04
51 – 60	01	01
61 – 70	02	02
Total	100	100.00

Out of 100 patients, maximum patients were in the age group of 11-20 years – 39%. Next, maximum patients were in the age group of 21-30 years -32%. Only 2% were in the age group of 61-70 years, 1% in age group of 51-60 years, 4% in 41-50 years, 15% in the age group of 31-40 years and 7% in age group of 0-10 years.

3) Division of Patient According To Score

Patients were divided into three groups according to Modified Alvarado score as follows, and the results compared with the operative and histopathological findings.

Group-I (Score1-4)	Conservative treatment.
Group-II (Score 5-6)	Re-assessed after few hours. Those settling were discharged, while those deteriorating with increasing scores were operated.
Group-III (Score 7-9)	Operative treatment.

Table 4: Division of Patient According To Score

Group	No. of patients	Percentage
Group-I	22	22
Group-II	34	34
Group-III	44	44
Total	100	100.00

The above observations were made, in group-I number of patients were 22, in group-II there were 34 and in group-III there were 44 patients.

4) Clinical Features

Table 5: Clinical Features

	No. of patients	Percentage
Symptoms		
Migration of pain to RIF	87	87
Anorexia	78	78
Nausea/Vomiting	74	74
Signs		
Tenderness over RIF	83	83
Rebound tenderness over RIF	53	53
Increased temperature	67	67
Laboratory Investigations		
Leucocytosis	60	60

Among 100 patients, 87 (87%) had migration of pain to right iliac fossa, 78 (78%) had anorexia, 74 (74%) patients had nausea/vomiting, 83 (83%) patients had tenderness over right iliac fossa, 53 (53%) patients had rebound tenderness over right iliac fossa, 67 (67%) patients had fever and leucocytosis was seen in 60 patients (60%).

5) Ultrasonography Findings

Table 6: Ultrasonography Findings

GROUP	USG		HPR appendicitis Positive (Histopathology Record)
	Positive	**Negative**	
Group-II (34)	12	22	7
Group-III (44)	36	8	39

USG finding in group-II among 34, 12 patients showed appendicitis and other 22 had no evidence of appendicitis. In group-III among 44 patients, 36 had appendicitis findings on USG and 8 had normal USG findings.

6) Distribution of Cases According To Alvarado Score

6.1 Distribution of Cases According to Alvarado Score (5-6)

Table 7.1: Distribution of Cases According To Alvarado Score (5-6)

Category of cases	No. of cases operated	No. of cases With HPR appendicitis	No. of cases without HPR appendicitis	Proportion of true positive
Male (n=22)	7	4	3	57.14
Female (n=10)	4	3	1	75.00
Child (n=2)	0	0	0	0
Total (n=34)	11	7	4	63.63

4 out of 7 males and 3 out of 4 females had acute appendicitis. The overall negative appendicectomy rate of patients with scores ≤6 was 36.37%.

6.2 Distribution of Cases According To Alvarado Score (7-9)

Table 7.2: Distribution of Cases According To Alvarado Score (7-9)

Category of cases	No. of cases operated	No. of cases with HPR appendicitis	No. of cases without HPR appendicitis	Proportion of true positive
Male (n=22)	22	21	1	95.45
Female (n=14)	14	11	3	78.57
Child (n=8)	8	7	1	87.50
Total (n=44)	44	39	5	88.63

39 cases out of 44 cases had acute appendicitis. The sensitivity of Alvarado score of ≥7 was 88.63%. The sensitivity was low in females 78.57% and highest in males 95.45% and in children it was 87.50%. Negative appendicectomy rate was 4.54% among males, 21.43% among females and 12.5% among children.

7) Correlation of Age and gender according to score

Table 8: Correlation of Age and gender according to score

	Group I (n=22)	*Group II (n=34)*	*Group III (n=44)*	*P value*
Age in years				
• 1-20	6(27.3%)	19(55.9%)	21(47.7%)	0.016*
• 21-40	16(72.7%)	15(44.1%)	16(36.4%)	
• 41-60	0	0	5(11.4%)	
• >60	0	0	2(4.5%)	
Gender				
• Male	13(59.1%)	24(70.6%)	27(61.4%)	0.639
• Female	9(40.9%)	10(29.4%)	17(38.6%)	

8) Correlation of Symptoms and Signs according to score

Table 9: Correlation of Symptoms and Signs according to score

Symptoms and Signs	Group I (n=22)	Group II (n=34)	Group III (n=44)	P value
Migration of Pain to RIF	20 (90.9%)	27(79.4%)	40(90.9%)	0.325
Nausea/ Vomiting	12(54.5%)	20(58.8%)	39(88.6%)	0.002**
Anorexia	16(72.7%)	20(58.8%)	39(88.6%)	0.009**
Tenderness over RIF	7(31.8%)	29(85.3%)	44(100.0%)	<0.001**
Rebound tenderness	3(13.6%)	11(32.4%)	35(79.5%)	<0.001**
Temp >37.3ºC	18(81.8%)	20(58.8%)	27(61.4%)	0.174
Leukocytosis	1(4.5%)	13(38.2%)	42(95.4%)	<0.001**

9) Correlation of HPR and USG according to Total score

Table 10: Correlation of HPR and USG according to Total score

Symptoms and Signs	Group I (n=22)	Group II (n=34)	Group III (n=44)	P value
HPR	0	6(17.6%)	39(88.6%)	<0.001**
USG	0	12(35.3%)	36(81.8%)	<0.001**

P values are obtained by chi-square test/Fisher Exact test.

4. Discussion

Acute appendicitis being one of the commonest surgical abdominal emergencies with lifetime prevalence of approximately 1 in 7[45], its diagnosis can sometimes be difficult. In an attempt to prevent negative appendicectomy Alvarado score can be used.

Hence, in the present study, an attempt is made to evaluate the efficiency of Alvarado score in pre-operative diagnosis of acute appendicitis done over a period of 20 months (Nov 2015 to June 2017), were included in this prospective study.

Table 11: Comparison Of Alvarado Score (7-9) with other studies

Category	Present study (%)	Hemant Nautiyal et al[52] (%)	Kalan M et al[11] (%)
Male	95.45	90	93.0
Female	78.57	100	67.0
Child	87.50	100	100.0
Total	88.63	96.6	83.7

Sensitivity of appendicitis 95.45% for male in the present study with score of 7 to 9 correlates well with the figures of studies by Hemant Nautiyal et al[52] (90%) and with that of studies by Kalan M et al[11] (93.%).
Sensitivity of acute appendicitis 78.57% for females in the present study with score of 7 to 9 correlates well with the figures of studies by Hemant Nautiyal et al[52] (100%) and but more than that of sensitivity of study by Kalan M[11] (67%).

Sensitivity of acute appendicitis 87.50% for children in the present study with score of 7 to 9 correlates well with the figures of study by Hemant Nautiyal et al[52] (100%), but has

same sensitive compared to study conducted by Kalan M et al[11] (100%).

The overall sensitivity of acute appendicitis being 88.63% in the present study with score of 7 to 9 correlates well with the figures of studies by Kalan M et al[11] (83.7%) and Hemant Nautiyal et al[52] (96.6%).

Table 12: Comparison of Alvarado Score (5-6) with other studies

Category	Present study (%)	Hemant Nautiyal et al[52] (%)	Kalan M et al[11] (%)
Male	57.14	93.75	67.0
Female	75.00	83.30	50.0
Child	--	0	0
Total	66.07	88.52	62.5

Among the score from 5 to 6, the following observations were made. The sensitivity of acute appendicitis 57.14% for males in our study is lesser than the sensitivity of studies by Kalan M et al[11] (67%) and Hemant Nautiyal et al[52] (93.75%).

And sensitivity of acute appendicitis 75% for females in the present study is high compared with the figures of studies by Kalan M et al[11] (50%) and Hemant Nautiyal et al[43] (83.3%). No Child in Group-II was operated.

The overall sensitivity of acute appendicitis being 66.07% in the present study with score of 5 to 6 correlates well with the figures of studies by Kalan M et al[11] (62.5%) and less compared to Hemant Nautiyal et al[52] (88.52%).

In another study by Mohanty Sudhir Kumar et al[46] was conducted on 45 patients prospectively using the modified Alvarado score. They found positive predictive value of 95.2% for males and for females, 93.3%, which was higher than our study.

They concluded that the score was useful in distinguishing acute appendicitis from other acute abdominal conditions, thus decreasing negative appendicectomy.

In another study by Fente BG[53] was conducted on 128 patients retrospectively using the Alvarado score. They found that sensitivity of 92.93% and specificity of 92.93% were recorded in their study.

They concluded that the score is a simple, safe and cost effective aid in diagnosis of acute appendicitis and decreases negative appendicectomy rate.

In another study by Sanjot B. Kurane[54] was conducted on 60 patients prospectively using the Alvarado score. They found that modified Alvarado score has sensitivity of 78.26%, and specificity 83.78% and Ultrasonography had sensitivity of 82.61%, specificity of 89.19%.

They concluded that the score is a useful tool in clinical decision making. However additional information provided by ultrasonography improves diagnostic.

5. Conclusion

Though acute appendicitis is the commonest surgical abdominal emergency with a life time prevalence of approximate 1 in 733, its diagnosis can sometimes be difficult.

From the present study, it may be concluded that high scores (7-9) in modified Alvarado Score is a dependable aid in early diagnosis of acute appendicitis in men and children as compared to other studies, but same is not true as far as women are concerned.

USG abdomen is a useful tool in diagnosis of appendicitis (HPR positive) in patients with score 5 to 6 and 7 to 9.

Our study had almost similar results as of the studies, Bengezi et al[46], Fente BG[53], Sanjot B. Kurane[54] and as mentioned before Kalan M et al[11] and Hemant Nautiyal et al[52] .

6. Summary

This study was conducted on 100 consecutive patients provisionally diagnosed to have acute appendicitis. Alvarado Score was applied to all these patients.

- Maximum number of cases were seen in age group of 11-20 years, 37 cases (37.%).
- 87 (87%) patients presented with pain in the right lower quadrant of abdomen, lasting fewer than 7 days.
- High scores (7-9) in men, children is dependable and in early diagnosis of acute appendicitis, whereas it is not so in case of females.

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