Original Research Article

Evaluation of Alvarado Score in the Diagnosis of Acute Appendicitis in Tertiary Care Centre of Kumaun Region

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ABSTRACT

Introduction – In attempts to increase the diagnostic accuracy and reduce the high rate of negative appendicectomy, physicians recommended the use of the Alvarado score in predicting the presence or absence of appendicitis. The main aim of our study is to evaluate the diagnostic accuracy of Alvarado score in acute appendicitis in patients of Kumaon region and correlate the clinical, peroperative and histopathological findings with each other.

Methods - Patients were assessed in the casualty, and Alvarado score was obtained for all patients within 48 hours from the onset of the symptoms and the majority within 24 hours. If patients were thought on clinical evaluation to require appendicectomy, then this was performed, regardless of the score. Intraoperative findings were recorded and specimen of appendix was sent for histopathological examination. Pathological findings were observed and were compared with the Alvarado score.

Results – Alvarado score for histologically proven normal appendix was minimum whereas those for dull serosa with transmural infiltration of polymorphs with areas of hemorrhage and necrosis were maximum. Statistically there was a significant correlation between total score and histopathological findings.

Conclusion - Alvarado score was found to be simple and easy to apply, since it relies only on history, clinical examination and routine laboratory investigations. Alvarado score provides an economical alternative to the other available costly diagnostic modalities such as CT scan, MRI scans etc.

INTRODUCTION

The vermiform appendix is a worm shaped organ situated at the posteromedial aspect of the caecum, where the three taenia coli coalesce about 2cm below the ileocaecal junction. Acute appendicitis is an inflammatory condition of the appendix and one of the most common cause for abdominal surgical emergencies[1,2]. From the time that it was first described by Reginald Heber Fitz in 1886[3], it has remained a topic of serial research works for various factors ranging from its etiology, to its management options. Over the years various types of investigations including laboratory and radiological, have been studied in detail with the aid of trials. These were conducted in the hope of finding the most sensitive test for diagnosing acute appendicitis. But in spite of the vast advances in the field of medicine, it has been time and again opined by various clinicians and authors that appendicitis is one condition whose diagnosis relies mainly upon the clinical features. As quoted by Bailey & Love, "Notwithstanding advances in modern radiographic imaging and diagnostic laboratory investigations, the diagnosis of appendicitis remains essentially clinical, requiring a mixture of observation, clinical acumen, and surgical science"[1]. So much has been stressed about the various methods

of diagnosis, only because the same is extremely important. Appendicitis, which if caught early and managed appropriately can be the most uneventful surgery, while the other end of the spectrum is also true, that when missed, appendicitis can turn into a disease with great morbidity and mortality.

Hence, having understood the importance for early and right diagnosis, and having understood that clinical evaluation provides the best and most accurate diagnostic modality for appendicitis; many clinical scoring systems have been developed over the years[4]. This has aided the clinician to a large extent in coming to the right diagnosis and providing early management. What began as a single scoring system, evolved into many over the years, as people constantly made modifications to the existing scoring systems based on the local demographics or by adding more factors. This brought along the next problem, of finding the single best scoring system, or the scoring system with the maximum sensitivity and diagnostic accuracy.

Most of the cases require immediate removal through surgery, either open or laparoscopic appendectomy. Recent studies suggest that approximately 6% of the population will suffer from acute appendicitis in their life time. If failed to diagnose early the condition is associated with significant morbidity and mortality.

In suspected cases of acute appendicitis, it is not possible to have a definite diagnosis histopathologically pre-operatively, hence there is an appreciable rate of negative appendicectomy. Many surgeons advocate early surgical interventions for treating acute appendicitis to avoid complications, accepting negative appendicectomy rate of about15-20%.

In attempts to increase the diagnostic accuracy and reduce the high rate of negative appendicectomy, various scoring systems such as Linderberg, Eskelinen, Fenyo, The Van Way and Teicher, RIPASA scoring system, Izbicki have been developed which aid to increase the accuracy of preoperative diagnosis of acute appendicitis. American College of Emergency Physicians recommended the use of the Alvarado score in predicting the presence or absence of appendicitis. This scoring system is mainly based on clinical symptoms and signs with minimal Investigational support. Alvarado score is assessed prospectively to increase accuracy in preoperative diagnosis of acute appendicitis.

It includes:

- 3 symptoms (migratory pain in right iliac fossa, anorexia, vomiting/nausea),
- 3 signs (fever, tenderness & rebound tenderness in right iliac fossa)
- 2 lab investigations (leukocytosis, shift to left of neutrophils). (Table1)

Table 1: Alvarado Score

S.No.	Symptoms/Signs/Laboratory findings	Score
1.	Migratory right Iliac fossa pain	1
2.	Nausea/ vomiting	1
3.	Anorexia	1
4.	Tenderness in right iliac fossa	2
5.	Rebound tenderness	1
6.	Elevated temperature	1
7.	Leukocytosis	2
8.	Shift to left	1

Total=10

In most of the studies conducted, the patients are divided into 3 groups on the basis of the total Alvarado score: Group1 =Score 1-4, Group 2=5-6 and Group 3=7-10.

Other Scoring systems are:
1. Modified Alvarado Scoring System (Mass)[7]
2. Ripasa Scoring System[8]
3. Paediatric Appendicitis Score[9]
4. Tzanaki Scoring[10]
5. Low Risk For Appendicitis Score (Kharbanda)[11]
6. Lintula Score[12]
7. Eskelinen Score[13]
8. Ohmann Score[14]
9. Fenyo-Lindberg Score[15]
10. Christian Score[16]

In study conducted by Dey S et al, the frequency of normal appendicectomy was 13% and the positive predictive value

was 86%. Hence the study concluded that Alvarado scoring system is easy, simple, cheap and useful tool in preoperative diagnosis of acute appendicitis and can work effectively in routine practice. Scores >7 definitely warrant a virtual confirmation of acute diagnosis and early operation is indicated to avoid complications like perforation. Patients with score 5-6 require admission and reevaluation for possible deterioration of clinical condition and earliest possible intervention. Even though the scoring system may be effective in the adults, the authors in this study agree with the opinion that it is not effective and reliable in younger children.

The main aim of our study is to evaluate the diagnostic accuracy of Alvarado score in acute appendicitis in patients of Kumaon region and correlate the clinical, peroperative and histopathological findings with each other.

AIM AND OBJECTIVES
To evaluate efficacy of Alvarado scoring system in diagnosis of acute appendicitis and its correlation with operative and HPE finding.

OBJECTIVES
1. To evaluate the clinico-epidemiological profile of acute appendicitis.
2. To find the effectiveness of Alvarado score in diagnosing acute appendicitis by correlating it with the operative and histopathological findings.
3. To review the usefulness of cutting down the rate of negative appendicectomy without increasing the morbidity and mortality.

MATERIALS AND METHODS
Study design: Cross sectional study
Sample size: All the patients presented with sign and symptom of acute appendicitis who were admitted under Department of Surgery, GMC Haldwani and associated Dr. Sushila Tiwari Hospital.
Period of Study: 20 months January 2018-Sept 2019

Inclusion Criteria: Patients of age >10 years and of both sexes presenting to surgery department with suspicion of acute appendicitis based on history and positive finding on physical examination.

Exclusion Criteria:
- Patients presenting with urological, gynecological or other surgical problems including patients with mass in right iliac fossa.
- Right iliac fossa Lump
- Those who are not willing /interested were excluded from this study.
- Children below the age of 10 years.
- Incidental appendicectomy
- Patient undergoing interval appendicectomy

STATISTICAL TOOLS EMPLOYED
The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 21.0 statistical Analysis Software. The values were represented in Number (%) and Mean±SD.

METHODOLOGY
The aim of study was to evaluate the efficacy of Alvarado scoring system in diagnosis of acute appendicitis and its correlation with operative and HPE finding. We included all patients who presented with signs and symptoms of acute appendicitis who were admitted under Department of General Surgery, GMCHaldwani and associated Dr. Sushila Tiwari Hospital.

The admitted patients were subjected to thorough clinical examination, followed by other baseline investigations likeHb, TLC, DLC, Kidney function test with serum electrolyte, Liver Function Test, Urine examination, X-Ray Chest, X-Ray KUB and ECG. A Performa containing general information about the patient plus eight variables based on the Alvarado scoring system was filled.

Scoring system:
- 1-4 - Appendicitis unlikely (U)
- 5-6 - Appendicitis low probability (LP)
- 7-8 - Appendicitis high probability (HP)
- 9-10- Appendicitis definitive (D)

Patients were assessed in the casualty, and Alvarado score was obtained for all patients within 48 hours from the onset of the symptoms and the majority within 24 hours. If patients were thought on clinical evaluation to require appendicectomy, then this was performed, regardless of the score. Intraoperative findings were recorded and specimen of appendix was sent for histopathological examination. Pathological findings were observed and were compared with the Alvarado score. All the subjects included in the study remained in contact with doctor for early post-operative complications.

RESULTS & OBSERVATIONS

The present study was carried out to evaluate the usefulness of Alvarado score in the diagnosis of acute appendicitis in a tertiary care center of Kumaun region. For this purpose, a total of 150 cases falling in sampling frame were enrolled in the study.

Table 2: Age and gender profile of cases enrolled in the study

SN	Age Group	Male		Female		Total	
		No.	%	No.	%	No.	%
1.	11-20 Years	23	25.3	24	40.7	47	31.3
2.	21-30 Years	12	13.2	10	16.9	22	14.7
3.	31-40 Years	22	24.2	11	18.6	33	22.0
4.	41-50 Years	12	13.2	14	23.7	26	17.3
5.	51-60 Years	16	17.6	0	0.0	16	10.7
6.	61-70 Years	2	2.2	0	0.0	2	1.3
7.	71-80 Years	4	4.4	0	0.0	4	2.7
Total		91 (60.7%)		59 (39.3%)		150 (100%)	
Mean±SD(Range) Years		36.64±17.46 (11-75)		27.83±13.03 (11-50)		33.17±16.40 (11-75)	

't'=3.320; p=0.001

Table 3: Distribution of cases according to presence of Symptoms/ Signs and Laboratory Findings

SN	Finding	No. of patients	Percentage
1.	Migratory right Iliac fossa pain	146	97.3
2.	Nausea/ vomiting	91	60.7
3.	Anorexia	125	83.3
4.	Tenderness in right iliac fossa	94	62.7
5.	Rebound tenderness	72	48.0
6.	Elevated temperature	138	92.0
7.	Leukocytosis	148	98.7
8.	Shift to left	72	48.0

Table 4: Distribution of cases according to diagnostic category based on Alvarado Score

SN	Finding	No. of patients	Percentage
1.	Low probability (Score ≤6)	27	18.0
2.	High probability (Score 7-8)	93	62.0
3.	Definite Diagnosis (Score 9-10)	30	20.0
Mean Alvarado Score±SD (Range)		7.52±1.12 (5-9)	

Table 5: Distribution of cases according to Intraoperative findings

SN	Finding	No. of patients	Percentage
1.	Normal Appendix	28	18.7
2.	Normal size appendix with mesenteric lymphadenitis	2	1.3
3.	Enlarged, inflamed edematous appendix	78	51.9
4.	Fibropurulent exudate on serosa with prominent vessels with enlarged appendix	32	21.3
5.	Inflamed edematous ulcerated appendix with prominent vessels	6	4.0
6.	Purulent exudate on serosa with gangrenous and perforated appendix	4	2.7

Table 6: Distribution of cases according to Histopathological Findings

SN	Finding	No. of patients	Percentage
1.	Normal Appendix	30	20.0
2.	Transmural infiltration of polymorphs	68	45.3
3.	Minimal to dense neutrophils in muscularis propria with necrosis	32	21.3
4.	Transmural infiltration of Polymorphs with minimal fibrosis and necrosis	6	4.0
5.	Transmural infiltration of Polymorphs with areas of hemorrhage and necrosis	4	2.7
6.	Dull serosa with transmural infiltration of polymorphs with areas of hemorrhage and necrosis	4	2.7
7.	Transmural infiltration of eosinophils	2	1.3
8.	Neutrophilic infiltration of muscularis propria	2	1.3
9.	Serosal infiltration of polymorphs with transmural infiltration of eosinophils	2	1.3

Table 7: Distribution of cases according to Final Diagnosis

SN	Finding	No. of patients	Percentage
1.	Acute appendicitis	84	56.0
2.	Gangrenous appendicitis	36	24.0
3.	Mesenteric lymphadenitis	2	1.3
4.	Normal appendix	28	18.7

Table 8: Correlation between age and Final Diagnosis

SN	Final Diagnosis	No. of patients	Mean Age	±SD
1.	Acute appendicitis	84	35.29	16.32
2.	Gangrenous appendicitis	36	29.89	16.46
3.	Mesenteric lymphadenitis	2	12.00	0.00
4.	Normal appendix	28	32.57	15.85

F=2.117; p=0.101

Table 9: Correlation of Intraoperative Findings and Total Score

SN	Finding	No. of patients	Mean Score	±SD
1.	Normal Appendix	28	6.39	1.17
2.	Normal size appendix with mesenteric lymphadenitis	2	6.00	.00
3.	Enlarged, inflamed edematous appendix	78	7.67	0.89
4.	Fibropurulent exudate on serosa with prominent vessels with enlarged appendix	32	8.03	.97
5.	Inflamed edematous ulcerated appendix with prominent vessels	6	8.33	1.03
6.	Purulent exudate on serosa with gangrenous and perforated appendix	4	8.00	.00

F=10.16; p<0.001

Table 10: Distribution of Histopathological Findings with Total Score

SN	Finding	No. of patients	Mean	±SD
1.	Normal Appendix	30	6.37	1.129
2.	Transmural infiltration of polymorphs/eosinophils	70	7.60	.875
3.	Minimal to dense neutrophils in muscularis propria with necrosis	32	8.03	.967
4.	Transmural infiltration of Polymorphs with minimal fibrosis and necrosis	6	8.33	1.033
5.	Transmural infiltration of Polymorphs with areas of hemorrhage and necrosis	4	8.00	.000
6.	Dull serosa with transmural infiltration of polymorphs with areas of hemorrhage and necrosis	4	9.00	.000
8.	Neutrophilic infiltration of muscularis propria	2	7.00	.000
9.	Serosal infiltration of polymorphs with transmural infiltration of eosinophils	2	8.00	.000

F=10.36; p<0.001

Table 11(a): Sensitivity and Specificity of Alvadaro Score. Acute and Gangrenous Appendicitis (Positive Appendicitis) vs Normal/Mesenteric lymphadenitis (Negative Appendicitis) – Criteria 1 (Definite score as the criteria)

Alvadaro score category	Acute/Gangrenous Appendicitis		Total
	Yes	No	
Definite (Score 9-10)	30	0	30
HP/LP (Score <9)	90	30	120
Total	120	30	150
Sensitivity	Specificity	PPV	NPV	Accuracy
25%	100%	100%	25%	40.0%

Table 11(b): Acute and Gangrenous Appendicitis (Positive Appendicitis) vs Normal/Mesenteric lymphadenitis (Negative Appendicitis) – Criteria 2 (Definite/High probability as the diagnostic criteria)

Alvadaro score category	Acute/Gangrenous Appendicitis		Total
	Yes	No	
Definite/HP (Score 7 or above)	109	14	123
LP (Score ≤6)	11	16	27
Total	120	30	150
Sensitivity	Specificity	PPV	NPV	Accuracy
90.8%	53.3%	88.6%	59.3%	83.3%

DISCUSSION

Acute appendicitis (AA) is the most common cause of acute abdomen in all age groups. Accurate and prompt diagnosis in those admitted to the emergency room with the preliminary diagnosis of AA remains problematic. The aim is to make an early and accurate diagnosis before the development of complications, thereby reducing the prevalence of negative appendectomy. Studies in the literature have recommended hospital discharge for patients with AS ≤4. In the study of Khan et al when patients with AS ≤4 were divided into two as those discharged after monitoring (emergency room and surgery clinic) and those who underwent surgery, 17 of 100 patients were in the first group, and were discharged. Three of the patients returned within 48 hours and the new AS was calculated as 7; they underwent surgery and AA was detected (17%).

The sample size of our study was 150. Majority of the cases (60.7%) were

males with male to female ratio of 1.54:1. The age of the patients ranged from 11-75years, with mean age of 33.17±16.4. Majority of patients (80%) aged up to 40years. Mean age of males (36.84±17.46) was significantly higher as compared to females (p value=0.001).

Almost all patients had leucocytosis (98.37%)> migratory right iliac fossa pain (97.3%)>elevated temperature (92%) >anorexia (83.3%)> tenderness in right iliac fossa (62.7%)> rebound tenderness (48%) and shift to left(48%).

Most common symptom among both males and females was migratory right iliac fossa pain> nausea/ vomiting> anorexia. Proportion of males was higher as compared to females for both migratory right iliac fossa pain and anorexia but the difference was not statistically significant (p value >0.05). For nausea/ vomiting the proportion of females (87.9%)>males(81.3%) with no statistical significance.

For fever/ raised temperature and rebound tenderness, proportion of males> females. For tenderness the proportion of females was higher than males, however the difference between 2 genders was not statistically significant. The difference between 2 genders was found to be significant only for fever/ raised temperature which was higher in males (95.6%) as compared to females (p value=0.043).

100% males had leucocytosis as compared to 96.6% females but the difference was not statically significant (p value=0.07). Shift to left was seen in 46.2% males as compared to females (50.8%) with no statistical significance (p value 0.574).Range of Alvarado score varied from 5-9. Majority (62%) were in high probability> definite diagnosis (20%)> low probability (18%). Mean Alvarado score came out to be 7.52±1.12.

All 150 patients with clinical diagnosis of acute appendicitis were subjected to surgery, 28 patients (18.7%) of which had normal appendix and 2 patients (1.3%) had normal appendix with

mesenteric lymphadenitis. The gross findings in majority of cases (78, 51.9%) had enlarged inflamed appendix >fibropurulent exudates on serosa with prominent vessels and enlarged appendix (21.3%)>inflamed edematous ulcerated inflamed appendix with prominent vessels (4%)> purulent exudates on serosa with gangrenous and perforated appendix(2.7%).

20% of cases operated had normal appendix on histology. Maximum cases (45.3%) had transmural infiltration of polymorphs, 21.3% showed minimum to dense neutrophils in muscularis propria with necrosis. 4 % cases showed transmural infiltration of polymorphs with areas of hemorrhage and necrosis and 2.7% cases showed transmural infiltration of polymorphs with areas of hemorrhage and necrosis and dull serosa. Another 1.3% showed transmural infiltration of eosinophils, neutrophilic infiltrates in muscularis propria and serosal infiltrates of polymorphs with transmural infiltration of eosinophis.

Majority of cases (n=84,56%) had acute appendicitis> gangrenous appendicitis(24%)> mesenteric lymphadenitis1.3%, 28 patients(18.7%) had normal appendix. Incidence of negative appendicitis was 20%(30). Mean age of patient with diagnosis of acute appendicitis was 35.29±16.32, gangrenous appendicitis 29.89±16.46, mesenteric lymphadenitis 12.00, normal appendix 35.67±15.87years. there was no statistically significant correlation of mean age and final diagnosis. Except for mesenteric lymphadenitis(n=2), were both cases were females, there was no significant correlation between gender and final diagnosis.82 patients (54.7%) were from hills and 68 patients (45.3%) were from plains. Except for mesenteric lymphadenitis for which 1 case each was from hills and plain area, all other cases were from hills. There was no significant correlation between diagnosis and location (p value=0.987).

Mean Alvarado score of normal appendix and normal appendix with

mesenteric lymphadenitis was minimum. The score of enlarged inflamed edematous appendix (7.67±0.89) <purulent exudation serosa with gangrenous and perforated appendix (8±0) <fibropurulent exudate on serosa with prominent vessels and enlarged appendix (8.03±1.03) <inflamed edematous appendix with prominent vessels (8.33±1.03) respectively, thus showing a significant difference among intraoperative findings.

Alvarado score for histologically proven normal appendix was minimum whereas those for dull serosa with transmural infiltration of polymorphs with areas of hemorrhage and necrosis were maximum. Statistically there was a significant correlation between total score and histopathological findings.

Using definite score (9-10) as a criterion, Alvarado score had a sensitivity of 25% and specificity of 100%. Positive predictive value was 100% and negative predictive value was 25%. Accuracy of score was only 40%.

Using score>=7 as a criterion, Alvarado was 90.8% sensitive, 53.3% specific and had a PPV of 88.6% and NPV of 59.3%. the accuracy was 83.3%.

Sensitivity and specificity of Alvarado score in hilly areas:

1. Using definite score (>=9) as criteria, the sensitivity of Alvarado score was 40.4%, specificity 100%, PPV 100%, and NPV of 30.2%. The accuracy of score was 42.7%.
2. Using high probability score (score>=7) as criteria, Alvarado score was 87.9% sensitive, 50% specific, had a PPV of 87.9% and NPV value of 50%. The accuracy was 86.5%

Sensitivity and specificity of Alvarado score in plain areas:

1. Using definite score (>=9) as criteria, sensitivity was 25%, specificity was 100%, PPV was 100%, NPV 24.6% and accuracy was 36.8%.
2. Using score>=7 as criteria, sensitivity was 94.4%, specificity was 57.1%, PPV was 89.5%, NPV was 72.9% and accuracy was 86.8%.

Incidence of negative appendicitis (Mesenteric lymphadenitis and normal appendix) 28+2 = 30 (20%).

In this study, none of the patients with perforated appendix had an Alvarado score of less than 7. This means that patient with score between 5-7 may safely be kept under observation followed by serial reevaluation with Alvarado scoring and the decision to operate or not may be changed accordingly. Alvarado score was found to be simple and easy to apply, since it relies only on history, clinical examination and routine laboratory investigations. Alvarado score provides an economical alternative to the other available costly diagnostic modalities such as CT scan, MRI scans etc. Such economic implications are particularly important in the context of our poor patients. The study illustrates that this simple scoring system in adult males suspected of having acute appendicitis works reliably well. This is a single center study which remains a limitation.

CONCLUSION

The diagnosis of acute abdominal pain is still a major problem despite the considerable improvement in history taking, clinical examination, computer-aided decision support and special investigations such as ultrasound. Appendicitis still poses diagnostic challenge and many methods have been investigated to try to reduce the removal of a normal appendix without increasing the perforation rate. Radiological methods such as ultrasonography, which is operator dependent and computed tomography with its expense and radiation hazard as well as laparoscopy, which is invasive and expensive, are all methods that have been investigated previously. Alvarado score is a non-invasive, safe diagnostic procedure, which is simple, fast, reliable and repeatable, it can be used in all conditions, without expensive and complicated supportive diagnostic methods. It increases the diagnostic certainty of

clinical examination in diagnosis of acute appendicitis. It also provides an economical alternative to the other available costly diagnostic modalities such as CT scan, MRI scans etc. Such economic implications are particularly important in the context of our poor patients. Good clinical assessment and skills of the surgeon remains the mainstay of establishing the diagnosis of acute appendicitis.

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