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Correlation of Alvarado Score with Surgical and Histopathological Findings in Acute Appendicitis

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Abstract

Background: Atypical clinical presentation of appendicitis necessitate laboratory and imaging investigations to confirm the diagnosis,[16] hence the presence of atypical features may make diagnosis difficult.
Materials and methods: A prospective analytical study among patients operated for acute appendicitis was undertaken to establish a correlation of Alvarado score with the surgical and histopathological findings.
Materials and Methods: 101 patients were selected according to the calculated sample size and subjected to all the relevant investigations, as per the predetermined study tools and operated. Cases were classified based on their Alvarado score into three groups (1-4, 5-6, 7-10). The resected appendix specimens were subjected to histopathological examination (HPE).
Results: Majority of patients were 20-30 years old (38.6%) and the minority in <20 years old group. 50% of patients with a score ranging from 1-4 presented after 2 days from onset of symptoms. The majority of patients with time since onset of more than 2 days had acute necrotic appendicitis on HPE while the majority of patients with time since onset of less than 1 day had acute suppurative appendicitis on HPE. The positivity rate of Alvarado scores of 7-10 was 63.6% with a negativity rate of 23.1%, positivity rate of scores 1-4 was 3.4% and negativity rate was 38.5%, positivity rate of scores 5-6 was 33% and negativity rate was 38.5%. The sensitivity of the scoring system was 80.68% while specificity was 69.23%. The negative appendicectomy rate in the study was 30.77%.
Conclusion: Alvarado score remains a good screening tool to rule-in acute appendicitis clinically and help in the decision-making process with regards to the management of patients concerned.

Keywords: Appendicitis, Alvarado score, MANTRELS, suppurative appendicitis

Introduction

Abdominal pain is the most prevalent[2] presentation in emergency care, acute appendicitis (AA) being one the most common causes of abdominal urgency,[3] and appendicectomy, the gold standard for treatment of AA, is the most frequently performed emergency surgery in the world.[4] Atypical features may make diagnosis difficult in 20% to 33% of patients, especially during the initial stages.[8] It is important to elicit an accurate history from the patient and/or family, in the case of pediatric patients. Regional inflammation can also present with an ileus, diarrhea, small bowel obstruction, and hematuria. Certain physical signs with their respective eponyms can be

helpful in discerning the location of the appendix: Rovsing's sign, pain in the right lower quadrants after release of gentle pressure on the left lower quadrant (normal position); Dunphy's sign, pain with coughing (retrocaecal appendix); obturator sign, pain with internal rotation of the hip (pelvic appendix); iliopsoas sign, pain with flexion of the hip (retrocaecal appendix). In addition, pain with rectal or cervical examinations is also suggestive of pelvic appendicitis. Patients with appendicitis usually have leukocytosis of 10,000 cells/cumm or more, with a higher leukocytosis associated with gangrenous and perforated appendicitis (~17,000 cells/cumm). The use of an objective scoring system such as the Alvarado system can reduce the negative appendicectomy rate to 0-5%. It is an aid in diagnosing acute appendicitis and in arriving at a conclusion whether a particular case should be operated or not, thereby reducing the number of negative laparotomies.[9] Delayed diagnosis of appendicitis could lead to complications like perforated and gangrenous appendix, peritonitis, sepsis, increased morbidity and mortality.[10] Usually, appendicular abscess is walled off in the right lower quadrant, although retroperitoneal abscesses including psoas abscess, liver abscess, fistulas, and pylephlebitis (portal vein inflammation) can also occur when left untreated. Immediate surgery is necessary in patients that appear septic, but this is usually associated with higher complications, including abscesses and enterocutaneous fistulae due to dense adhesions and inflammation.

There are other conditions which also cause pain in the right iliac fossa, inflammatory (e.g., endometriosis, inflammatory bowel disease) or noninflammatory (e.g., neoplasia) in origin. Conditions such as enteritis, ureterolithiasis, nonappendiceal diverticulitis, mesenteric adenitis, pelvic inflammatory disease and oophoritis can also mimic acute appendicitis.[11]

In 1986, Alvarado constructed a 10-point clinical scoring system, also known by the acronym MANTRELS, for the diagnosis of acute appendicitis based on symptoms, signs, and diagnostic tests in patients presenting with suspected acute appendicitis.[13] The Alvarado score enables risk stratification in patients presenting with abdominal pain, linking the probability of appendicitis, to recommendations regarding discharge, observation, or surgical intervention. The score is well calibrated in men, inconsistent in children, and over-predicts the probability of appendicitis in 90% cases for the diagnosis of acute appendicitis.[14] Further investigations, such as ultrasound scanning and computed tomography (CT) scanning are recommended when the probability of appendicitis is in the intermediate range.[15]

Features on an ultrasound that suggest appendicitis include a diameter greater than 6 mm, probe tenderness, presence of faecolith, increased echogenicity of the fat and periappendiceal fluid. However, ultrasonography has a high rate of false positive and false negative results.[18] Also, ultrasonography is an operator-dependent modality and the diagnostic values are different in various studies.[16] Computed tomography with contrast is the imaging investigation of choice due to its highsensitivity and specificity,[19] but it is expensive and not available in all centres. In addition, in cases of typical AA, its use may delay appendicectomy and increase the risk of perforation.[20]

Materials and Methods:

A cross sectional study of consecutive patients for a period of two years from August 2019 to July 2021 of all age groups, both males and females between 14 to 65 years who underwent emergency appendicectomy. Exclusion criteria were pregnant women and immunocompromised persons or HBsAg positive or HIV positive. Sample size calculated as $N = (4PQ)/L^2$, where N = Sample Size, P = Prevalence, Q= 100-P, L= Allowable error taken at 5%. Considering Negative response rate of 10% sample size for the study was taken as 101. Independent variables were age, sex, family income per month and address (Rural/Urban). Dependent variables included Clinical data and Alvarado score, intraoperative surgical findings and histopathological examination result. Alvarado Score more than 5 was taken as significant for acute appendicitis. A proforma designed specifically for the study was used for data collection. Data collected were entered in IBM SPSS Version 21.0 for Windows, Armonk NY: IBM Corp. Chi squared test was used to see the association between independent variables like age groups, religion, occupation and outcome variables like histopathological findings, and Alvarado score. Ethical approval from the Research Ethical Board

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(REB), Regional Institute of Medical Sciences (RIMS), Imphal was obtained. Informed written consent were obtained from the patient and responsible attendant(s). The study was a self-sponsored study and there was no conflict of interest.

Results:

The majority of the patients to be in the 2nd and 3rd decades of life. The most common occurrence was in the age group of 20-30 years (38.6% of cases). Mean age was 35 years within a standard deviation of 12.2 years.

Chi-Square Test/Fisher Exact Test was used to compare the clinical variables used in the study with the three Alvarado score groups of the study participants. In the different age groups, 50% of patients with score of 1-4 (group 1) were from 20-30 years old group. Score 5-6 group (group 2) comprised 50% from 20-30 years old group, 20.6% from 31-40 years old group, 14.7% from 41-50 years old group, 11.8% from >50 years old group and 2.9% from <20 years group. In score 7-10 group (group 3), 30.5% were from 20-30 years old group, 27.1% were in the 31-40 years group, 18.6% were in the 41-50 years group, 15.3% were in the >50 years group and 8.5% were in the <20 years old group. With time since onset <1 day, 67.6% had scores between 5 and 6, 45.8% had scores 7-10 and 12.5% had score 1-4. With time since onset of 1-2 days, 37.5% had score of 1-4, 25.4% had scores 7-10 and 11.8% had score of 5-6. With time since onset >2 days, 50% patients had a score of 1-4, 28.8% had a score of 7-10 and 20.6% had a score of 5-6.

Table 1. Clinical features Frequency distribution in relation to ALVARADO SCORE of patients studied.

Complication	ALVARADO SCORE			Total (n=101)	P Value
	SCORE 1-4 (n=8)	SCORE 5-6 (n=34)	SCORE 7-10 (n=59)		
Migratory RIF pain	5(62.5%)	19(55.9%)	31(52.5%)	55(54.5%)	0.851
Nausea/Vomiting	3(37.5%)	22(64.7%)	53(89.8%)	78(77.2%)	<0.001
Anorexia	1(12.5%)	21(61.8%)	49(83.1%)	71(70.3%)	<0.001
RIF tenderness	5(62.5%)	31(91.2%)	59(100%)	95(94.1%)	<0.001
RIF rebound tenderness	0(0%)	4(11.8%)	39(66.1%)	43(42.6%)	<0.001
Fever	1(12.5%)	16(47.1%)	47(79.7%)	64(63.4%)	<0.001
Leukocytosis	1(12.5%)	17(50%)	59(100%)	77(76.2%)	<0.001
Left shift	1(12.5%)	8(23.5%)	37(62.7%)	46(45.5%)	<0.001

Chi-Square Test/Fisher Exact Test

In the study participants, 94.1% had tenderness in the right iliac fossa. 77.2% participants had a history of nausea/vomiting. 76.2% participants had leukocytosis, 70.3% patients had a history of loss of appetite/anorexia, 63.4% had a history of fever. 54.5% participants had a history of migratory pain in right iliac fossa, 45.5% showed a left shift leukocytosis and 42.6% had rebound tenderness in right iliac fossa.

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Table 2: HPE of appendix- Frequency distribution in relation to ALVARADO SCORE of patients studied

HPE of appendix	ALVARADO SCORE			Total
	SCORE 1-4	SCORE 5-6	SCORE 7-10	
Acute appendicitis	3(37.5%)	17(50%)	20(33.9%)	40(39.6%)
Acute necrotic appendicitis	0(0%)	1(2.9%)	18(30.5%)	19(18.8%)
Acute suppurative appendicitis	0(0%)	11(32.4%)	18(30.5%)	29(28.7%)
Normal	5(62.5%)	5(14.7%)	3(5.1%)	13(12.9%)
Total	8(100%)	34(100%)	59(100%)	101(100%)

P≤0.001, Significant, Fisher Exact Test

Table 2 shows frequency distribution of results of histopathological examination of appendix specimen in relation to the Alvarado score groups. In scores of 1-4, 62.5% had normal appendix in HPE while 27.5% had acute appendicitis. In scores of 5-6, 50% had acute appendicitis, 32.4% had acute suppurative appendicitis, 14.7% had normal findings and 2.9% had acute necrotic appendicitis. In scores of 7-10, 33.9% had acute appendicitis, 30.5% had acute necrotic appendicitis, 30.5% had acute suppurative appendicitis and 5.1% had normal findings.

Table 3: Association of clinical variables according to HPE of appendix of patients studied

Variables	HPE of appendix				Total	P Value
	Acute Appendicitis	Acute Necrotic Appendicitis	Acute Suppurative Appendicitis	Normal		
Age in Years						
<20	2(5%)	2(10.5%)	1(3.4%)	1(7.7%)	6(5.9%)	0.416
20-30	15(37.5%)	5(26.3%)	11(37.9%)	8(61.5%)	39(38.6%)	
31-40	8(20%)	7(36.8%)	6(20.7%)	3(23.1%)	24(23.8%)	
41-50	11(27.5%)	2(10.5%)	5(17.2%)	0(0%)	18(17.8%)	
>50	4(10%)	3(15.8%)	6(20.7%)	1(7.7%)	14(13.9%)	
Gender						
Female	20(50%)	7(36.8%)	15(51.7%)	5(38.5%)	47(46.5%)	0.667
Male	20(50%)	12(63.2%)	14(48.3%)	8(61.5%)	54(53.5%)	
Time Since onset						
<1	24(60%)	3(15.8%)	18(62.1%)	6(46.2%)	51(50.5%)	<0.001
1-2	10(25%)	1(5.3%)	6(20.7%)	5(38.5%)	22(21.8%)	

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>2	6(15%)	15(78.9%)	5(17.2%)	2(15.4%)	28(27.7%)	
Religion						
Hindu	29(72.5%)	10(52.6%)	18(62.1%)	7(53.8%)	64(63.4%)	0.191
Muslim	10(25%)	5(26.3%)	10(34.5%)	4(30.8%)	29(28.7%)	
Christian	1(2.5%)	4(21.1%)	1(3.4%)	2(15.4%)	8(7.9%)	
Occupation						
Business	7(17.5%)	3(15.8%)	6(20.7%)	3(23.1%)	19(18.8%)	0.671
Employed	16(40%)	9(47.4%)	12(41.4%)	8(61.5%)	45(44.6%)	
Unemployed	13(32.5%)	3(15.8%)	9(31%)	2(15.4%)	27(26.7%)	
Professional	4(10%)	4(21.1%)	2(6.9%)	0(0%)	10(9.9%)	
Region						
Urban	19(47.5%)	11(57.9%)	17(58.6%)	8(61.5%)	55(54.5%)	0.720
Rural	21(52.5%)	8(42.1%)	12(41.4%)	5(38.5%)	46(45.5%)	
Total	40(100%)	19(100%)	29(100%)	13(100%)	101(100%)	

Chi-Square Test/Fisher Exact Test

Of the total negative HPE cases, 38.5% each were of score groups 1-4 and 5-6 while 23.1% were from score group 7-10. In cases with a positive finding suggestive of acute appendicitis, 63.6% were from score group of 7-10, 33% were from score group 5-6 and 3.4% were from score group 1-4. Hence scores between 7 and 10 had the highest HPE positivity for acute appendicitis. The receptor operated characteristic curve showed statistically significant values (p value<0.001) of the Alvarado score when the cutoff is taken as 5. Sensitivity was found to be 80.68% while specificity was 69.23% making the Alvarado score have a good rule-in character for clinically diagnosing acute appendicitis. The positive predictive value was found to be 91.4 and negative predictive value was 62.5. The diagnostic accuracy of the Alvarado score was 82.6%. The negative appendicectomy rate was 30.77%.

Discussion:

The most common age group with features of acute appendicitis was 20-30 years old (38.6%). Mean age was 35 years with a standard deviation of 12.2 years. Likewise, in the study conducted by Chaudhari YP et al[22], the most common age for appendicitis was found to be 21-30 years. Mean age was 31.67 years with a standard deviation of 13.69 years in the study conducted by Lokesh S et al[14]. There was a male preponderance (53.5%) over females (46.5%) in our study. Likewise, male preponderance was seen (51.5%) in the study conducted by Nascimento RR et al[8]. Similar observations were reported by Mahesh SV et al[9] with 76% being males and 24% females. Alvarado A[10] showed 58% to be male patients and 42% to be females. In the study by Lokesh et al[14], 53.3% were male patients while 46.7% were females. Soomro AG et al[21] similarly showed in their study that there was a male preponderance (66.07%) over females (33.92%). A study by Omiyale Ao et al[23] had a majority of male patients (53.4%). In a study by Selvi RT et al[25], a higher number of appendicectomies were done in males (59%) compared to females (41%). A retrospective study by Jat MA et al[26] had a ratio of males to females of 1.4:1. Likewise, a study by OkzanS et al[27] showed the majority of the study population to be males (70.3%). The study by Tekele MT et al[28] also had a majority of males (68%). Öszoy Z et al[30] conducted a

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study which showed a majority of male patients (62%). Hence the finding of our study was corroborated with the majority of previously conducted studies.

The majority of patients in the study (59 patients; 58.4%) had an Alvarado score falling between 7 and 10. 34 patients (33.7%) had scores of 5-6 and 8 patients (7.9%) had scores of 1-4 preoperatively. In the study by Nascimento RR et al[8], the majority of the patients presented a score greater than or equal to 5. Lokesh S et al [14] had similar findings with the majority (32.7%) of patients having a score of 5 followed by 27.4% having a score of 6. in the study by Soomro AG et al[21], 70.4% patients had scores between 6 and 10, 15.4% had a score of 5 and 14.2% had a score. All the cases with an Alvarado score of 7-10 (i.e., 59 patients) had tenderness in the right iliac fossa. 91.2% of patients with a score of 5-6 were positive for the same followed by 62.5% of the patients with scores of 1-4 who were also positive for the sign. The next most common component of the Alvarado score in our study population was nausea/vomiting. A total of 77.2% gave a positive history of nausea/vomiting. Again, it was most common in the score group 7-10 (89.8%), followed by score group 5-6 (64.7%) and score group 1-4 (37.5%). The bloodwork showed 76.2% of the patients to have leukocytosis where 100% of the patients in score group 7-10 had positive findings, 50% in the score group 5-6 had positive findings and 12.5% in score group1-4 had positive findings. 70.3% of the patients had a history of loss of appetite. 54.5% of the patients had a positive history of migratory pain in the right iliac fossa. Soomro AG et al[21] in their study showed the most common presentation to be migratory pain in the right iliac fossa (in 67.8%), followed by fever (67.8%), and nausea/vomiting (49.7%). Chaudhari YP et al[22] in their study also had pain in the right iliac fossa in 100% of the study population. This was followed by fever (in 86.36%), and vomiting (in 54.54%). A shift to the left in peripheral blood smear was seen in 45.5% of the cases with the highest numbers in score group 7-10 (37 out of 59). Only 1 out of 8 cases in score group 1-4 showed shift to the left. On histopathological examination of the resected appendix specimens, appendix was inflamed in 87.1% of cases. Acute appendicitis was found to be the most frequent occurrence, seen in 39.6% of the cases studied. 50% of cases in score group 5-6 had a finding of acute appendicitis. This was followed by acute suppurative appendicitis (28.7%), acute necrotic appendicitis (18.8%). 30.5% of cases in score group 7-10 had acute necrotic appendicitis proven on HPE. In a study conducted by Lokesh S et al[14], acute appendicitis was confirmed on HPE in 78.6% cases and complicated appendicitis was seen in 21.4% cases. In the present study, 12.9% or 13 of 101 cases had a normal finding on histopathological examination. In the cases with normal appendices, no other intraabdominal pathology was detected to modify the diagnosis. The majority of these (62.5%) belonged to score group 1-4. 5.1% of the cases belonged to score group 7-10. In a study by Mahesh SV et al[9], appendix was inflamed in 86% cases whereas it was normal in 14% casesOur study found a significant correlation (p value <0.001) of the Alvarado score with the final diagnosis of acute appendicitis on surgical and histopathological findings when the cutoff score is 5. The sensitivity of the study was found to be 80.68%, while the specificity ranked lower at 69.23%. The diagnostic accuracy of Alvarado score was found to be 82.6%. In a study by Tekele MT et al[28], when the Alvarado score cutoff value was set at 7, the sensitivity was 75.2%, specificity was 76.1% and diagnostic accuracy was 75.4%. In our study, positive predictive value is 91.4%, and negative predictive value is 62.5%. A study by Jalil et al[17] showed overall sensitivity of 66%, specificity of 81%, positive predictive value of 96% and negative predictive value of 29%. The sensitivity and specificity values of this study differed from those of our own study. The sensitivity and specificity in a study by Mahesh SV et al[9] are more in line with our study at 74.43% and 57.14% respectively, however with a cutoff score at 7. The investigators showed a negative appendicectomy rate of 14%. The negative appendicectomy rate in our study is found to be 30.77%. Nascimento RR et al[8] in their study, found that scores greater than or equal to 6 were associated with a greater probability of histopathological diagnostic confirmation of appendicitis, with a negative/nontherapeutic appendicectomy rate of 7.9%. The negative appendicectomy rate in the study by Omiyale AO et al[23] was 11.3%. In a study conducted by Merhi BA et al[24], the positive

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predictive value of Alvarado score was 80.7% and negative appendicectomy rate was 11.3%.

Conclusion:

Majority of the patients were males, corroborating with findings of previously conducted studies. Majority of the patients were over 20 years of age. Based on the findings of our study, we concluded that Alvarado score is a sensitive tool in the diagnosis of acute appendicitis. This study corroborated the findings of earlier studies as discussed earlier, and led to further understanding of the diagnostic accuracy of Alvarado score in a clinical scenario of acute appendicitis. The specificity of the score in our study was relatively low, which resulted in a higher rate of negative appendicectomy when compared to previously conducted studies. This makes the Alvarado score a good screening tool to rule-in acute appendicitis clinically and help in the decision-making process with regards to the management of patients concerned. Further studies in larger populations are needed in this direction to further consolidate the correlation and diagnostic strength of Alvarado score in acute appendicitis to better manage the cases.

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