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RESEARCH ARTICLE

EVALUATION OF ACUTE APPENDICITIS BY MODIFIED ALVARADO SCORING AND ULTRASOUND– A PROSPECTIVE STUDY

[1]Dr. Mutahir Bahar Wani, [2]Dr. Naveed Anjum Qureshi, [3]Dr. Kehkashan Chowhan and [4,*]Dr. Bikramjit Singh Sodhi

[1]Post Graduate Deptt., of Surgery GMC Jammu, J and K
[2]Senior Resident GMC Jammu, J and K
[3]Post Graduate Student Deptt., of Radiology GMC Jammu, J and K
[4]Senior Resident, Gs Medical College and Hospital Pilkhua, Hapur, U.P, India

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ABSTRACT

Acute appendicitis is one of the most common cause of abdominal pain and one of the most common cause of surgical emergencies. Western literature reports that 6% of population had risk of suffering from appendicitis during their lifetime. Failure to make an early diagnosis converts acute appendicitis to perforated appendicitis, a disease with potential complications including intra-abdominal abscesses, wound infection, septicemia and death.

AIMS AND OBJECTIVES: To evaluate the accuracy of the combined use of modified Alvarado scoring system and ultrasound in the diagnosis of acute appendicitis.

- To assess the association between clinical, radiological, operative and histopathological findings and evaluation of their accuracy.

MATERIAL AND METHODS:

The present study was undertaken in the Department of General Surgery at Government Medical College, Jammu. All the patients who presented with right lower quadrant pain were assigned a score using the Modified Alvarado Score. .

INCLUSION CRITERIA

- Those admitted in G.M.C Jammu having acute lower right sided abdominal pain with a clinical and /or ultrasonographic diagnosis of acute appendicitis and who were operated for the same.
- All patients who were willing to participate in the study.

EXCLUSION CRITERIA

- Patients who were diagnosed to have other causes of right lower quadrant pain.
- Age less than 10 years.
- Pregnant females.
- Patients with appendicular lump.

CONCLUSION: Acute Appendicitis is a common surgical emergency, mostly affecting young adults. Early diagnosis and operative intervention is necessary to prevent complications of acute appendicitis. The overall negative appendectomy rate is low but it is high in females of reproductive age group.

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INTRODUCTION

Acute appendicitis is one of the most common cause of abdominal pain and one of the most common cause of surgical emergencies. Western literature reports that 6% of population had risk of suffering from appendicitis during their lifetime. Failure to make an early diagnosis converts acute appendicitis to perforated appendicitis, a disease with potential complications including intra-abdominal abscesses, wound infection, septicemia and death. Vermiform appendix is a narrow, worm shaped tube, which springs from the postero-mediral wall of the caecum. The existence of the appendix was known even when the pyramids were being built because certain Coptic jars containing bowels inscribed with reference to the "worm of bowel" and Hermonic Books of Thoth and Books of Dead contain statements which probably refer to appendix.

***Corresponding author:** *Dr. Bikramjit Singh Sodhi*
Senior Resident, Gs Medical College and Hospital Pilkhua, Hapur, U.P, India

Appendix just appears at 8th week of gestation as an out pouching of the caecum. During both antenatal and post natal development, the growth rate of caecum exceeds that of appendix, displacing the appendix medially towards the ileocecal valve. The relationship of base of appendix to caecum remains constant, whereas the tip can be found in a retrocaecal, pelvic, subcaecal, preileal or right paracolic position. The anatomic considerations have significant clinical importance in context of acute appendicitis.The three taenia coli converge at the junction of caecum with the appendix and can be a useful landmark to identify the base of appendix. The Appendix can vary in length from 1-30 cm but most commonly ranges from 6-9 cm with its outer diameter ranging from 3-8 mm and its lumen ranging from 1- 3 mm.

The Appendiceal artery, a branch of illeocolic artery, originates posterior to terminal ileum and enters the mesoappendix near the base of appendix. The lymphatics drain into the anterior ileocolic lymph nodes. Histological examination shows goblet cells which produce mucus, scattered throughout the mucosa. The submucosa contains lymphoid follicles, for many years, the appendix was viewed as vestigial organ with no known function. But it is now well recognized that the appendix is an immunologic organ and participates in the secretion of immunoglobulins, particularly igA. Although an integral part of gut associated lymphoid tissue (GALT) system, its function is not associated with any predisposition to sepsis or other manifestation of immune compromise. Lymphoid tissue first appears in appendix approximately 2 weeks after birth. The amount of connective tissue increases throughout puberty and remains constant for next decade and then begins to decrease with age. After 60 yrs of age, virtually no lymphoid tissue remains in appendix.

AIMS AND OBJECTIVES

- To evaluate the accuracy of the combined use of modified Alvarado scoring system and ultrasound in the diagnosis of acute appendicitis.
- To assess the association between clinical, radiological, operative and histopathological findings and evaluation of their accuracy.

MATERIALS AND METHODS

The present study was undertaken in the Department of General Surgery at Government Medical College, Jammu. All the patients who presented with right lower quadrant pain were assigned a score using the Modified Alvarado Score. The decision to proceed with surgery was taken if the patients have a Modified Alvarado Score of 7 or more and/or if the ultrasound showed features of appendicitis after other causes of right lower quadrant pain were ruled out. All the patients with a score of 7 or more were operated irrespective of their ultrasound findings. A total of 250 patients were included in the study.

Source of Data

All the patients admitted in G.M.C Jammu with pain in right lower abdomen in whom acute appendicitis is suspected were taken for the study from December 2015 to November 2016.

Inclusion Criteria

- Those admitted in G.M.C Jammu having acute lower right sided abdominal pain with a clinical and /or ultrasonographic diagnosis of acute appendicitis and who were operated for the same.
- All patients who were willing to participate in the study.

Exclusion Criteria

- Patients who were diagnosed to have other causes of right lower quadrant pain.
- Age less than 10 years.
- Pregnant females.
- Patients with appendicular lump.

Observation

A total of 250 patients with pain right iliac fossa, suggestive of acute appendicitis were evaluated on the basis of Alvarado's scoring and Ultrasound findings. Out of these, 200 patients underwent open appendectomy in emergency settings. Out of these, 145 patients were males and number of female patients was 55, with a Male to Female ratio of 2.63 : 1**.** 50 patients were not operated upon. They were those patients who improved clinically during the observation period or had normal ultrasound or some other diagnosis was made on further clinical assessment and investigations.

Table 1. Number of operated patients in different age groups

Age groups	Number of patients		Total
	Male	Female	
10-19	52	20	72
20-29	47	14	61
30-39	22	14	36
40-49	12	4	16
50-59	9	3	12
60-70	2	1	3
Total	145	55	200

All patients were scored on a scale of 1-9 on Modified Alvarado's Scoring (MAS) and were grouped into one of the following 4 categories.

Category-1 (MAS 1-4) – Appendicitis Unlikely – No. of Patients in this group was 40. Only 5 of them were operated and rest 35 patients were observed for 24-48 hours and then discharged.
Category-2 (5-6) – Possible – No. of Patients were 46, out of which 31 were operated and rest 15 were observed for 24-48 hours and then discharged.
Category-3 (7-8) – Probable – No. of Patients were 145, all of which were operated.
Category-4 (9) – Definitive – No. of Patients were 19, all of these were also operated.

There were 40 patients in category 1 (MAS of 1 to 4), out of these 35 patients were managed conservatively because they had normal ultrasound or they improved clinically during the observation period. Only 5 patients, 3 males and 2 females in this category were operated because they either had features of appendicitis on ultrasound or they did not settled during the observation period. Out of these 1 patient had findings suggestive of appendicitis on Ultrasonography, 1 patient had normal ultrasound while 3 patients had only probe tenderness with no definitive target lesion. Intra-operatively 2 out of the 5 patients had normal appendix; both were females, also both had normal appendix on Histopathological examination.

Table 2. Showing observations of operated patients in different Modified Alvarado score groups

Modified Alvarado Score (MAS)	No. of patients			Ultrasound findings			Intraop. zindings		Histopath. Findings	
	Male	Female	Total	Positive	Negative	Only probe tenderness +	Positive	Negative.	Positive	Negative.
1-4	3	2	5	1	1	3	3	2	3	2
5-6	22	9	31	20	5	6	28	3	30	1
7-8	107	38	145	105	20	20	142	3	145	0
9	13	6	19	15	1	3	19	0	19	0
Total	145	55	200	141	27	32	192	8	197	3

One patient, 28 years old female, had features of appendicitis on ultrasound. But intraoperatively appendix was normal and a chocolate cyst was found in right ovary. Appendectomy was done and excision of the chocolate cyst was also done. Other patient, a 12 year old female, had only probe tenderness on ultrasound with no target lesion. Because her symptoms did not improve on conservative management and due to high clinical suspicion she was operated upon. Unfortunately it was a negative appendectomy and appendix was normal intraoperatively as well as histopathologically. Out of the other 3 operated patients 1 had normal ultrasound, while 2 patients had only probe tenderness with no target lesion. All 3 had inflamed appendix intraoperatively as well as histopathologically.

46 patients fell into the second category (i.e. MAS of 5-6). Out of these 15 were not operated and were discharged. These were those patients who either had normal ultrasound or who improved clinically during the observation period. 31 patients in this category were operated. Out of these 22 were males and 9 were females. 20 patients from this category were operated, because they had features of appendicitis on ultrasound while the other 11 patients who had normal or equivocal ultrasound findings were operated because they did not improve clinically during the observation period. Intraoperatively 28 out of 31 patients had inflamed appendix whereas 3 had normal appendix. Out of these three patients 2 had features of inflamed appendix on Histopathological examination while only one had normal appendix. Thus there was one negative appendectomy in this category, it was a 23 year old female patient whose ultrasound showed features of appendicitis but intraoperatively and histopathologically appendix was normal. Thus ultrasound had false positive findings in this patient.

Table 3: Results of operated patients on the basis of Modified Alvarado compared with histopathology reports

Modified Alvarado score	Diagnosis on HPE		Total
	Appendicitis	Normal appendix	
7-9	164	0	164
1-6	33	3	36
Total	197	3	200

Table 4. Results of operated patients on the basis of ultrasound findings compared with histopathology reports

Ultrasound	Diagnosis on HPE		Total
	Appendicitis	Normal appendix	
Positive	139	2	141
Negative or equivocal	58	1	59
Total	197	3	200

There were 145 patients in the third category (i.e. MAS of 7-8). Out of these 107 were males and 38 were females. In this category 105 patients had features of appendicitis on Ultrasonography, 20 had normal ultrasound, while 20 of them had only probe tenderness with no target lesion on USG. All 145 patients were operated. Intra-operatively, 142 patients had inflamed appendix and 3 patients had normal looking appendix. Upon Histopathological Examination all 145 patients confirmed the diagnosis as appendicitis. Thus there was no negative appendectomy in this category. There were 19 patients in the fourth category (i.e. MAS of 9). Out of these 13 were males and 6 were females. In this category 15 patients were found to have features of appendicitis on Ultrasonography and 3 patients had only probe tenderness with no definitive target lesion while 1 had normal USG. Intra-operatively all 19 patients had inflamed appendix. Upon Histopathological Examination all 19 cases were positive for appendicitis. From the data shown in table 3, sensitivity of modified Alvarado score in diagnosing acute appendicitis is 83.24%, and specificity is 100%.

Table 5: Results of operated patients based on both MAS and ultrasound combined together, compared with histopathology reports

MAS + ultrasound	Diagnosis		Total
	Appendicitis	Normal appendix	
MAS >6 + MAS 5-6 with pos. USG	183	1	184
MAS <5 + MAS 5-6 with neg. USG	14	2	16
Total	197	3	200

From table 4 it is calculated that sensitivity of ultrasound in diagnosing acute appendicitis was 70.55%, and its specificity was 33.33%. Now from the above two tables it is evident that MAS alone has a high specificity but a low sensitivity and has a high false negative rate of 16.75%. Also when only ultrasound is taken into consideration it also had a low sensitivity as well as specificity with a false negative rate of 29.44%. Thus to improve the sensitivity of diagnosing acute appendicitis and to reduce the rate of false negative cases it is advisable to combine both of these criteria in preoperative diagnosis of acute appendicitis.

Here all those patients with MAS of 7 or more were considered as appendicitis; also those patients with MAS of 5-6 with a positive ultrasound were also considered as appendicitis and were operated immediately. All the patients with MAS of 4 or less with a negative ultrasound were excluded from the diagnosis of appendicitis and were considered for discharge. Rest of the patients (i.e. those with MAS of 5-6 with a negative ultrasound and those with MAS of 4 or less with a positive ultrasound) were further observed for a period of 24-48 hours and serially rescored and rescanned and decision to operate was taken accordingly. By combining these two criteria the sensitivity of diagnosing acute appendicitis was increased to 92.89% where as the specificity changed to 66.66%. Also the rate of false negative cases was reduced to 07.10% as shown in table 5.

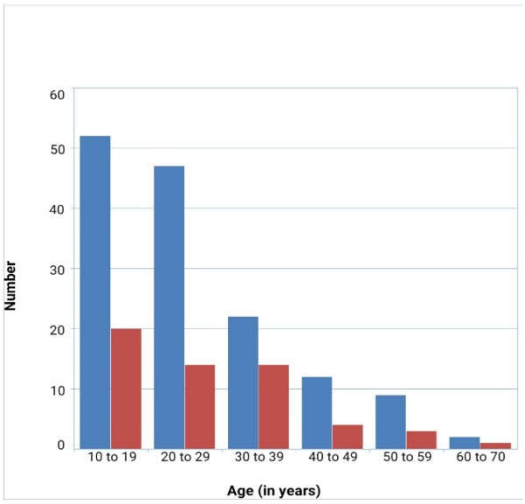

Figure 1. Age wise distribution of patients

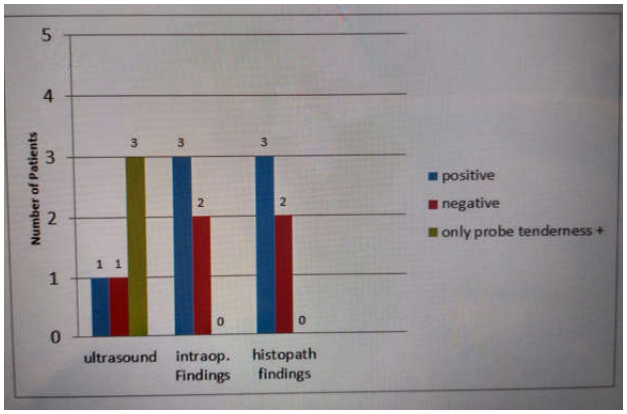

Figure 2. Alvarado score (1-4)

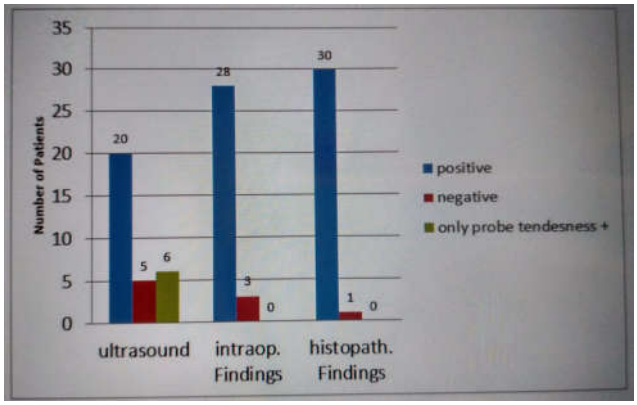

Figure 3. Alvarado score (5-6)

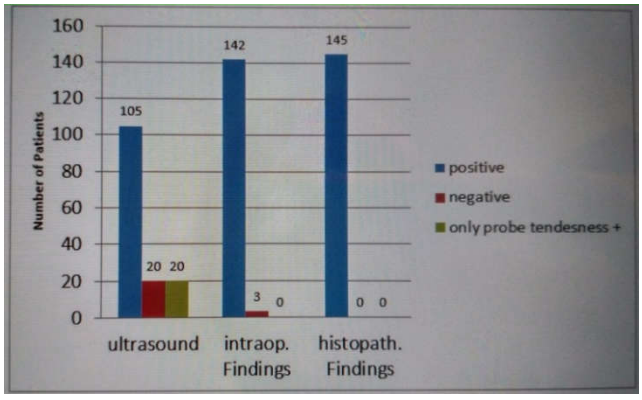

Figure 4. Alvarado score (7-8)

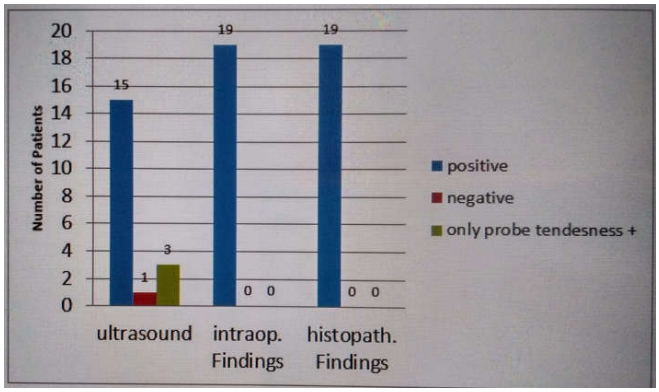

Figure 5. Alvarado score (9)

DISCUSSION

The mean age for the study was 51.97 years. This is in contrast with other studies (by Alfredo Alvarado; Kanumba ES, Mabula JB, Rambau P, *et al*. ; Dey S, Mohanta PK, Singh VK et al.) done on appendicitis which showed a mean age of 22.7 years to 30.6 years.. In our study, the highest number of appendicitis cases is in the second decade of life and is rarely diagnosed after the sixth decade. This is in agreement with the findings of other author Lamps LW. Appendicitis is more common in males than females as was reported in other studies (Alfredo Alvarado; Kamran H, Naveed D, Asad S, *et al.*). The sensitivity of the Modified Alvarado score in our study is 83.2%. The specificity of Modified Alvarado score in our study is 100%. The sensitivity of ultrasound in diagnosing patients as appendicitis in our study is 70.5%, while the specificity is 33.33%. The combined sensitivity of both these parameters is 92.89%, where as the combined specificity is 66.66%. The total negative appendectomy rate was 1.5 %, ranging from 0% in patients with score of 7 or more to 8.3% in patients with score of 6 or less. This is very less as compared with other studies (by Singh K, Gupta S, Pargal P et al) which showed a negative appendicectomy rate of 18.5% to 22.9%.%. In our study negative appendectomy rate for males was 0.68%, where as for females it was 4.44%. All the patients whose MAS was 7 or more were correctly diagnosed as appendicitis as confirmed by HPE. Thus in our study MAS has a sensitivity of 100 % whenever the score is 7 to 9. Ultrasound, though helpful in confirming the diagnosis preoperatively, may sometimes be normal or equivocal. In category 3 and 4 ultrasound had a sensitivity of 72.4% - 78.9%. Thus one can make a preoperative diagnosis of acute appendicitis when modified Alvarado score is 7 or more, though their ultrasound may sometimes be normal. These patients should be considered for appendectomy as an emergency procedure, so as to prevent complications of appendicitis. In category 2 (i.e. MAS of 5-6), modified Alvarado score and ultrasound both had a low individual sensitivity in preoperatively diagnosing the patients of appendicitis. But when both were taken into consideration the combined sensitivity increased to 95 %. Thus for patients falling in this category one should not rely on MAS or ultrasound individually but one can preoperatively diagnose the patients as appendicitis, and proceed to open appendectomy, if both parameters are taken into consideration. The patients with normal ultrasound should be observed further for 24-48 hours and decision to operate should be taken on serial rescoring (on MAS scale) and repeat USG scan.

In category 1, both modified Alvarado score and ultrasound had very low sensitivity, individually as well as in

combination. 35 out of 40 of the patients in this category were correctly excluded from having appendicitis, and were discharged. Also 2 out of the other 5 operated patients had normal appendix intraoperatively as well as histopathologically. Thus MAS of 4 or less had a high specificity (92.5%) in excluding the patients who do not have appendicitis. So the patients falling in this category (i.e. MAS 1-4) with positive or negative ultrasound should be observed for another 24-48 hours. Reassessment and further investigations like CT Scan can be done if symptoms and signs still persist. The patients who settle clinically, should be discharged.

Conclusion

Acute Appendicitis is a common surgical emergency, mostly affecting young adults. Early diagnosis and operative intervention is necessary to prevent complications of acute appendicitis. The overall negative appendectomy rate is low but it is high in females of reproductive age group. Modified Alvarado scoring system is an easily applicable scoring system for early preoperative diagnosis of appendicitis. It is highly reliable when MAS is high (7-9). For low Modified Alvarado score (MAS 1-4), it is helpful in excluding the patients from being preoperatively labelled as appendicitis, thus avoiding their unnecessary surgery. For patients with intermediate Modified Alvarado score (MAS 5-6), this system is not much reliable in preoperative diagnosis of appendicitis, but when combined with graded compression ultrasonography findings the sensitivity can be increased. Also the negative appendectomy rate can be kept very low by combining both these criteria, i.e. Modified Alvarado score and ultrasound.

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