

# Evaluation of Modified Alvarado Scoring System in Pre-operative Diagnosis of Acute Appendicitis

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## Abstract

**Background:** Acute appendicitis is the most common surgical cause of emergency laparotomy. Despite more than 100 years of experience, accurate diagnosis still evades the surgeon. The rate of negative appendectomy has been reported to be between 20 and 30%. Surgeons have been resorting to various scoring systems to aid in diagnosis and operative decision-making.

**Aims and Objectives:** The aim of this study is to review the usefulness of modified Alvarado scoring system and to evaluate its feasibility and value as an aid to surgical diagnosis and in reducing the number of negative laparotomies.

**Methodology:** A study of 50 patients presenting with pain abdomen and diagnosed provisionally as acute appendicitis was undertaken. Depending on individual presentation, a score was calculated for each case, from nine values (based on modified Alvarado system). Operative and conservative intervention was undertaken in patients with scores between 5–9 and <5, respectively. When surgery was done, the appendix specimen was sent for holoprosencephaly. An attempt was made to correlate the clinical presentation with pathological findings.

**Results and Observations:** In our study, males were predominant in number, in the ratio of 1.7:1 with females. Out of 44 who were operated, 36 had appendicitis and 8 had normal appendix with other diseases. The overall sensitivity of the MASS was 87.87%. Males had a sensitivity of 90.62% and females had sensitivity of 72.22%. After application of the scoring system, the overall negative appendectomy rate was 16%.

**Conclusion:** Modified Alvarado scoring system significantly reduced the rate of negative appendectomy. It can be applied in routine practice, even in district general hospitals with minimal laboratory facilities. It has greater sensitivity in adult males than in females.

**Key words:** Acute appendicitis, Modified Alvarado score, Sensitivity

## INTRODUCTION

Acute appendicitis is the most common surgical cause of emergency laparotomy. Simple appendicitis can progress to perforation, which is associated with a much higher morbidity and mortality, and surgeons have, therefore, been inclined to operate when the diagnosis is probable rather than wait until it is certain.<sup>[1]</sup> The surgical principle about acute appendicitis “*when in doubt, take it out*” is not correct in view of the number of major and minor complications following appendectomy. Despite more than 100 years

experience, accurate diagnosis still evades the surgeon. Due to its myriad presentations, acute appendicitis is a common but difficult diagnostic problem. The accuracy of the clinical examination has been reported to range from 71% to 97% and varies greatly depending on the experience of the examiner.<sup>[2]</sup> However, because missed ruptured appendixes have dire consequences, surgeons have traditionally accepted 20% rate of negative findings at appendectomy and the removal of a normal appendix.<sup>[3]</sup> The rate of negative appendectomy (removal of a normal appendix in patients with other causes of abdominal pain) is reported to be between 20% and 30%.<sup>[3,4]</sup>

The classical signs and symptoms of acute appendicitis were first reported by Fitz<sup>[5]</sup> in 1886. Since then, it has remained the most common diagnosis for hospital admission requiring laparotomy.<sup>[6,7]</sup> Approximately 6% of the population will suffer from acute appendicitis during their lifetime, therefore, much effort has been directed toward early diagnosis

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and intervention.<sup>[8]</sup> This effort has successfully lowered the mortality rate to less than 0.1% for non-complicated appendicitis, 0.6% where there is gangrene, and 5% for perforated cases.<sup>[8]</sup> The diagnosis of appendicitis can be difficult, occasionally taxing the diagnostic skills of even the most experienced surgeon. Equivocal cases usually require inpatient observation. This delay in diagnosis may increase the morbidity and costs. Attempts to increase the diagnostic accuracy in acute appendicitis have included computer-aided diagnosis, imaging by ultrasonography, laparoscopy, and even radioactive isotope imaging.<sup>[9-12]</sup> Various scoring systems have been devised to aid diagnosis.<sup>[13,14]</sup>

The Alvarado score was described in 1986<sup>[15]</sup> and has been validated in adult surgical practice. The use of an objective scoring system such as the Alvarado system can reduce the negative appendectomy rate to 0–5%.<sup>[15-17]</sup>

A scoring system described by Alvarado was designed to reduce the negative appendectomy rate without increasing morbidity and mortality which was modified by Kalan *et al.*<sup>[18]</sup>

However, this system is not a substitute for clinical judgment and just an aid in diagnosing acute appendicitis and assists in arriving at a conclusion whether a particular case should be operated or not so that the number of negative laparotomies will be reduced.

## AIM AND OBJECTIVE OF THE STUDY

### Aim

The aim of this study was to evaluate the sensitivity of modified Alvarado scoring system in the diagnosis of acute appendicitis in adults.

### Objective

The objective of the study was to evaluate its feasibility and value as an aid in surgical decision-making in cases of possible appendicitis and in reducing the number of negative laparotomies.

## METHODOLOGY

A prospective study of 50 patients who were ill enough to warrant surgery for suspected appendicitis admitted in Government Medical College, Siddipet, under various surgical units was conducted during a period from January 2019 to January 2020.

### Inclusion Criteria

Patient coming to hospital with pain abdomen and diagnosed provisionally as acute appendicitis and are willing for surgery are included in the study.

### Exclusion Criteria

The following criteria were excluded from the study:

- Patient coming to hospital with pain abdomen along with distention of abdomen
- Pregnant females
- Any mass per abdomen
- Patient with previous history of any abdominal surgeries
- Patient not willing for surgery.

Depending on individual presentation of signs and symptoms, a score was calculated for each case of suspected appendicitis from nine values (based on modified Alvarado system).

## OBSERVATIONS AND RESULTS

### Study Design

A prospective clinical study consisting of 50 acute abdomen cases that were ill enough to warrant surgery for suspected appendicitis is undertaken to evaluate the sensitivity of modified Alvarado scoring system with respect to its diagnostic accuracy.

### Statistical Methods

Fisher's exact test has been used to find the significance of scoring system of appendicitis in male and female in conformation with holoprosencephaly (HPE). The odds ratio has been used to find the strength of relationship between scoring system with HPE. Diagnostic statistics has been used to find the diagnostic value of scoring system in diagnosing for appendicitis [Tables 1-8].

## DISCUSSION

Acute appendicitis remains a common abdominal emergency throughout the world. The diagnosis of acute appendicitis continues to be difficult due to the variable presentation of the disease and the lack of reliable diagnostic test. Although there are lots of advances in the diagnostic field with the invention of sophisticated investigations, diagnosis of acute appendicitis remains an enigma for the attendant surgeon. None of the investigations such as ultrasound, computed tomography, and nuclear magnetic resonance can conclusively diagnose appendicitis.

Time and again, it has proved that some of the investigations already discussed are costly, time consuming, require more sophisticated equipment, and expertise, while some are not feasible and not readily available.

Hence, even today, a thorough clinical examination with basic investigations like white blood cell (WBC) count

remains cornerstone in the diagnosis of acute appendicitis. With this background, many eminent surgeons and physicians have been adopting different scoring systems to decrease negative appendectomy.

Although there has been some improvement in the diagnosis of acute appendicitis over the past several decades, the percentage of normal appendices reported in various series varies from 8 to 33%.<sup>[14,16]</sup> Clinical scoring systems have proved useful in the management of number of surgical conditions. In the past few years, various scores have been developed to aid the diagnosis of acute appendicitis. Although many diagnostic scores have been advocated, most are complex and difficult to implement in the clinical situation. The Alvarado score is a simple scoring system that can be instituted easily. To be useful, a scoring system must be both sensitive and specific.

The modified Alvarado score proved to be effective in one study in adult patients with acute appendicitis. The modified Alvarado scoring system is simple to use and easy to apply, since it relies on history, clinical examination, and basic laboratory investigations.

The present study was undertaken to evaluate the usefulness of modified Alvarado scoring system in reducing the number of negative appendectomy and to evaluate the sensitivity of MASS in the diagnosis of acute appendicitis.

Our results and observations were discussed and compared with various other studies. The age group in which acute appendicitis occurred commonly was between 11 and 30 years. It is clear that incidence is less in younger and older age groups with peak incidence in the 2<sup>nd</sup> and 3<sup>rd</sup> decades.

In the present series, the males outnumbered females in the ratio of 1.7:1.

Pain was the most common presenting symptom and has been observed in all the cases (100%) in the present series. The classical shifting of pain from umbilical region to the right iliac fossa (RIF) was seen in all cases.

Next common symptoms observed were nausea/vomiting in 86% of cases and anorexia in 74% of cases.

Burning micturition was seen in 6% and bowel disturbance was seen in the form of constipation (8%) and diarrhea (10%).

Majority of the patients had aching type of pain and some (8%) had colicky pain.

Fever was of low grade with corresponding rise in pulse rate and was present in 74% of cases.

Majority of the patients presented within 24 h after the onset of pain, with most of them presenting between 12 and 24 h of onset of pain.

On clinical examination, tenderness at McBurney's point was the most common sign (92%). Guarding was present in 20% of patients. It was present when the inflammation was severe. Rebound tenderness was present in 68%. In these cases, there was the presence of local peritonitis or when inflamed appendix was more anteriorly placed. Abdominal rigidity in 8% was due to perforated appendix or gangrenous appendix.

Rovsing's sign was positive in 14%. This sign is seen whenever there is inflammation in the RIF. Psoas test was positive in 12% of cases, whereas obturator test was positive in 24% due to retrocecal appendix.

Hyperesthesia was present in 8%, rectal tenderness in 6%. About 4% had appendicular mass.

In the present study, the thin-layer chromatography was increased in 76%, and it was within normal range in 24%.

Plain X-ray abdomen taken in erect posture showed ground-glass appearance in 2 patients, suggestive of diffuse peritonitis. Two patients had fluid levels localized to the cecum. Free gas under the diaphragm was not present in the cases with perforated acute appendicitis. In none of the patients, fecolith casting a radio-opaque shadow could be demonstrated.

For assessment, the patients were categorized into three groups, namely, male, female, and children. Out of 50 cases studied, 32 were male, 18 were female, and 2 were children (<12 years).

Out of 32 males, scores of >7–9 were 23; scores of 5–7 were 6, and 3 had score <5 and 2 patients had mass in RIF.

These five patients did not undergo surgery. The patients with mass in RIF were advised for interval appendectomy.

Out of 18 female patients, 12 had score >7–9, 5 had score 5–6, and 1 had score <5, none had mass in RIF. Management was on same lines as for males. One patient did not undergo operation.

All the two children had score >7–9 and were operated on.

A total of 44 patients were operated, of which 27 were male, 17 females, and 2 children. Twenty-one males having score of 7–9 were had acute appendicitis, 1 patient had normal appendix with Meckel's diverticulitis.

Male patients having score of 5–6 were 6, out of which 4 patients had acute appendicitis, 2 patients had normal appendix, and 2 patients had mesenteric lymphadenitis.

In 12 female patients having a score 7–9, 9 had acute appendicitis, 3 patients had normal appendix with other diseases, out of which 2 had pelvic inflammatory disease (PID) and 1 patient had mesenteric lymphadenitis. In 5 females with score 5–6, 3 had acute appendicitis, 2 had normal appendix with other diseases -1 PID, and 1 mesenteric lymphadenitis.

All the children subjected to appendicectomy had acute appendicitis.

In our series, a score of 7–9 using modified Alvarado system had a total sensitivity of 87.87%.

Increased proportion (36.36%) of negative appendicectomy is noticed (4.14 times more) for the Alvarado score 5–6 and significantly decreased proportion (12.12%) negative appendicectomy is noticed (0.24 times less) for the Alvarado score 7–9.

In our series, negative appendicectomy rate in females with score 5–6 was 40% and with score 7–9 was 25%. Men with score 5–6 had negative appendicectomy rate of 33.34% and with score 7–9 had negative appendicectomy rate of 4.76%. Hence, in the overall, females (27.78%) had more negative appendicectomy rate compared to males (9.38%), as the other diseases like PIDs were more common in the reproductive age group. Since intra-abdominal infection in females, particularly lower abdomen, can be quite confusing, it is difficult to differentiate acute appendicitis from gynecological conditions like twisted ovarian cyst and PID.

The overall Alvarado score >5 has got more sensitivity (87.87%) and diagnostic accuracy (76%) of diagnosing patients for appendicitis. This indicates that by particularly adopting this system, negative laparotomies can be reduced by a figure of 16%. Those patients who scored <5 did not require subsequent laparotomy, indicating the usefulness of the system in ruling out acute appendicitis.

In our series, when the score was more than 7, suggesting an inflammation localized to the RIF, surgery was done within 6 h of the patient getting admitted to hospital and it was observed that these patients had badly inflamed appendices, again indicating the sensitivity of the system. Laparoscopy can be advised as a diagnostic tool to minimize negative appendicectomy rates.

In patients whom score was 5–6, were observed and reassessed after a period of 12–24 h. Where there was

**Table 1: Age distribution with sex**

Age in years	Male	Female	Total
10	2 (6.3)	-	2 (4.0)
11–20	17 (53.1)	8 (44.4)	25 (50.0)
21–30	10 (31.3)	6 (33.3)	16 (32.0)
31–40	2 (6.3)	2 (11.1)	4 (8.0)
41–50	1 (3.1)	2 (11.1)	3 (6.0)
>50	-	-	-
Total	32	18	50
Inference	82% of the cases are in the age group of 11–30 years		

**Table 2: Presentation of clinical features**

Clinical features	Number	%
Symptoms		
Abdominal pain	50	100.0
Anorexia	37	74.0
Nausea/vomiting	43	86.0
Constipation	4	8
Diarrhea	5	10
Burning micturition	3	6

**Table 3: Presentation of clinical features**

Clinical features	Number	%
Signs		
Right iliac fossa – tenderness	46	92.0
Rebound – tenderness	34	68.0
Fever	37	74.0
Muscle guarding	5	10
Abdominal rigidity	3	6
Mass in right iliac fossa	2	4
Psoas sign	3	6
Obturator sign	6	6
Rovsing's sign	2	4
Hyperesthesia at Sherren's triangle	2	4
Rectal tenderness	3	6

**Table 4: Presentation of clinical features**

Clinical features	Number	%
Symptoms		
Migratory right iliac fossa pain	50	100.0
Anorexia	37	74.0
Nausea/vomiting	43	86.0
Signs		
Right iliac fossa –tenderness	46	92.0
Rebound –tenderness	34	68.0
Fever	37	74.0
Laboratory findings		
Leukocytosis	38	76.0

persistence of abdominal tenderness with increased WBC count, appendicectomy was done. These patients were also found to have congested and inflamed appendix.

In our series, we had two patients in pediatric age group. All of them had a score of >7 and were operated within

**Table 5: Results of modified Alvarado score**

Alvarado score	Total (n=50)	Male	Female	Children
<5	4 (8.0)	3 (6.0)	1 (2.0)	-
5-6	11 (22.0)	6 (12.0)	5 (10.0)	-
7-9	35 (70.0)	23 (46.0)	12 (24.0)	2* (4.0)
Mass in right iliac fossa	2 (4.0)	2 (4.0)	-	-

\* Male children

**Table 6: Pathological diagnosis of the specimen of appendix sent for histopathological study**

Histopathology (n=44)	Number	%
Normal	8	
AC. Catarrhal	10	22.73
AC. Suppurative	19	43.18
AC. Gangrenous	4	9.09
AC. Perforative	3	6.82

**Table 7: Negative appendectomy**

Negative appendectomy (n=50)	Number	%
Male	3	9.38
Female	5	27.78
Children	-	-
Overall	8	16.00

**Table 8: Post-operative complications**

Post-operative complications (n=50)	Number	%
Wound infection	2	4
Respiratory tract infection	1	2
Paralytic illness	1	2

6 h of admission. Operative finding was invariably, an inflamed appendix, indication 100% sensitivity in children.

In our present study, the usefulness of the system was demonstrated beyond doubt by reducing the number of negative laparotomies, especially in men and children. In women, negative laparotomies were still high and this can be reduced by laparoscopy.

## CONCLUSION

- Alvarado scoring system significantly reduces the number of negative laparotomies without increasing overall rate of appendicular perforation
- It can work effectively in routine practice as an adjunct to surgical decision-making in questionable acute appendicitis
- It is effective in children and men but diagnostic laparoscopy is advised to minimize the unacceptably high false-positive rate in women

- It is simple to use and easy to apply since it relies only on history, clinical examination, and basic laboratory investigations
- It is cost effective and can be used in all district general hospitals with basic laboratory facilities.

## SUMMARY

- A study to evaluate the usefulness of modified Alvarado system as an aid to diagnosis in suspected case of appendicitis and help in surgical decision-making
- Fifty individuals admitted with provisional diagnosis of acute appendicitis, scored according to presentation, on a total of 9
- Patients treated conservatively or surgically based on score
- Results of conservative, surgical intervention, and HPE reviewed
- It was found that modified Alvarado score correlated very well with diagnosis of acute appendicitis, especially in children and adult males and to a lesser degree in females
- It was concluded that modified Alvarado scoring system significantly reduces the rate of negative laparotomies without increasing overall rate of appendicular perforation.

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