Original Research Article

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KIMS modification of Alvarado's score for acute appendicitis

Daivasikamani Premkumar*

Department of Surgery, Karpaga Vinayaga Institute of Medical sciences and research center, Maduranthagam, Kanchepuram, Tamil Nadu, India

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***Correspondence:** Dr. Premkumar Daivasikamani, E-mail: dr.premkumar52@gmail.com

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ABSTRACT

Background: Abdominal pain is one of the most frequent presentations to the emergency department (ED). Acute appendicitis is by no means an easy diagnosis to make and can baffle the best. Problems related to the diagnosis of appendicitis are evidenced by the significant negative laparotomy rate. A scoring system described by Alvarado was designed to reduce the negative appendicectomy rate without increasing morbidity and mortality. Alvarado's score does not include ultrasonogram which is most commonly done investigation before any abdominal surgery.

Methods: The study included the ultrasonography and modified the scoring system and retrospectively we analyzed 153 patients who were admitted as acute appendicitis. When interpreted considering the clinical examination, sonography and modified scoring system and it significantly reduced the rate of false-negative appendectomies. The use of diagnostic imaging tests such as CT scan or ultrasonography should be selective in those with atypical presentation or findings. Laparoscopy, barium enema, ultrasonography and computer assistance have all been shown to improve accuracy, but no one method is of proven superiority.

Results: By using KIMS modification of Alvarado's score it was found that unnecessary appendectomy can be avoided in 11 out of 132 patients.

Conclusions: Such diagnostic aids or intensive in-hospital observation must be used to reduce the 15-30 per cent negative laparotomy rate when acute appendicitis is suspected, without increasing the incidence of appendiceal perforation.

Keywords: Acute appendicitis, Alvarado's score, Abdominal pain, Appendicectomy, KIMS modification

INTRODUCTION

Abdominal pain is one of the most frequent presentations to the emergency department (ED). Acute appendicitis is difficult to diagnose in the initial stages and can baffle the best surgeon. A failure of early diagnosis can lead to progression of the disease with its attendant morbidity and occasional mortality. Although the treatment of appendicitis has remained the same for over 250 years, diagnostic techniques have changed immensely. Problems related to the diagnosis of appendicitis are evidenced by the significant negative laparotomy rate. A negative appendicectomy rate of 20-44% is not unusual in the surgical literature and many surgeons would accept a negative appendicectomy rate of up to 30% as inevitable.¹ A scoring system described recently by Alvarado was designed to reduce the negative appendicectomy rate without increasing morbidity and mortality.² There are many scores to diagnose acute appendicitis and Alvarado's score is most popular one. But Alvarado's score does not include ultrasonogram which is most commonly done investigation before any abdominal surgery. So, we retrospectively analyzed 153 patients who were admitted as acute appendicitis. We modified the Alvarado scoring system by including the ultrasonogram and giving more importance to signs.

METHODS

All the patients admitted as acute appendicitis underwent clinical examination, laboratory investigations and ultrasonography. Clinical examination was stressed on temperature more than 1000F, anorexia, nausea, vomiting, right iliac fosse pain (RIF), tenderness right iliac fosse and rebound tenderness. We modified the Alvarado's score by including ultrasonogram and modified the points. Most of the patients were not able to tell about the shifting of pain from umbilicus to RIF so the pain in right iliac fosse was taken as criteria. In the clinical symptoms the anorexia, nausea, vomiting was joined together and one point was given as all of them denotes gastro intestinal disease and pain is a subjective feeling and pain perception varies with individuals and one point was given for tenderness but rebound tenderness is observative finding hence 2 points was given. In the investigations raise in the total count and shift to the right are common finding in acute infection hence each were given one point. As ultra-sonogram has become routine investigation available and noninvasive and it was included and 2 points was given (Table 1).

Table 1: The KIMS modification and Alvarado's score.

Name	KIMS modification	Alvarado's score
Abdominal pain which migrates to RIF	1	1
Anorexia	1	1
Nausea and vomiting		1
Tenderness in right lower quadrant/RIF	1	2
Rebound tenderness	2	1
Elevated temperature (t=37.3 ^o C)	1	1
Leucocytosis (WCC>10,000/cmm)	1	2
Shift of white cells to the left (i.e. neutrophilia)	1	1
Ultrasonogram /CT scan	2	0
Total	10	10

RESULTS

Out of the 153 cases ultrasonography revealed appendicular mass in three patients and were treated conservatively and taken up for surgery later. Four patients were diagnosed as acute appendicitis but not willing for surgery. These 7 patients were excluded from the study and 146 patients were studied and the points were calculated for them. Comparing KIMS modification and Alvarado's score there some changes in the score (Table 2).

Name	KIMS modification 146	Percentage	Alvarado's score 146	Percentage
Anorexia	63	43	74	50.6
Nausea and vomiting			67	45.8
Tenderness in right lower quadrant/RIF	136	93	136	93
Rebound tenderness	93	63.7	93	63.7
Ultrasonogram /CT scan	108	74	0	0

Table 2: Comparing KIMS modification and Alvarado's score.

Out of 153 patients 132 patients had fever and leucocytosis and shift to right, 128 patients had RIF pain, anorexia and tenderness in RIF and 89 patients had RIF pain, anorexia, tenderness RIF and rebound tenderness. Ultrasonogram showed acute appendicitis in 108 patients. If we follow the Alvarado's score 128 patients were above 7/10 but in modification, it was reduced to 92. And between 5 to7 in Alvarado score there were 18 patients

and in study score, it was 15. All 128 patients above 7/10 underwent emergency appendectomy and 33 patients were treated symptomatically. Out of 128 patients who underwent surgery 4 had normal appendix in modification and by Alvarado's score it is 15. By including ultrasonogram and raising score for rebound tenderness 11 negative appendicectomy could have been avoided (Table 3).

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modification and Alvarado's score.		
Table 5. Comparing the surgical results of K)

Table 2. Companing the surgical results of KIMS

	KIMS modification	Alvarado's
Sumaami	112	100
Surgery	115	128
Biopsy normal appendix	4	15
Percentage of normal appendix	3.5%	11.7%

DISCUSSION

There are many scores to diagnose acute appendicitis and some of them are,

- Alvarado score (MANTRELS)
- Modified Alvarado's score
- Pediatric appendicitis score (Samuel)
- Low risk for appendicitis score (Kharbanda)
- Lintula score
- Eskelinen score
- Fenyo Lindberg score
- Ohmann score
- Christian score
- RIPASA score.

After going through all the scores, analysed study group and concluded to propose own scoring system to diagnose and treat acute appendicitis. In this scoring system, we gave 3 points for both clinical symptoms and signs. We gave importance to rebound tenderness with score of 2 and one for right iliac fossa tenderness. We clubbed together the nausea, vomiting and anorexia together and gave one. Study included the ultrasonography finding and rarely CT finding and 2 points were given.

The scoring system for appendicitis was initially thought by Teicher et al in the year 1983. They studied two groups of patients' history, physical examination and laboratory and identified 23 predictive factors. But only seven predictive factors had differentiating weights and reached statistical significance: sex, age, duration of symptoms, GU symptoms, involuntary right lower quadrant muscle spasm, right-sided rectal mass, and white blood cell count.

One hundred consecutive cases of proven appendicitis (AAp) were retrospectively reviewed and compared with 100 consecutive cases that had normal appendices removed because of erroneous preoperative diagnosis of appendicitis (NAp). Using these seven predictors, 38% NAps would have been spared laparotomy. This simple scoring system could have eliminated over one third of the unnecessary laparotomy in their sample.³Alvarado conducted a retrospective study of 305 patients hospitalized with abdominal pain suggestive of acute appendicitis. Eight predictive factors were found to be useful in making the diagnosis of acute appendicitis.

They are localized tenderness in the right lower quadrant, leucocytosis, and migration of pain, shift to the left, temperature elevation, nausea-vomiting, anorexia and rebound pain. Based on this weight, they devised a practical diagnostic score that may help in interpreting acute appendicitis.⁴

The accuracy of the modified Alvarado score was assessed prospectively in the preoperative diagnosis of acute appendicitis in children. The overall sensitivity of a modified Alvarado score of >or = 7 was 76.3% and its specificity was 78.8%. Current clinical practice is more accurate than the modified Alvarado score in the diagnosis of acute appendicitis in children.⁵ The study shows that the accuracy of the modified Alvarado score was not greater than the Alvarado score in the diagnosis of acute appendicitis.⁶

Pediatric score was proposed by Samuel was very difficult to calculate hence not popular.⁷ The Pediatric Appendicitis Score had a sensitivity of 1, specificity of 0.92, positive predictive value of 0.96, and negative predictive value of 0.99. The low risk for appendicitis score (Kharbanda) and the Lintula score relies on clinical data alone hence not followed. The Eskelinen score is relatively complex to perform, (requiring factor multiplication) and was originally designed for use within a computer program could not be applied all the places.

The Fenyo-Lindberg score appears to be one of the most complex, incorporating criteria with multiple levels of response that both add to and subtract from the total score requires lot of effort to reach a figure. Ohmannis a good score but others have simplified it and easily can be calculated. Christian Score uses a mere 5 criteria. abdominal pain; vomiting; right lower quadrant tenderness; low grade fever (< or = 38.8 degrees C); and polymorphonuclear leucocytosis (TC > or = 10,000 with polymorphs > or = 75%). If four out of five or five out of five criteria were present on admission, appendicectomy was carried out. On the other hand, if three out of five criteria were present on admission, the patient was subjected to active inpatient observation until either the development of the fourth criterion. This is a rather simple score, which unfortunately does not to appear to have been validated or assessed in a pediatric specific population, but probably should be.⁸ What is probably the newest member to the group of appendicitis scores is the RIPASA Score, named after its hospital of origin in Brunei.7

Chong et al, evaluated their new score by prospectively enrolling 200 adults and children in a comparison of the RIPASA and Alvarado Scores. In this group of patients, the RIPASA was statistically superior to the Alvarado Score in Sensitivity (98% versus 68%), NPV (97% versus 71%) and accuracy (92% versus 87%). Specificity, PPV and negative appendectomy rates were similar between the 2 scores. Hence already existing Alvarado's score was preferred. As there were no perforations amongst the group with a score on admission of less than 6 who were observed for the first 24 hours the Alvarado's scoring system could be safely used by general practitioners in deciding whether to refer a patient to hospital. The main difficulty in assessment remains in women of childbearing age particularly those in the low score range 5-6 where there is an unacceptably high negative appendicectomy rate.⁹

Combining Alvarado scoring with radiological methods like USG or preferably CT scanning can lead to accurate preoperative diagnosis of the condition. However, the cost factor with imaging needs to be given a serious thought, especially in the developing world where financial constraints significantly guide the investigative approach to a patient.⁹

The standard Alvarado score for acute appendicitis had a sensitivity of 92% and a specificity of 82%, with an accuracy of 92%. When CT findings were included resulted in the greatest accuracy (98%) in diagnosing appendicitis in patients with scores in the range of 5 to 7. So, patients with scores of 5 to 7, CT should be performed.¹⁰

When comparing ultrasound to the Alvarado score for the diagnosis of acute appendicitis, neither one is significantly advantageous. However, the false positive rate is reduced to zero when both studies are positive and ultrasound improved diagnostic accuracy when the Alvarado score was negative or equivocal. However, the additional information provided by ultrasound does improve diagnostic accuracy in the case of a negative or equivocal Alvarado score.¹¹

Appendicitis was diagnosed in 66% of the women after open surgery and in 73% after laparoscopy. During laparoscopy, was appendicitis misdiagnosed in only 7% of the women, from whom the appendix unnecessarily removed, whereas 34% in the open surgery group had a healthy appendix removed.¹²

Ultrasonogram findings supportive of the diagnosis of appendicitis include. a peristaltic, no compressible, dilated appendix (>6 mm outer diameter)

- Appendicolith
- Distinct appendiceal wall layers
- Echogenic prominent pericaecal fat
- Peri appendiceal fluid collection
- Target appearance (axial section) gradedcompression US is the examination of choice if there is doubt whether an appendectomy should be performed.¹³

Doppler examination of the appendix has proven to be a useful adjunct to improve the sensitivity by demonstrating increased flow in an inflamed appendix.¹⁴ A recently described dynamic ultrasound technique using

a sequential 3 step patient positioning protocol has been shown to increase the visualization rate of the appendix.

In the study, patients were initially examined in the conventional supine position, followed by the left posterior oblique position (45° LPO) and then a "secondlook" supine position. Reported detection rates increased from 30% in the initial supine position to 44% in the LPO position and a further increase to 53% with the "secondlook" supine position. The authors suggested that the effect of the LPO positioning step improved the acoustic window by shifting bowel contents.¹⁵ Additional information provided by ultrasonography improves diagnostic accuracy. The overall sensitivity was 89%, the specificity was 95%, and the accuracy was 93%. When the results in women were analysed separately (n = 49), the overall accuracy was 96%. When interpreted considering the clinical examination, sonography should significantly reduce the rate of false-negative appendectomies, particularly in women.16

The primary CT signs which are considered pathognomonic for appendicitis include:

- The presence of an enlarged, inflamed appendix with a diameter greater than 8 mm in children (6 mm in adults)
- Visualization of an appendicolith.¹⁷

Secondary CT signs which are suggestive of, but not diagnostic for, appendicitis include:

- Pericecal inflammatory process with obscuration of the fat plane anterior to the psoas muscle
- Peri appendiceal fatty infiltration
- Inflammatory changes or abscess in the right lower quadrant, with or without visualization of an abnormal appendix or appendicolith
- Pelvic abscess
- Thickening of the caecal apex (up to 80%): caecal bar sign, arrowhead sign and terminal ileal wall (seen in 50% of children and 5% of adults with appendicitis)
- Small bowel obstruction (seen in 30% of children and 10% of adults with appendicitis).

CT is highly sensitive (94-98%) and specific (up to 97%) for the diagnosis of acute appendicitis and allows for alternative causes of abdominal pain to also be diagnosed. The need for contrast (IV, oral or both) is debatable and varies from institution to institution. In the equivocal clinical presentation of appendicitis as defined by Alvarado scores of 4 to 6, adjunctive CT is recommended to confirm the diagnosis in the ED setting. If clinical presentation suggests acute appendicitis by an Alvarado score of 7 or higher, surgical consultation is recommended. Computed tomography is not indicated in patients with Alvarado scores of 3 or lower to diagnose acute appendicitis.¹⁸ Computed tomography scan has

emerged as the dominant imaging modality for evaluation of suspected appendicitis in adults.

However, in view of its cost, radiation risk, and the potential delay in therapeutic intervention, CT scans should be reserved for clinically equivocal cases. A single CT abdomen pelvis exposes a patient to 14 mSv of ionizing radiation, which adds an additional cancer risk of up to 0.2% for an individual of 30 years of age. CT evaluation has value mainly in male patients with AS of 6 and below and female patients with AS 8 or less; the positive likelihood ratio of CT was significantly superior to the positive likelihood ratio of the AS within these score ranges.¹⁹ Since 1998, helical CT with rectally administered contrast material has been shown to reduce the total number of inpatient observation days, laparotomies with negative findings, and per-patient cost. Helical CT is a highly sensitive and specific tool for diagnosing pediatric appendicitis. In contrast; limitations of graded-compression ultrasonography in children include highly operator-dependent sensitivity and specificity values and relative infrequency with which the normal appendix can be visualized in this population.²⁰ Both graded compression sonography and CT have been widely utilized in the imaging assessment of the condition. The principal advantages of sonography are its lower cost, lack of ionizing radiation, and ability to assess ovarian pathology that can often mimic acute appendicitis in female patients.

The principal advantages of CT include less operator dependency than sonography as reflected by a higher diagnostic accuracy, and enhanced delineation of disease extent in perforated appendicitis. Methods advocated to assist in the diagnosis of appendicitis include laparoscopy.²¹ Two groups of 30 women with clinical signs of appendicitis were randomized to immediate appendicectomy or diagnostic laparoscopy. In the latter group, appendicectomy was performed if a diagnosis of acute appendicitis was established or if the appendix could not be visualized. There was no significant difference in postoperative morbidity rate in the two groups. Diagnostic laparoscopy is safe and can be recommended in patients with suspected acute appendicitis, particularly in women. A macroscopically normal-looking appendix can be left in place.22 Comparison of the sensitivity, accuracy, and negative predictive values for MR imaging and sonography was found to be statistically significant (p < 0.05, chi-square test), indicating that MR imaging was superior to sonography in revealing appendicitis.MR imaging can be used after suboptimal or non-diagnostic sonography in cases of suspected acute appendicitis.23

Laparoscopy, barium enema, ultrasonography and computer assistance have all been shown to improve accuracy, but no one method is of proven superiority. Such diagnostic aids or intensive in-hospital observation must be used to reduce the 15-30 per cent negative laparotomy rate when acute appendicitis is suspected, without increasing the incidence of appendiceal perforation.²⁴ The accuracy was 97% for clinical evaluation by a pediatric surgeon compared with an accuracy of 82% for ultrasound alone and 90% for CT scan alone. These data show that a protocol based on clinical evaluation by a pediatric surgeon with selective use of imaging was highly accurate for the diagnosis of appendicitis in children. Low rates of negative appendectomy (5%) and perforation (17%) were achieved without the potential costs and radiation exposure of excess imaging.²⁵ The incidence of perforation and complications were not statistically decreased after the implementation of ultrasound. Ultrasound did not decrease the length of hospital stay, and in addition added approximately \$48,000 to the treatment cost of appendicitis in 1989. Thus, despite adding cost, ultrasonography for appendicitis did not improve ability to diagnose or accurately treat appendicitis.²⁶

The sensitivity and specificity of MASS in this study was 94.1% (males 95.8% and females (88.3%) and 90.4% (males 92.9% and females 89.7%) respectively. MASS should be complemented with diagnostic procedure like laparoscopy or imaging such as ultrasound scan or CT scan to minimize the rate of negative appendectomy. ²⁷Although the use of ultrasound to diagnose acute appendicitis in children has excellent results, the decision for surgery remains a clinical one because of the continuing false-negative and false-positive results from sonography.²⁸ Alvarado score and the pediatric appendicitis score, many other models have been developed. Overall, these have been shown to improve clinical and process outcomes including reduced negative appendectomy rates, reduced radiation exposure from unwarranted DI studies, and reduced missed diagnoses. However, one must remain optimistically cautious; to date these Scores have yet to demonstrate sensitivity or specificity sufficient enough to recommend their use beyond calculated risk stratification (low, moderate or high).²⁹ A protocol of ultrasonography (US) followed by computed tomography with rectal contrast (CTRC) has been shown to be 94% accurate in the diagnosis of acute appendicitis in children.³⁰

CONCLUSION

The management of colorectal cancer has progressed over the past few decades because of many advances, including those in genetics, pathology, imaging, medical oncology, radiation oncology, and surgery.¹⁶ Undoubtedly, the management of patients afflicted with colorectal cancer will evolve as advances continue to be made in the multiple disciplines that contribute to the diagnosis and treatment of colorectal cancer.

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