

Evaluation of Modified Alvarado Score Compared with Histopathological Diagnosis in Acute Appendicitis

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Abstract

Original Research Article

Background: Decision-making in patients with acute appendicitis poses a diagnostic challenge worldwide, despite much advancement in abdominal surgery. A number of scoring systems have been advocated to minimize the number of negative appendectomies. However, Modified Alvarado Score System (MASS) is the most prominent and widely used one. Considering limited data regarding correlation between Modified Alvarado Score and post-operative histopathological findings, the study was designed to assess the usefulness of Modified Alvarado Score compared with histopathological report in diagnosis of acute appendicitis. **Methods:** This cross sectional observational study was conducted at the department of General Surgery, Mymensingh Medical College & Hospital, Mymensingh. All of the admitted patients with acute appendicitis were approached for inclusion of the study. All patients who met the inclusion criteria were consecutively enrolled in the study. Prior final inclusion, informed written consent form was ensured. Ethical issues were maintained in according to the Declaration of Helsinki. Appendectomy was done based on the overall clinical judgement. Pre-operative Modified Alvarado Score was assessed for all patient. The diagnosis was confirmed by histopathological examination. Data was collected by the researcher(me) and total 106 patients were included. Following collection, all data were sorted, checked and verified. After that data analysis was done by using SPSS statistical computer software (version 22). **Results:** A total number of 106 patients were studied. Their ages ranged from 12 to 51 years (mean 26.38 ± 7.49 SD). There were 73.6% males and 26.4% females. All patients in this study underwent appendectomy. Majority respondents had Modified Alvarado Score more than or equal to 7 (84%) and 16% had score below 7. According to histopathology findings, 14.16% respondents had normal appendix with or without other pathology and 85.84% had acute appendicitis. Considering Modified Alvarado Score ≥ 7 indicative to the histopathologically positive cases, it is observed that Modified Alvarado Score is significantly associated with histopathology findings ($p < 0.05$). Overall, sensitivity, specificity and accuracy of Modified Alvarado Score for prediction of acute appendicitis was 94.50%, 80.00% and 92.45%, respectively. **Conclusion:** Modified Alvarado Score correlated with the post-operative histopathological diagnosis of the acute appendicitis in our settings. However, before generalization, further larger multicentred study are recommended.

Keywords: Evaluation of Modified, Alvarado Score, Histopathological Diagnosis, Acute Appendicitis.

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INTRODUCTION

Acute appendicitis is the most common cause of acute abdomen requiring emergency surgery both in developed and developing countries [1]. Early appendectomy was first recommended and performed for acute appendicitis in 1880s and till today is the most frequently performed emergency abdominal surgery in the world [2]. Acute appendicitis is a common cause of abdominal pain and can be difficult to diagnose, especially during early stages although various aids exists to facilitate more accurate diagnosis and reduce

the rate of negative appendectomy. Female have a consistently higher rate of negative appendectomy, the incidence is 47% compared to 29.7% in males [3]. Kanumba *et al.*, 2011; shows it is 38.3% and 26.8% respectively [4]. The early and accurate diagnosis of acute appendicitis is still a difficult problem. A typical patient is one presenting with right lower abdominal pain, nausea and vomiting, having tenderness and guarding in right iliac fossa. However these signs and symptoms are not very specific for acute appendicitis and can mimic other acute abdominal conditions.

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Therefore, decision making may be difficult especially for junior surgeons [5]. The Modified Alvarado Scoring system (MASS) is an inexpensive and easily reproducible diagnostic tool for acute appendicitis [6]. Several different approaches have been developed to improve diagnosis in suspected appendicitis and to decrease negative appendectomies. The description of MASS was introduced in 1994 has greatly improved ability to diagnosis [7]. MASS is effective, cheap and quick to apply [8]. The Modified Alvarado Score which uses three clinical symptom and sign and a basic laboratory investigation was found to be simple and easy to use scoring system for the diagnosis of acute appendicitis and can be used by junior surgeons in the emergency setting [9]. The aim of the study was to evaluate the Modified Alvarado Scoring system correlated with histopathological report for diagnosis of acute appendicitis.

METHODS AND MATERIALS

Study Design: Cross sectional study.

Place of Study: Department of Surgery, Mymensingh Medical College Hospital, Mymensingh, Bangladesh.

Period of Study: From September 2017 to February 2019. The Ethical Review Committee (ERC) of Mymensingh Medical College approved the protocol prior to commencement of the study in November, 2017. After starting of Institutional Review Board (IRB) in Mymensingh Medical College, the IRB again approved the protocol and give certificate in 24th June 2018.

Study Population: During the study period, all patients above the age of 12 years with acute appendicitis admitted in Department of Surgery, Mymensingh Medical College Hospital.

Sample Size: Sample size was calculated by using Cochran's formula considering 95% level of confidence interval, 5% precision level (marginal error) and as prevalence of acute appendicitis in our setting is 16% Bhar *et al.*, [10]. Therefore, the sample size calculation is written below: - So, calculated sample size was 206. In this study, due to time limitation and unavailability of the patients, total 106 sample size were considered for this study.

Inclusion Criteria:

- All patients above the age of 12 years with clinically suspected acute appendicitis admitted into department of surgery of MMCH.
- Patients who want to do histopathology after appendicectomy and Modified Alvarado Scoring pre-operatively.

Exclusion Criteria:

- Patients with Modified Alvarado Scoring <5.

- Patients those undergo elective appendicectomy.
- Known cause of other abdominal pathology.
- Patients under 12 years of age.

Study Procedure: This hospital based cross sectional study was conducted for the eighteen months of duration following approval of the protocol. Sampling technique was purposive. This study was carried out on 106 patients with abdominal pain suspecting acute appendicitis. In all, 106 patients were selected from the admitted patients at the Department of Surgery in MMCH according to the inclusion and exclusion criteria. All patients underwent clinical assessment pre-operatively by the Modified Alvarado Score. According to the Modified Alvarado Score, patients were graded into three groups based on three symptoms (Migratory RIF pain, Anorexia, Nausea/Vomiting), three signs (Tenderness in RIF, Rebound Tenderness, Elevated Temperature) and one laboratory test (leukocytosis). Intraoperative assessment was also done to determine the cause of abdominal pain in suitable cases. All patients underwent emergency appendicectomy and all appendices removed at operation were sent for histopathology. The diagnosis of acute appendicitis was confirmed by histopathological examination. Subsequently, histopathological reports were collected and recorded into the data collection form. All data collection were done by myself and the pre-structured data collection form were filled up by face to face interview. Collected data were edited and sorted according to the variables. Data entry and analysis were done by using SPSS 22.

Data Management and Analysis: Following data collection, entered into a password-protected Microsoft Access data entry platform. The entered data were assessed for completeness, accuracy and consistency before analysis was commenced. Data analysis was carried out by using SPSS version 22. Exploratory data analysis were carried out to describe the study population where categorical variables were summarized using frequency tables while continuous variables were summarized using measures of central tendency and dispersion such as mean and standard deviation. In order to determine associations between the variables, chi squared tests was used. Differences was considered significant at the $P < 0.05$ level for all these tests. Results were presented by using tables, figures, charts, diagrams and textual summaries.

RESULTS

The study was done among 106 patients who underwent appendicectomy in Department of Surgery, Mymensingh Medical College Hospital.

Table 1: Demographic characteristics of respondents (N=106)

Age	Frequency	Percentage
11-20 years	20	18.99
21-30 years	51	48.19
31-40 years	26	24.50
41-50 years	7	6.6
>50 years	2	1.9
Sex		
Male	78	73.6
Female	24	26.4
Residence		
Urban	38	35.8
Rural	68	64.2
Occupation		
Service Holder	22	20.8
Business	12	11.3
Housewife	21	19.8
Unemployed	9	8.5
student	13	12.3
Others	29	27.4
Socioeconomic Class		
Low Socioeconomic Class	52	49.1
Middle Socioeconomic Class	41	38.7
Upper Socioeconomic Class	13	12.3

Mean age of respondents was 26.38±7.49 years. Majority respondents were in age group 21-30 years (48.1%) and followed by in decreasing order 31-40 years (24.5%), 11-20 years (18.9%), 41-50 years (6.6%) and >50 years (1.9%). Among total study population, 73.6% respondents were male and 26.4% respondents were female. Majority respondents were belong to rural area (64.2%) and 35.8% respondents were belong to urban area. Majority respondents were service holders by occupation (20.8%) and followed by

in decreasing order Housewife (19.8%), Student (12.3%), Business (11%) and unemployed (8.5%). Around 27.4% respondents were categorized as others which includes day labourer, garment worker, hawker and rickshaw puller. Majority respondents were belong to low socioeconomic class (49.1%) where as 38.7% respondents were belong to middle socioeconomic class and 12.3% respondents were belong to upper socioeconomic class.

Table 2: Distribution of respondents by clinical features and investigation (N=106)

Symptom and sign	No of cases with score (<7)	No of cases with score (≥7)	Total	Percentage
Migratory right iliac fossa pain	08	43	51	48.11%
Anorexia	14	72	86	81.13%
Nausea / vomiting	12	71	83	78.30%
Tenderness in right iliac fossa	17	89	106	100%
Rebound tenderness	11	62	73	68.86%
Elevated temperature >37.3deg C	06	42	48	45.28%
Leukocytosis	04	81	85	80.18%

100% respondents had tenderness in right iliac fossa, 68.86% had rebound tenderness and 48.11% had migratory right iliac fossa pain. Anorexia (81.13%),

Nausea/vomiting (78.30%), Leucocytosis (80.18%), Increased temperature (45.28%).

Table 3: Distribution of respondents by Modified Alvarado Score (N=106)

Modified Alvarado Score	Frequency	Percentage (%)
≥7	89	84%
<7	17	16%
Total	106	100%

Majority respondents had Modified Alvarado Score more than or equal to 7 (84%) and 16% had score below 7.

Table 4: Distribution of respondents by per operative findings (N=106)

Operative Findings		Frequency	Total Frequency	Percentage (%)	Total (%)
Acute appendicitis & related condition	Inflamed appendix	79	91	74.52%	85.84%
	Perforated appendix	09		8.49%	
	Gangrenous appendix	03		2.83%	
Normal appendix with or without other pathology	Ectopic pregnancy	04	15	3.77%	14.16%
	Twisted ovarian Cyst	03		2.83%	
	Mesenteric Lymphadenitis	02		1.88%	
	Meckel's Diverticulum	01		0.94%	
	Normal appendix	05		4.71%	

Around 85.84% (91) respondents had been found with acute appendicitis and related condition, 74.52% had acute appendicitis, 8.49% had perforated appendix and 2.83% had gangrenous appendix. Around 14.16% (15) had been found normal appendix with

other pathology, 3.77% had ectopic pregnancy, 2.83% had twisted ovarian cyst, 1.88% mesenteric lymphadenitis and 0.94% had Meckel's diverticulum. Among 4.71% respondents no other pathology had been found.

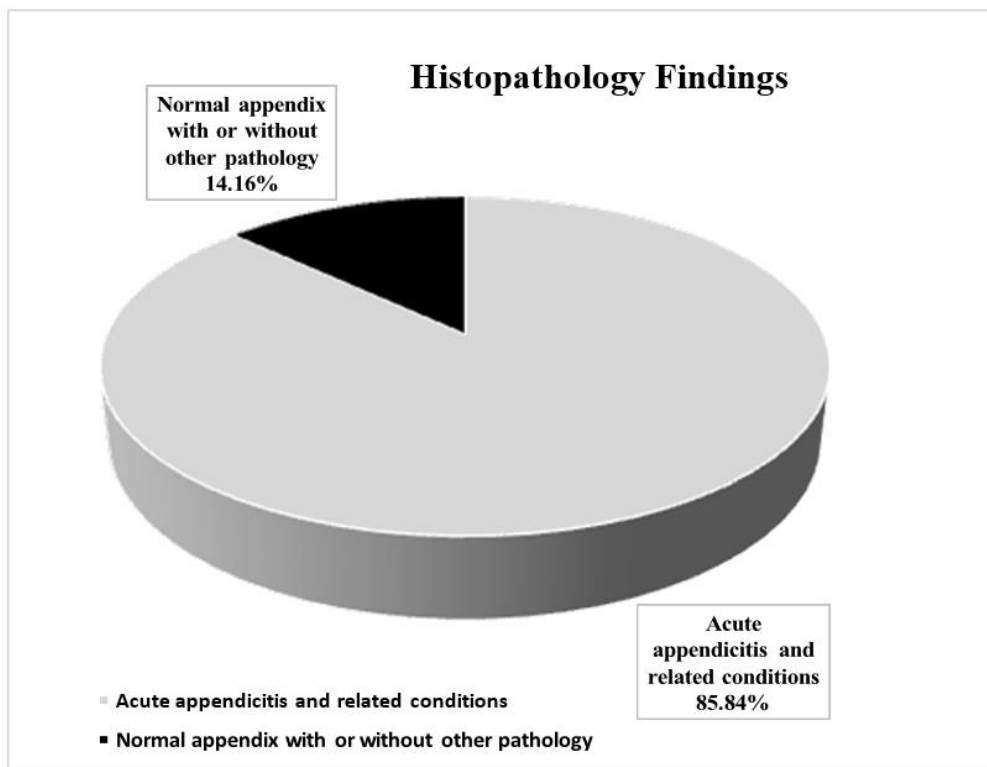


Figure 1: Distribution of respondents by histopathology findings (N=106)

According to histopathology findings, 14.16% respondents had normal appendix with or without other

pathology and 85.84% had acute appendicitis and related condition.

Table 5: Association between concurrent diagnosis by histopathology and Modified (N=106)

Modified Alvarado Score	Histopathology	Findings	P value*
	Acute Appendicitis and related condition	Normal Appendix with or without other pathology	
≥7	86	03	<0.001
<7	05	12	
Total	91	15	

Modified Alvarado score is significantly associated with histopathology findings. When the

score is ≥7, the histopathology indicates positive findings.

Table 6: Cross tabulation showing concurrent diagnosis by histopathology and Modified Alvarado Score (cut off value 7) (N=106)

Modified Alvarado Score	Histopathologic diagnosis (Standard diagnosis)		Total
	Acute appendicitis with related condition	Normal appendix with or without other pathology	
≥ 7	86	3	89
< 7	05	12	17
Total	91	15	106

Table 6 showing that out of 91 acute appendicitis and related condition, Modified Alvarado score had been found ≥ 7 in 86 respondents while, < 7 had been found in 5 respondents. Among 15 patients

who underwent negative appendectomy, Modified Alvarado score had been found < 7 among 12 and ≥ 7 among 3 respondents.

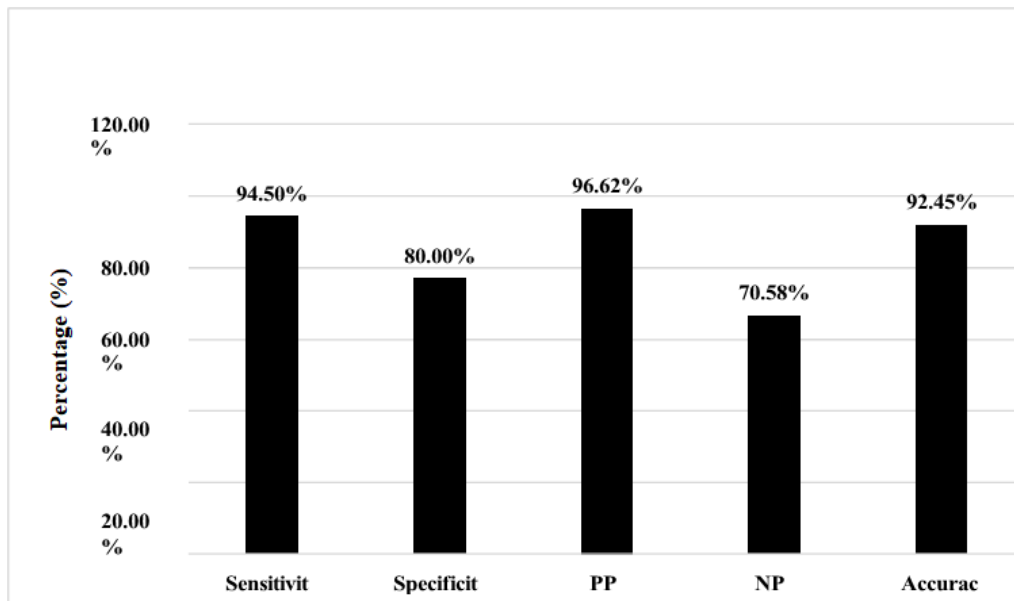
**Figure 2: Bar diagram showing diagnostic potential of Modified Alvarado Score (cut off value 7) regarding acute appendicitis (N=106)**

Figure 2 showing that Modified Alvarado score (at cut off value 7) had 94.50% sensitivity to correctly diagnose acute appendicitis but lesser specificity (80.00%). Overall, the accuracy is 92.45%.

DISCUSSION

The study was done among 106 patients who underwent appendectomy in Department of Surgery of Mymensingh Medical College Hospital. Modified Alvarado scoring was done on respondents pre operatively and histopathological examination was done post operatively. Mean age of respondents was 26.38 ± 7.49 years. Majority respondents were in age group 21-30 years (48.1%) and 31-40 years (24.5%). Ashindoitiang John Adi found majority respondents in age group of 21-30 years which collaborates with present study. In the study of Livingston *et al.*, maximum incidence of appendicitis was seen in the age group of 20 to 29 years, which was 47% [11]. Among total study population, 73.6% respondents were male and 26.4% respondents were female. Barman *et al.*, also found 60% male dominance in a similar study [7]. Sobnach *et al.*, also found male dominance 64% in

another similar study [6]. Appendicitis rates 1.2 to 2.3 fold higher for males have also been reported by other investigators, D'souza *et al.*, [12] but this difference remains unexplained. The elevated rates in males across all age groups suggest that hormonal changes in females may not play as significant an etiologic role as previously hypothesized [13]. In this study 64.2% respondents were belong to rural area and 35.8% respondents were belong to urban area. The study was held in Mymensingh Medical College which is a Govt tertiary level Hospital. So most of the patients going there for consultation are mainly from the rural bulk of population hailing nearby. The occupation of respondents had been found as service holder (20.8%), Housewife (19.8%) and others (27.4%) which includes day labourer, garment worker, hawker and rickshaw puller. Most of the respondents were belong to low and middle socioeconomic class (49.1% and 38.7%). Modified Alvarado Score ≥ 7 was found 44 respondents from lower socioeconomic class, 34 from middle socioeconomic class and 11 from upper socioeconomic class. On the other hand Modified Alvarado Score < 7 was found 8 respondents from low socioeconomic class,

7 from middle socioeconomic class and 2 from upper socioeconomic class. The clinical manifestation of appendicitis showed that most patients presented with nausea / vomiting (78.30%), and anorexia (81.13%). Pain was the cardinal symptom in all the patients and it was colicky in nature and tenderness at right iliac fossa (100%), migratory pain in right iliac fossa (48.11%), rebound tenderness (68.86%). Fever was a common symptom as it was seen in (45.28%) of the cases and leukocytosis was present in 80.18% cases. In a similar study by Adi Ashindoitiang John found Right lower quadrant pain among 59.5% of the total study population. Nausea was present among 68%, vomiting among 69% and anorexia among 48.5% of total population Adi, 2011 [3]. Preoperatively majority Modified Alvarado scoring was done among each respondents and 84% respondents scored ≥ 7 , 16% scored below 7. A scoring system for early diagnosis of acute appendicitis was developed by Alvarado in 1986, based on clinical signs, symptoms and differential leucocyte count with left shift of neutrophil maturation yielding a score of 10, is known as Alvarado Score. Kalan *et al.*, omitted left shift of neutrophil maturation parameter and produced Modified Alvarado Score, it is 9 point scoring system that helps in increasing accuracy of preoperative diagnosis and thus reducing negative appendectomy rate. Score of 7 or more has been recommended for surgery [14]. According to post-operative histopathology findings, 14.16% respondents had normal appendix with or without other pathology and 85.84% had acute appendicitis and related condition. 74.52% had inflamed appendix, 8.49% had perforated appendix and 2.83% had gangrenous appendix. Among the respondents who underwent negative appendectomy, 3.77% had ectopic pregnancy, 2.83% had twisted ovarian cyst, 1.88% mesenteric lymphadenitis and 0.94% had Meckel's diverticulum and among 4.71% respondents no pathology had been found. Acute appendicitis is a clinical diagnosis. Many patients still undergo negative appendectomies despite the widespread use of advanced imaging modalities and many predictive scoring systems. Even in a developed country like United Kingdom, there is no defined 'acceptable' Negative Appendectomy Rate [15]. In present study, the rate of negative appendectomy was 14.16%. In a similar study by Malik and sheikh, a total of 174 respondents underwent appendectomy, out of which a normal appendix was removed in 20 respondents (11.49%) [8]. In spite of little variation in percentage these study findings collaborate with each other. A negative appendectomy rate of 20-40% has been reported in the literature and surgeons in order to avoid the complications of perforated appendicitis usually acceptable negative appendectomy rate of about 15-20% Livingston *et al.*, [11]. A higher threshold in performing appendectomy may improve its diagnostic accuracy but carries an increased risk of appendicular perforation and sepsis; thereby increasing morbidity and mortality. Ultrasonography or computed tomography

imaging may improve the diagnostic accuracy of acute appendicitis but it is associated with an escalated cost [16]. Livingston EH *et al.*, has found that due to injudicious use of CT imaging may diagnose early low-grade appendicitis leading to appendectomies which otherwise would have resolved by antibiotics therapy alone [11]. In this study Modified Alvarado score is significantly associated with histopathology findings. When the score is ≥ 7 , the histopathology indicated positive findings. In this study 91(85.84%) respondents diagnosed as acute appendicitis and related condition, Modified Alvarado score had been found ≥ 7 in 86 (94.50%) respondents while, < 7 had been found in 5 respondents. Among 15 patients who underwent negative appendectomy, Modified Alvarado score had been found < 7 among 12 and ≥ 7 among 3 respondents. Comparing results in this study to different studies in literatures. This study shows histopathologically positive appendectomy in 85.84% and 94.50% for scoring ≥ 7 . Sahim *et al.*, shows histopathology positive appendectomy in 80.9% and 92.6% for scoring ≥ 7 [17]. Another study by Sridhar *et al.*, shows 97.67% of patients who were thought to be positive by MAS (≥ 7) and actually had acute appendicitis by histopathology in 94.00% cases [18]. These study findings collaborate each other. Modified Alvarado score (at cut off value 7) had sensitivity of 94.50% [95% CI 89.82- 99.18%] to correctly diagnose acute appendicitis but lesser specificity of 80.00% [95% CI 59.75-100.24%], PPV 96.62% [95% CI 92.88-100.37%] and NPV 70.58% [95% CI 48.92-92.24%]. Overall, the accuracy was 92.45%. All of these values were statistically significant ($p < 0.001$). In his suggested that patients with scores of 7 or higher should be operated on Alvarado, *et al.*, [19]. In the same manner, for the MASS, the cut off point of 7 has been used in present investigation. In a similar study by Al- Esawi *et al.*, the sensitivity, specificity, positive predictive value and negative predictive values in our series were 93.24%, 84.21 %, 95.83% and 76.19 % respectively by taking a cut-off point of 7 [20]. Similar results have been obtained by Kanumba *et al.*, with sensitivity, specificity, positive predictive value and negative predictive values of 94.1%, 90.4%, 95.2% and 88.4% respectively [4]. Nishikant Gujar *et al.*, also found sensitivity and specificity of Modified Alvarado Score 98.44% and 94.44% respectively [14]. All these study results collaborate each other by concluding that MASS could be an option to diagnose correctly. Acute appendicitis at cut off value 7. The estimated rate of negative appendectomy in this study is 14.16%, which is less than the accepted rate worldwide, about 15-20% Livingston *et al.*, [11]. Judgments cannot be made about this rate until the perforation rate are being included.

CONCLUSION

In the diagnosis of acute appendicitis, the Modified Alvarado Score is a fast, simple, reliable, noninvasive, repeatable and safe diagnostic modality without extra expense. It is very handy in peripheral hospitals where back up facilities are sparse. The

application of this scoring system improves diagnostic accuracy and consequently reduces negative appendicectomy and thus reduces complication rates.

Limitations

- Not comparing the results with other methods for diagnosis of acute appendicitis.
- All data were collected from a single tertiary care site.

Recommendation

- Modified Alvarado Score is an inexpensive tool for the diagnosis of acute appendicitis with a satisfactory level of sensitivity and specificity and may be used in day to day practice.
- In doubtful cases, ultrasonography may improve the sensitivity and specificity of Modified Alvarado Score in the diagnosis of acute appendicitis.
- Further study in this topics should be done involving multiple centers.

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