ORIGINAL ARTICLE

Evaluation of the Alvarado score in acute abdominal pain

Hamid Kariman, M.D.,[1] Majid Shojaee, M.D.,[1] Anita Sabzghabaei, M.D.,[1]
Rosita Khatamian, M.D.,[2] Hojjat Derakhshanfar, M.D.,[1] Hamidreza Hatamabadi, M.D.[1]

[1]Department of Emergency Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran;
[2]Department of Emergency Medicine, Birjand University of Medical Sciences, Khorasan, Iran

ABSTRACT

BACKGROUND: The Alvarado score is utilized to determine the likelihood of appendicitis based on clinical signs, symptoms, and laboratory results. The goal of this study was to determine whether Alvarado scores can be used to aid in the accurate diagnosis of appendicitis.

METHODS: Alvarado score evaluations were performed on 300 patients that were referred to or presented to the emergency room with acute abdominal pain.

RESULTS: Out of the 300 patients, 85.66% had Alvarado scores of 7 or less and 14.33% had Alvarado scores greater than 7. For patients that had confirmed appendicitis, 25.7% had Alvarado scores of 7 or less, whereas 93% had Alvarado scores greater than 7. The Alvarado scoring system had poor sensitivity at 37%, and the specificity of this scoring system was high at 95%.

CONCLUSION: Our findings suggest that patients presenting with abdominal pain and Alvarado scores greater than 7 are more likely to have appendicitis. As such, the Alvarado scoring system may be utilized to better predict whether a patient has appendicitis. An Alvarado score that is positive for appendicitis would consist of a score greater than 7, which suggests that the patient has a 93% chance of having appendicitis. A negative Alvarado score is 7 or lower, suggesting a 26% probability of having appendicitis. In all, the Alvarado scoring system is a good rule-in test, but it does not adequately rule-out appendicitis.

Key words: Abdominal pain; Alvarado score; eppendicitis.

INTRODUCTION

Abdominal pain is one of the most common clinical complaints and accounts for more than 10% of emergency department presentations. The hospitalization rate for patients over 60 years old ranges from 18% to 42%.[1] Following abdominal pain due to non-specific causes, appendicitis is the most common cause of abdominal pain that requires an emergent operation.[2] The prevalence of appendicitis is greater in men than in women.[2] Even though computed tomography (CT) and ultrasound imaging are utilized for diagnosing appendicitis, the false positive diagnosis rate has not improved. However, in pregnant women between 40-49 years old, the number of unnecessary appendectomies is greater than males. Unnecessary appendectomies are most prevalent in females older than 80 years of age.[3] Therefore, in order to further refine the accuracy of appendicitis diagnosis, it may be helpful to supplement clinical and imaging results with the Alvarado score (Table 1).[4]

Many conditions have similar clinical manifestations to appendicitis. The most common sources of non-specific abdominal pain are acute cystitis, acute pancreatitis, diverticulitis, ulcerative colitis, peritonitis, bowel obstruction, trauma, hepatitis, dissecting aortic aneurysm, ovarian cyst, and ectopic pregnancy.[3] The decision to operate depends on a combination of obtaining a complete medical history, physical examination, imaging, and laboratory results; however, misdiagnosis or a delay in diagnosis and treatment still occurs and contributes to adverse patient outcomes. Thus, the main objective of this study was to determine whether obtaining Alvarado scores would increase the accuracy of diagnosing appendicitis. To achieve

Address for correspondence: Majid Shojaee, M.D.
Emergency Department, Emam Hossein Medical Center, Shahid Madani Street, Tehran, Iran.
Tel: +982173432380 E-mail: m.shojaee@sbmu.ac.ir

Qucik Response Code

Ulus Travma Acil Cerr Derg
2014;20(2):86-90
doi: 10.5505/tjtes.2014.69639

this, we evaluated the Alvarado scores in 300 patients that presented to the Imam Hossein Emergency Department with non-specific abdominal pain. Moreover, the patient population that we provide care to has great cultural and socioeconomic diversity, and the findings of this study may help clarify whether the validity of Alvarado scoring system is still adequate by calculating its positive and negative predictive value.

MATERIALS AND METHODS

This study was conducted in 2011 and is a prospective, observational, descriptive-analytical and cross-sectional analysis. Alvarado scores were obtained from blinded evaluators that rated patients that presented with acute abdominal pain to the Imam Hossein Hospital Emergency Department. Initially, the patient sample numbered 380 such that the accepted margin of error was 5% with a confidence interval of 95%, and the distribution response was 50% for a population of 20,000. The Imam Hossein Hospital is an educational tertiary center, and patients are referred there if they are in need of further work-up or certain complex operations. Patients were frequently evaluated throughout their admission so to document whether their Alvarado scores changed over time. If appendicitis was diagnosed, an appendectomy was performed and the appendix tissues were examined by a pathologist so to verify diagnosis. Patients received follow-up for one week following discharge so to identify possible complications or the need to perform surgery.

Patients older than 16 years of age that presented with abdominal pain due to extra-abdominal pathology such as pneumonia, acute myocardial infarction, drug intoxication, drug and alcohol misuse, mental retardation or other mental disorders, trauma to the abdomen, pregnancy, or had difficulties in verbal communication were excluded from the study (n=80). As such, the final study sample included 300 patients. Statistical data were evaluated with SPSS software version 13.0 to calculate and compare means, standard deviations and frequencies. Alvarado scoring system sensitivity and specificity was calculated so to determine its validity. Likelihood ratios (LRs) were also determined for the Alvarado scoring system. In all correlation analyses a p-value less than 5% was considered statistically significant. Patients were given a detailed description of the study and provided their informed consent before participating in this investigation.

RESULTS

As shown in Table 1, Alvarado scores were determined for each patient. On average, the study subjects were 39.97 years-old, 46.3% were female, and 65.3% were married. Only 14.7% of the patients were educated in the university. The overall mean Alvarado score was 4.23, and Alvarado score frequencies are shown in Table 2.

From the 300 patients that participated in this study, 36% had confirmed cases of appendicitis according to pathology reports. A total of 194 patients had abdominal pain due to other causes. Of the 106 patients that had confirmed appendicitis, 62.26% had an Alvarado score ≤7, whereas 37.73% of patients had Alvarado scores above 7. Of the 194 patients that were diagnosed with abdominal pain due to other causes, 98.4% had an Alvarado score ≤7 and only 1.54% of patients had Alvarado scores greater than 7 (Table 3).

Table 1. Alvarado scoring system example

Characteristics	Score
Right lower quadrant tenderness	2
Rebound tenderness	1
Elevated temperature (>37.3°C or >99.1°F)	1
Migration of pain to the right lower quadrant	1
Anorexia	1
Nausea or vomiting	1
Leukocytosis >10.000 white blood cells	2
Leukocytosis with left shift	1

Table 2. Alvarado score distribution frequencies

Frequency (%)	Alvarado characteristic
26	Migration of pain to right lower quadrant
45.3	Anorexia
61	Nausea and vomiting
57.7	Tenderness in right lower quadrant
32	Rebound pain
14	Elevated body temperature
49	Leukocytosis
31.7	Leukocytosis with left shift

There were 3 cases that received an initial diagnosis of abdominal pain due to a cause other than appendicitis, but their Alvarado scores were greater than 7. During follow-up, 2 of these patients developed appendicitis and underwent an appendectomy. Of the 257 patients that had an Alvarado score ≤7, 25.7% of them had confirmed appendicitis and 74.3% of the patients had abdominal pain due to other causes (Tables 4 and 5). For the 161 male patients, 15 of them had Alvarado scores greater than 7, and for the 139 female patients, 28 had Alvarado scores greater than 7 ($p<0.0076$). There were significant differences in Alvarado scoring between males and females (Table 6). Mean Alvarado scores in the patients with appendicitis were significantly higher than those for patients without appendicitis ($p<0.0001$). Also this relation was found between men and women (Table 7).

Overall, 25.7% of patients that had Alvarado scores of 7 or

Table 3. Abdominal pain causes according to Alvarado score

Abdominal pain due to other causes		Appendicitis		
n	%	n	%	
191	98.43	66	62.26	Alvarado score ≤7
3	1.54	40	37.73	Alvarado score >7
194	100	106	100	Total number of patients

Table 4.

Total		Other causes		Appendicitis		
n	%	n	%	n	%	
257	100	191	74.3	66	25.7	Alvarado ≤7
43	100	3	7	40	93	Alvarado >7

less had confirmed cases of appendicitis; however, 93% of patients with Alvarado scores greater than 7 had appendicitis ($p<0.0001$) (Table 3). Alvarado scoring system sensitivity and specificity were found to be 37% with a 95% confidence interval (CI) of 0.23-0.46 and 95.65% with a 95% CI of 0.96-0.99, respectively. The positive likelihood ratio (LR) was 24.4 with a 95% CI of 0.077-0.979, and the negative LR was 0.63 with a 95% CI of 0.61-0.70.

DISCUSSION

In this study, there was a statistically significant difference in the amount of patients that had confirmed cases of appendicitis if their Alvarado score was greater than 7 ($p<0.0001$). Additionally, the calculated sensitivity was 37% and specificity was 95.65% for the Alvarado scoring system. Only 3 patients with Alvarado scores greater than 7 were not initially diagnosed with appendicitis, but a week after discharge two of those patients were found to have appendicitis. In a study conducted in the Islam Abad Medical University in 2007, patients diagnosed with abdominal pain that received appendectomies were categorized based on Alvarado score: the first group had scores ≥7 and the second group had scores <7. They found that regardless of the Alvarado score, 53.54% had confirmed cases of appendicitis in the first group and 38.96% had appendicitis in the second group according to pathology reports. They determined that Alvarado score sensitivity was 58.2% and the sensitivity was 88.9%. [4] In comparison with our data, this study had attributed the Alvarado scoring system with a higher sensitivity and specificity.

Table 5. Alvarado scores according to diagnosis

	Diagnosis																						Total	
	Appendicitis		Urinary Tract Infection		Unknown		Cholecystitis		Renal colic		EP		Peritonitis		Diverticulitis		Malignancy		Ovarian cyst		Volvulus		Dyspepsia		Pancreatitis			
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Alvarado score ≤7	66	25.7	6	2.3	108	42.0	36	14.0	6	2.3	9	3.5	4	1.6	4	1.6	6	2.3	4	1.6	2	0.8	2	0.8	4	1.6	257	100.0
Alvarado score >7	40	93.0	0	0	3	7.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	100.0
Total	106	35.3	6	2.0	111	37.0	36	12.0	6	2.0	9	3.0	4	1.3	4	1.3	6	2.0	4	1.3	2	0.7	2	0.7	4	1.3	300	100.0

EP: Ectopic pregnancy; UTI: Urinary tract infection.

Table 6. Comparison of Alvarado scores between males and females

Alvarado Score		Male		Female	
		n	%	n	%
Score >7, 43 (100%)		27	62.7	16	37.2
Alvarado ≤7, 257 (100%)		111	43.2	146	56.8
Chi-squared value	7.12				
Degrees of freedom	1				
Two-tailed p-value	0.0076				

Table 7. Mean Alvarado scores for males and females

Alvarado score	Diagnosis	Male	Female
Alvarado >7	Appendicitis	9.6	9.73
	Other causes	8	8
Alvarado ≤7	Appendicitis	6.1	6.4
	Other causes	3.2	2.8

In another study conducted in Pakistan during 2003, 100 patients with suspected appendicitis were categorized into 3 groups: group one had Alvarado scores ≥7 and underwent an appendectomy, group two had Alvarado scores ranging from 5-6 and were hospitalized for observation, and group three had Alvarado scores ≥4 and were discharged. Several patients that developed elevated Alvarado scores ≥7 in group two (that were initially given Alvarado scores ≤7) received an appendectomy and histological examination confirmed the diagnosis of appendicitis. In the 60 patients that underwent an appendectomy, 54 of them developed confirmed cases of appendicitis according to tissue pathology findings. Of the 15.6% patients that underwent unnecessary appendectomies, 7.8% of them experienced an appendix perforation. Overall, the Alvarado scoring system was found to have a positive predictive value of 84.35%.[5] The positive predictive value found in that study approaches our value of 93%, which is greater than previously reported.

In 1996, an investigation was performed in England that was a prospective analysis of elderly female patients that received elective laparoscopic appendectomies. Modified Alvarado scores were also determined for patients with suspected appendicitis. Overall, 84 patients comprised the experimental group and 97 patients made up the control group. Depending on the group that the patients were assigned, they were treated by a separate medical team and Modified Alvarado scores and the presence leukocytosis were determined for all subjects. Patients that demonstrated leukocytosis with left shift were removed from the study. The experimental group was divided into 3 groups depending on Modified Alvarado score: 0-3, 4-6, and 7-9. In the experimental group, only 5% of the patients received an unnecessary appendectomy as compared to 18% of controls. Moreover, 10% of adult women were not found to have appendicitis according to laparoscopic examination, averting unnecessary appendectomies.[6] Overall, these results indicate that the Modified Alvarado scoring system has a good positive predictive value, which agrees with our findings.

In another prospective study in southern India performed from 2004 to 2005, 231 patients with pain located in the right iliac fossa were evaluated. Patients were categorized between two groups based on their Alvarado scores: group one had scores ≤7 (n=118) and group two had scores ≥6 (n=113). Out of the 103 patients in group one that underwent surgery, 101 were found to have acute appendicitis. However, in group two, of the 29 patients that underwent an appendectomy, 6 patients had confirmed cases of appendicitis according to histological findings.[7] From ultrasound imaging, 110 cases of appendicitis were diagnosed and of those cases, 107 were confirmed. These findings indicate that 3 patients received false positive diagnoses. According to this study, it was found that the Alvarado scoring system had a sensitivity of 88.8%, which was higher than what we found, and a specificity of 75%, which was lower than what we determined in our study. In a study conducted by Sanabria and colleagues during 2007 in Columbia, it was found that unnecessary appendectomies were performed in 16.9% of males and 31.4% of females.[8] In men, clinical signs were more indicative of a diagnosis of appendicitis than laboratory results, but there were no such differences found in women. In our study, we did not ob-

serve these differences between men and women. In a study by Horzić et al.,[9] it was found that clinical findings were most critical in diagnosing appendicitis, but Alvarado scoring still demonstrated utility in diagnosing appendicitis due to the high specificity of this scoring system.[9] In a prospective study conducted in the surgical emergency unit of a teaching hospital in Baghdad, Iraq,[10] the Alvarado scoring system was utilized to help diagnose patients with suspected acute appendicitis (n=100). Of the patients with Modified Alvarado scores ≥7, 57.5% were female and 42.5% were male, and for those patients with Modified Alvarado score <7, 53.9% were female and 46.1% were male. Compared to our results, for patients that received Alvarado Scores >7, the percentage of females was lower, whereas for Alvarado scores <7, the percentage females was higher (Table 6). For Alvarado scores >7, the mean Alvarado score for females and males differed significantly for those diagnosed with acute appendicitis in our study. For patients with Alvarado Score <7, mean Alvarado scores between males and females were not significantly different (Table 7). These findings are similar to those in the P. D. Gurav et al. study performed in Government hospital in Sangli, India.[11]

In conclusion, the results of our study revealed that the Alvarado scoring system can be used in patients with acute abdominal pain, and may be effective in predicting appendicitis. A positive score (Alvarado score >7) suggests a 93% chance of having appendicitis, whereas a negative test (Alvarado score ≤7) suggests a 26% probability of having appendicitis. In all, the Alvarado scoring system is a good rule-in test, but not an adequate rule-out test.

Conflict of interest: None declared.

REFERENCES

1. Marx JA. Rosen's emergency medicine: concepts and clinical practice. In: Hockberger RS, et al. 7th ed., Philadelphia: Mosby-Elsevier; 2010.
2. Tintinalli JE. Tintinalli's emergency medicine: a comprehensive study guide. 7th ed. Stapczynski JS, et al. McGraw-Hill; 2009.
3. Brunicardi F. Schwartz's principles of surgery. 9th ed., Andersen D, et al. McGraw-Hill; 2009.
4. Ahmad A, Vohra L, Lehri A. Diagnostic accuracy of Alvarado score in the diagnosis of acute appendicitis. Pak J Med Sci 2009;25:118-21.
5. Khan I, ur Rehman A. Application of alvarado scoring system in diagnosis of acute appendicitis. J Ayub Med Coll Abbottabad 2005;17:41-4.
6. Lamparelli MJ, Hoque HM, Pogson CJ, Ball AB. A prospective evaluation of the combined use of the modified Alvarado score with selective laparoscopy in adult females in the management of suspected appendicitis. Ann R Coll Surg Engl 2000;82:192-5.
7. Baidya N, Rodrigues G, Rao A, Khan S. Evaluation of Alvarado score in acute appendicitis: a prospective study. The Internet Journal of Surgery 2007;9:1. Available at: http://ispub.com/IJS/9/1/10672.
8. Sanabria A, Domínguez LC, Bermúdez C, Serna A. Evaluation of diagnostic scales for appendicitis in patients with lower abdominal pain. Biomedica 2007;27:419-28.
9. Horzić M, Salamon A, Kopljar M, Skupnjak M, Cupurdija K, Vanjak D. Analysis of scores in diagnosis of acute appendicitis in women. Coll Antropol 2005;29:133-8.
10. Thabit MF, Al An sari HM, Kamoona BR. Evaluation of modified Alvarado score in the diagnosis of acute appendicitis at Baghdad Teaching Hospital. The Iraqi Postgraduate Medical Journal 2012:11:675-83.
11. P. D. Gurav, N. N. Hombalkar, Priya Dhandore, Mohd. Hamid. Evaluation of Right Iliac Fossa Pain with Reference to Alvarado Score - Can We Prevent Unnecessary Appendicectomies. JKIMSU 2013:2:24-9.

KLİNİK ÇALIŞMA - *ÖZET*

Akut karın ağrısında Alvarado skorunun değerlendirmesi

Dr. Hamid Kariman,[1] Dr. Majid Shojaee,[1] Dr. Anita Sabzghabaei,[1] Dr. Rosita Khatamian,[2] Dr. Hojjat Derakhshanfar,[1] Dr. Hamidreza Hatamabadi[1]

[1]Shahid Beheshti Üniversitesi Tıp Fakültesi, Acil Tıp Anabilim Dalı, Tahran, İran;
[2]Birjand Üniversitesi Tıp Fakültesi, Acil Tıp Anabilim Dalı, Khorasan, İran

AMAÇ: Apandisitten rahatsız hastalarda genellikle Alvarado skoru değerlendirilir. Bu çalışmada, nedenleri ne olursa olsun karın ağrısından rahatsız hastalarda Alvarado skorları karşılaştırıldı.

GEREÇ VE YÖNTEM: Bu prospektif çalışmada akut karın ağrısı olan ve acil servise sevk edilen 300 hasta ağrının nedeni ne olursa olsun Alvarado skoruyla değerlendirildi.

BULGULAR: Üç yüz hastadan 257'sinde (%85.66) Alvarado skorları 7 veya daha düşük iken 43 (%14.33) hastada 7'den daha yüksekti. Bu çalışmada Alvarado skorları 7 veya daha düşük olanlardan 66'sında (%25.7), Alvarado skorları 7'den daha yüksek olan 40 (%93) hastada, arada istatistiksel açıdan anlamlı farklılıklar olmak üzere apandisit saptanmıştı. Bu bulgu, karın ağrısı ve Alvarado skoru 7'den yüksek hastaların çok büyük bir olasılıkla apandisitten rahatsız olduğunu akla getirmektedir. Bu skorlama sisteminin apandisit için %95'lik bir özgüllük, ancak düşük bir duyarlılık (%37) derecesine sahip olduğu görünmektedir (%37).

SONUÇ: Apandisiti öngörme açısından akut karın ağrısı olan hastalarda Alvarado skorlama sistemi kullanılabilir. Pozitif bir test (Alvarado skoru >7) %93, negatif bir test (Alvarado skoru ≤7) ise %26 oranında apandisit olasılığını gösterecektir. Bu nedenle bu test apandisit lehine iyi, apandisiti dışlamak için ise yeterli olmayan bir testtir.

Anahtar sözcükler: Alvarado skoru; apandisit; karın ağrısı.

Ulus Travma Acil Cerr Derg 2014;20(2):86-90 doi: 10.5505/tjtes.2014.69639