

The place of scoring systems for the diagnosis of acute appendicitis a retrospective cohort study

Ozan Baris Namdaroglu¹, Volkan Oter², Serif Melih Karabeyoglu³

¹Izmir Bozyaka Teaching and Research Hospital Department of General Surgery, Izmir, Turkey

²Sakarya University, Faculty of Medicine, Department of Gastroenterological, Sakarya, Turkey

³Ahi Evran University, Faculty of Medicine, Department of General Surgery, Kirsehir, Turkey

Abstract

Aim: Acute appendicitis is among the most frequently observed reasons of abdominal pain. The high rate of dubiousness in diagnosis, high rate of negative appendectomy led to the introduction of scoring systems.

Despite today's advanced imaging methods and various scoring methods like Alvarado, making the diagnosis may not always be easy. On the other hand, negative appendectomy rate is reported to be 15-30%. Therefore accurate and rapid diagnosis is fundamental in acute appendicitis.

In our study we aimed to determine the place of scoring systems defined by Alvarado, Ohmann and Eskelinen for the diagnosis of acute appendicitis and their efficacy in lowering negative appendectomy rates.

Material and Methods: In our study, 120 patients who were operated as a result of diagnosis of acute appendicitis between May-2011 and July-2011 were retrospectively evaluated. Patients' Alvarado, Ohmann and Eskelinen scores were calculated for evaluation.

Result: It was seen that there was a statistically significant between high Alvarado and Ohmann scores and pathological acute appendicitis. Considering Eskelinen score, significant difference could not be determined.

Discussion: In conclusion, Alvarado, Ohmann and Eskelinen scoring systems were evaluated with regard to acute appendicitis and found a meaningful relationship between Alvarado and Ohmann scoring systems and the acute appendicitis it is thought that the use of the scoring system especially for children and the elder would decrease negative appendectomy and perforations. In addition, its coefficients which create a calculation difficulty in practical use limit the use of this scoring system in emergencies which work intensively.

Keywords: Acute Appendicitis; Predictive Value; Scoring Systems; Alvarado-Ohmann- Eskelinen.

INTRODUCTION

Acute appendicitis is among the most frequently observed reasons of abdominal pain and which is the disease to which abdominal urgent surgery is most frequently applied (1). Following its identification by Fitz in 1886, it has become one of the surgical diseases with the highest diagnosis problem for over than a century (2).

The classical story with anorexia, peri-umbilical pain followed by nausea and vomiting, right lower quadrant pain are observed in 50% of the patients. Nausea is observed in 61-92% of the patients, while anorexia in 74-78%. The complaint most frequently observed in acute appendicitis is abdominal pain (3).

Despite today's advanced imaging methods such as ultrasound (US) and computerized tomography (CT) and various scoring methods like Alvarado, making the diagnosis may not always be easy (4).

Due to late diagnosis, gangrenous appendicitis, perforation, phlegmonous appendicitis and abscess, and also plastron can emerge. On the other hand, negative appendectomy rate is reported to be 15-30% (5-7). Therefore accurate and rapid diagnosis is fundamental in acute appendicitis. For this reason we aimed in our study to determine the place of scoring systems defined by Alvarado, Ohmann and Eskelinen for the diagnosis of acute appendicitis and their efficacy in lowering negative appendectomy rates.

MATERIALS AND METHODS

In our study, 120 patients who applied to Ankara Numune Training and Research Hospital's Emergency Service between May 2011 and July 2011 with complaints of abdominal pain and who were operated as a result of diagnosis of acute appendicitis were retrospectively evaluated. The local ethics committee approval was taken. For these, 120 patients were evaluated. Socio-

Received: 03.01.2018 Accepted: 23.01.2018

Corresponding Author: Volkan Oter, Sakarya University, Faculty of Medicine, Department of Gastroenterological, Sakarya, Turkey
E-mail: otervolkan@gmail.com

demographic characteristics of the patients, their points in scoring systems, the imaging methods applied, surgical and pathological results were taken under consideration for evaluation.

The statistical analysis has been carried out with the help of the statistics program SPSS 11.5. Continuous variables were expressed as mean ± standard deviation (SD), while discrete variables as frequency (n) and percentage distribution. The distribution of the continuous variables was evaluated with Shapiro Wilks test.

For comparisons related to continuous variables Mann-Whitney U test was used, whereas for comparisons related to discrete variables Fischer Exact test, Yates Chi-square and Pearson Chi-square tests were applied. For the comparisons of areas under curves (AUC) non-parametric (empirical) approach has been adopted. The level p<0.05 has been accepted to be statistically meaningful.

This study was approved by the Ankara Numune Training and Research Hospital's Ethics Committee. (Number: 220/2011).

RESULTS

Seventy four of 120 patients (61.6%) who were operated with a diagnosis of acute appendicitis were males. Male-female ratio is calculated to be 1.6/1. The average age of the patients was determined to be 29.3 (±11.0) (Table 1).

When pathological data were assessed, it was observed that a total of 90 patients had acute appendicitis. Thirty seven of these (30.8%) had phlegmonous appendicitis, and 13 (10.8%) had necrotizing appendicitis. There were 30 patients (25%) for whom negative appendectomy was the case. Control group was established with the patients

with negative appendectomy results. When the patients' white blood cell count (WBC) was examined, it was seen that WBC significantly increased (p<0.001) for the patient group for which acute appendicitis was pathologically determined. Similarly, when C-reactive protein (CRP) was examined, a significant increase (p<0.05) was determined in acute appendicitis group. Anterior and posterior diameter measurements of appendix vermiformis taken through the ultrasound (US) imaging were assessed. It was seen that there was a statistically significant relationship between anterior and posterior diameter longer than 5 mm and pathologically determined acute appendicitis (p<0.001). Patients' Alvarado, Ohmann and Eskelinen scores were calculated and compared. It was seen that there was a statistically significant between high Alvarado (p<0.05) and Ohmann (p<0.05) scores and pathological acute appendicitis. Considering Eskelinen score, significant difference could not be determined (p>0.05) (Table 2).

Table 1. Sociodemographic characteristics of patients

	Acute appendicitis (+)	Acute appendicitis (-)	Total
Gender			
Male(n, %)	60 (%50)	14 (%11.7)	74 (%61.7)
Female (n, %)	30 (%25)	16 (%13.3)	46 (%38.3)
Age (mean±SD)	28.9±10.6	30.6±12.4	29.3±11.0

Areas under curves (AUC) belonging to the scoring systems under evaluation were compared with non-parametric method. AUC calculated for Alvarado, Ohmann and Eskelinen score systems, their confidence intervals, standard errors and p values are given in table 3, while ROC curves are given in Figure 1.

Table 2. Mean values of scores (SD: standart deviation Min-Max: minimum and maximum scores)

	Acute appendicitis (+)			Acute appendicitis (-)			p
	Mean ± SD	Median	Min-Max	Mean ± SD	Median	Min-Max	
Alvarado	7.8±1.4	8.0	2.0-10.0	6.9±1.6	7.0	4.0-9.0	p<0.05
Ohmann	13.8±1.5	14.0	9.0-16.0	13.1±1.8	13.0	8.5-16.0	p<0.05
Eskelinen	59.6±3.5	61.0	43.7-67.6	58.5±4.1	59.9	51.1-67.6	p>0.05

Table 3. Area under Curve of Scoring Systems (AUC: Area Under Curve)

	AUC	%95 Confidence Interval	Standart error	p
Alvarado	0.7	0.5-0.8	0.06	<0.05
Ohmann	0.6	0.5-0.7	0.06	>0.05
Eskelinen	0.6	0.5-0.7	0.07	>0.05

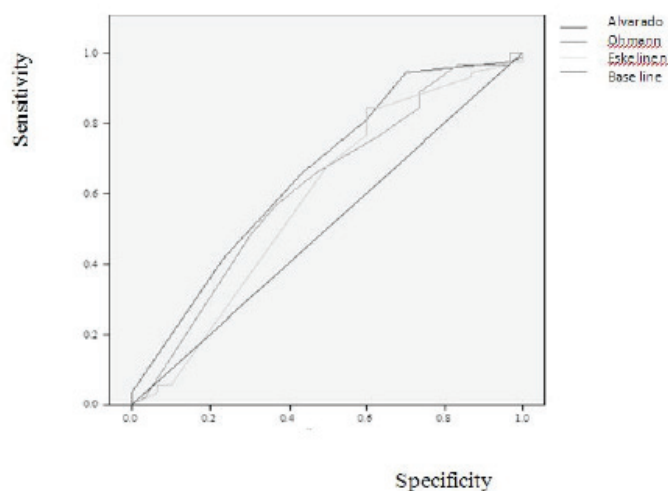


Figure 1. ROC curve of Scoring Systems

In our study were also determined sensitivities and specificities of the scoring systems as well as their positive and negative predictive values. Sensitivities, specificities, positive predictive values (PPV) and negative predictive values (NPV) of Alvarado, Ohmann and Eskelinen scoring systems are given in table 4 for some cut-off values.

DISCUSSION

Acute appendicitis is one of the most frequently observed surgical emergencies and is the disease for which abdominal urgent surgery is most frequently needed (8,9). The patient's complaints vary according to age, localization of appendix and the severity of inflammation. Anorexia and periumbilical pain followed by nausea, vomiting and abdominal pain localized at right lower quadrant are observed for almost 50% of the patients. For the patients operated with pre-diagnosis of acute appendicitis, pathology has been reported to be normal appendix at a rate of 15-30%. Making the diagnosis is not always easy, and diagnosis is difficult for 30-40% of the patients (10). The high rate of dubiousness in diagnosis, high rate of negative appendectomy led to the introduction of scoring systems. Thus we made a research on the efficacy of the scoring systems for diagnosis. Seventy four of 120 patients (61.6%) who were involved in our study were males. Male-female ratio was calculated to be 1.6/1, which is figure in line with the literature (11). Again in line with the literature, the rate of negative appendectomy in our study was found to be 25% (10).

The most frequently used inflammatory marker for acute appendicitis is WBC. For almost 80-85% of the patients with adult appendicitis, WBC is higher than 10.500 cell/ μ L. Majority of the patients also has dominance of neutrophils. Dueholm et. al. have studied the relationship between WBC and the probability of appendicitis and calculated the probability to be 2.8 when WBC is between 11.000-13.000 (12).

CRP synthesized from liver is an acute phase reactant and generally reaches a level higher than 1 mg/dL in acute

appendicitis. Very high CRP levels may have a relation with the appendicitis being gangrenous. Grönroos et. al., have stated that normal values of WBC and CRP is incompatible with acute appendicitis (13). Similar to our study, Asfar et. al., have found in their study a meaningful relationship between high WBC and CRP levels and acute appendicitis (14).

The usefulness of US for the diagnosis of acute appendicitis must be discussed. In a study involving 125 patients with a pre-diagnosis of acute appendicitis, showing atypical progression, Gutierrez et. al., have stated that non-compression of appendix in USG and abnormal doppler activity produce the best indicator for the diagnosis of acute appendicitis (15). Garcia-Aguayo et. al. and Sim et. al. have argued that ultrasonography provides for early diagnosis and prevents unnecessary appendectomy (16,17). Rettenbacher et. al. have determined in their study which was carried out with 278 patients and a control group of 240 that when the diameter of appendix is equal to and longer than 6 mm, there is sensitivity for acute appendicitis but the specificity is low, and emphasized that this is an important indicator for appendicitis exclusion (18). Je et. al. have found in their study that appendix diameter >5.7 mm is meaningful for acute appendicitis (19). Similar to these studies, we found in our study a statistically meaningful relationship between acute appendicitis and appendix diameter longer than 5 mm.

In Alvarado scoring system, it has been stated that Alvarado score ≥ 7 is meaningful for acute appendicitis and reflects the necessity for surgical intervention (4). In the study conducted by Vintilă et. al. it has been emphasized that Alvarado scoring system is a cheap, easy and simple method (20). Douglas et. al. and Winn et. al. have expressed that patients with Alvarado score ≤ 4 do not require appendectomy (21,22). Yıldırım et. al. have operated 51 patients among 55 with Alvarado scores between 8-10, and it was found that 50 of these operated patients had acute appendicitis (23). While Malik et. al. reported negative appendectomy rates to be 32.5%, it has been determined that for cases with Alvarado score equal to and above 7 this rate decreases to 18.8%. Since Alvarado score is 6 or lower for 80% of the negative appendectomies, it is thought that the use of the scoring system especially for children and the elder would decrease negative appendectomy and perforations (24). In a study carried out by Zielke et. al., the efficacy of ultrasonography and the efficacy of Ohmann and Eskelinen scoring systems for decreasing the rates of negative appendectomy have been compared, and it has been found that USG is more specific compared to scoring systems. It has been shown that scoring systems are useful in refusing the diagnosis of acute appendicitis (with a failure rate of 1% and 2% respectively) (25). Zielke et. al. have determined in another study that the scoring system developed by Ohmann decreases negative appendectomy rate by 14.3% and failed to diagnose appendicitis only in 6 (0.9%) patients and argued that the use of this scoring

system would be useful for the diagnosis of appendicitis and it could be used in clinical guides (26). In a study carried out by Horzic et. al. with 120 female patients, which involved the comparison of Modified Alvarado, Ohmann and Eskelinen scoring systems, it was found that specificity of Alvarado Score is 100% for the diagnosis of acute appendicitis above 7 but that when the cut-off point is taken as 4, the sensitivity is 83.3%. They stated that Ohmann Score failed to diagnose acute appendicitis only for 1 patient above 6 (0.9%), but that they could not determine a definite cut-off point for this scoring system, and also that at the maximum score which is 16 there are patients with normal appendix. For the Eskelinen Score, they stated that the rate of acute appendicitis patients above the score 55 is 94.4%, that the appendicitis cannot be diagnosed for 6 (5.5%) patients with the score below 45, and that they could not determine a definite cut-off point for the diagnosis of acute appendicitis with Eskelinen scoring system. Horzic argued that high scores can be operative for taking appendectomy decision but that scoring systems can also be insufficient due to different symptoms and findings among different sub-groups of the population as well as geographical characteristics added to these, therefore that the scoring systems should be reformulated taking into consideration these factors (27).

In our study we evaluated Alvarado, Ohmann and Eskelinen scoring systems with regard to acute appendicitis and found a meaningful relationship between Alvarado and Ohmann scoring systems and the acute appendicitis ($p < 0.05$). Taking into consideration the fact that Alvarado Scoring System does not include subjective criteria and also that it is not dependent upon the evaluated person, we come to the conclusion that its use can be useful for excluding the diagnosis of acute appendicitis, and that it can be used as a supportive instrument for the diagnosis of acute appendicitis together with other methods. The fact that rigidity which is among the parameters of Ohmann scoring system comes forth at later stages and that the age component gives different results for different sub-groups lead us to conclude that despite there are statistically meaningful high results for the general population, this scoring system can be insufficient for the diagnosis of acute appendicitis but that it can be used as a supportive instrument for excluding the diagnosis of acute appendicitis.

Due the fact that the duration of pain which is among the parameters of Eskelinen scoring system is dependent upon the application time of the patient for the calculation for the score and that rigidity comes forth at later stages, we consider this scoring system more fallacious compared to the others. In addition, its coefficients which create a calculation difficulty in practical use limit the use of this scoring system in emergencies which work intensively.

In conclusion, Alvarado, Ohmann and Eskelinen scoring systems were evaluated regarding to acute appendicitis and found a meaningful relationship between Alvarado

and Ohmann scoring systems. For the acute appendicitis, it is thought that the using of the scoring system especially for children and the elder would decrease negative appendectomy and perforations. In addition to that its' coefficients which create a calculation difficulty in practical use limit the use of this scoring system in emergencies which work intensively.

Acknowledgement, There are no conflicts of interest in connection with this paper and the material described is not under publication or consideration for publication elsewhere. This study has received no financial support.

REFERENCES

1. Yildirim O, Solak C, Koçer B, Unal B, Karabeyoğlu M, Bozkurt B, et al. The role of serum inflammatory markers in acute appendicitis and their success in preventing negative laparotomy. *J Invest Surg* 2006;19(6):345-52.
2. Fitz RH. Perforating inflammation of the vermiform appendix with special reference to its early diagnosis and treatment. *Am J Med Sci* 1886;92:321-46.
3. Yeh B. Evidence-based emergency medicine/rational clinical examination abstract. Does this adult patient have appendicitis? *Ann Emerg Med* 2008;52(3):301-3.
4. Alvarado A. A practical score for the early diagnosis of acute appendicitis. *Ann Emerg Med* 1986;15(5):557-64.
5. Saidi HS, Chavda SK. Use of a modified Alvarado score in the diagnosis of acute appendicitis. *East Afr Med J* 2003;80(8):411-4.
6. Ohmann C, Franke C, Yang Q, Margulies M, Chan M, van Elk PJ, et al. Diagnostic score for acute appendicitis. *Chirurg* 1995;66(2):135-41.
7. Ohmann C, Franke C, Yang Q. Clinical benefit of a diagnostic score for appendicitis: results of a prospective interventional study. German Study Group of Acute Abdominal Pain. *Arch Surg* 1999;134:993-6.
8. Ohmann C, Franke C, Kraemer M, Yang Q, et al. Status report on epidemiology of acute appendicitis. *Chirurg* 2002;73(8):769-76.
9. Khan MN, Davie E, Irshad K. The role of white cell count and C-reactive protein in the diagnosis of acute appendicitis. *J Ayub Med Coll Abbottabad* 2004;16(3):17-9.
10. Andersson RE, Hugander AP, Ghazi SH, Ravn H, Offenbartl SK, Nyström PO, et al. Diagnostic value of disease history, clinical presentation, and inflammatory parameters of appendicitis. *World J Surg* 1999;23(2):133-40.
11. Addiss DG, Shaffer N, Fowler BS, Tauxe RV, et al. The epidemiology of appendicitis and appendectomy in the United States. *Am J Epidemiol* 1990;132(5):910-25.
12. Dueholm S, Bagi P, Bud M. Laboratory aid in the diagnosis of acute appendicitis. A blinded, prospective trial concerning diagnostic value of leukocyte count, neutrophil differential count, and C-reactive protein. *Dis Colon Rectum* 1989;32(10):855-9.
13. Grönroos JM, Grönroos P. Leucocyte count and C-reactive protein in the diagnosis of acute appendicitis. *Br J Surg* 1999;86(4):501-4.
14. Asfar S, Safar H, Khoursheed M, Dashti H, al-Bader A. Would measurement of C-reactive protein reduce the rate of negative exploration for acute appendicitis? *J R Coll Surg Edinb* 2000;45(1):21-4.
15. Gutierrez CJ, Mariano MC, Faddis DM, Sullivan RR, Wong RS, Lourie DJ, et al. Doppler ultrasound accurately screens patients with appendicitis. *Am Surg* 1999;65(11):1015-17.
16. Garcia-Aguayo FJ, Gii P. Sonography in acute appendicitis: diagnostic utility and influence upon management and outcome. *Eur Radiol* 2000;10(12):1886-93.

17. Sim KT, Picone S, Crade M, Sweeney JP. Ultrasound with graded compression in the evaluation of acute appendicitis. *J Natl Med Assoc.* 1989;81(9):954-7.
18. Rettenbacher T, Hollerweger A, Macheiner P, Rettenbacher L, Tomaselli F, Schneider B, et al. Outer diameter of the vermiform appendix as a sign of acute appendicitis: evaluation at US. *Radiology* 2001;218(3):757-62.
19. Je BK, Kim SB, Lee SH, Lee KY, Cha SH. Diagnostic value of maximal-outer-diameter and maximal-mural-thickness in use of ultrasound for acute appendicitis in children. *World J Gastroenterol* 2009;15(23):2900-3.
20. Vintilă D, Popa P, Neacșu CN, Forțu L, Popa B, Georgescu SO. [The importance of the Alvarado score in differential diagnosis of the pain from the right lower abdominal quadrant] *Jurnalul de chirurgie (Iași)* 2012;8(2):178-83.
21. Douglas C, Macphersson E, Davidson M, Gani JS. Randomised controlled trial of ultrasonography in diagnosis of acute appendicitis, incorporating the Alvarado score. *BMJ*, 2000;321(7266):919-22.
22. Winn RD, Laura S, Douglas C, Davidson P, Gani JS. Protocol-based approach to suspected appendicitis, incorporating the alvarado score and outpatient antibiotics. *ANZ J Surg* 2004;74(5):324-9.
23. Yildirim E, Karagulle E, Kirbas I, Turk E, Hasdogan B, Teksam M, et al. Akut apandisit: Alvarado skoru ve agri baslangici ile cok kesitli BT bulgulari arasindaki iliski. *Diagn Interv Radiol* 2008;14(1):14-8.
24. Malik AA, Wani NA. Continuing diagnostic challenge of acute appendicitis: evaluation through modified Alvarado score. *Aust N Z J Surg* 1998;68(7):504-5.
25. Zielke A, Sitter H, Rampp T, Bohrer T, Rothmund M. Clinical decision-making, ultrasonography, and scores for evaluation of suspected acute appendicitis. *World J Surg* 2001;25(5):578-84.
26. Zielke A, Sitter H, Rampp TA, Schäfer E, Hasse C, Lorenz W, et al. Validation of a diagnostic scoring system (Ohmann score) in acute appendicitis. *Chirurg* 1999;70(7):777-83.
27. Horzic 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(1):133-8.