

Can Alvarado and Appendicitis Inflammatory Response scores evaluate the severity of acute appendicitis?

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ABSTRACT

BACKGROUND: The Alvarado score (AS) and the Appendicitis Inflammatory Response score (AIRS) were developed to diagnose acute appendicitis (AA). The aim of this study was to evaluate the severity of AA using the AS and the AIRS tools.

METHODS: Patients who presented between January 2016 and December 2017 and underwent surgery for AA and who had a preoperative AS and AIRS value were evaluated retrospectively. The details of age, sex, pathological severity, the presence of local peritonitis or fecaloid, drainage, appendix diameter, and operation type were evaluated according to the AS and the AIRS.

RESULTS: A total of 578 patients were included in the study. Appendicitis was the most common pathological severity classification (44.4%). The most common appendix diameter group was 7–10 mm (59.2%). The difference observed in the AS and AIRS results for all of the pathological severity categories was statistically significant ($p<0.05$). The AIRS revealed a statistically significant difference ($p<0.05$) in the detection of uncomplicated and complicated appendicitis. The AIRS difference was statistically significant for appendix diameter ($p<0.05$). The AS and the AIRS results were both statistically significant for drainage ($p<0.05$). The AS was correlated with pathological severity, local peritonitis, and drainage, while the AIRS was correlated with pathological severity, uncomplicated/complicated determination, appendix diameter, and drainage ($p<0.05$).

CONCLUSION: Both the AS and the AIRS can evaluate pathological severity, but only the AIRS can evaluate complicated or uncomplicated appendicitis and the diameter of the appendix. These tools can be used to reduce the number of unnecessary radiological or surgical interventions.

Keywords: Acute appendicitis; Alvarado score; Appendicitis Inflammatory Response score; drainage; local peritonitis; pathology.

INTRODUCTION

Acute abdominal pain is a common complaint of emergency admission, with ratio of 10%.^[1] Of the cases of acute abdominal pain, a reported 1.9% are caused by acute appendicitis (AA).^[2] The clinical presentation and symptoms of AA are frequently atypical and can be similar to other diseases, which makes diagnosis difficult. Delayed diagnosis, however, can lead to perforation of the appendix. Until recently, a 15% negative appendectomy rate was accepted in order to reduce the perforation rate.^[3] Some 2% of claims in emergency departments are cases of appendicitis.^[4] Today, in light of scientific

improvements as well as malpractice cases, the negative appendectomy must be very rare.

An anamnesis and physical examination are the initial methods for diagnosis, as in other diseases. The diagnostic accuracy of laboratory tests (especially leucocyte count, C-reactive protein [CRP], and neutrophil percentage) has been reported to be 82.5%.^[5] Diagnosis sensitivity has been reported for ultrasonography (USG) as 83.1%, computed tomography (CT) as 89.9% and magnetic resonance imaging (MRI) as 89.9%, and the specificity has been reported as 90.9%, 93.6%, and 93.6%, respectively.^[6] Scoring systems were developed to help diag-

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nose AA. The diagnosis sensitivity of the Alvarado score (AS) has been reported as 78.41%, the Appendicitis Inflammatory Response score (AIRS) as 78.41%, and the Raja Isteri Pengiran Anak Saleha Appendicitis scoring system (RIPASA) as 93.18%, while the diagnosis specificity has been reported as 100%, 91.67%, and 91.67%, respectively.^[7]

The severity of AA is generally evaluated radiologically. The white blood cell (WBC), CRP, and total bilirubin values, the neutrophil-to-lymphocyte ratio, and the combination of radiology and laboratory scoring systems are used for severity evaluation.^[8-12] The AS and the AIRS were designed to help diagnose AA. The aim of this study was to retrospectively assess use of the AS and the AIRS to evaluate severity of appendicitis.

MATERIALS AND METHODS

After receiving institutional approval from the ethics committee of Okmeydanı Training and Research Hospital, patients from between January 2016 and December 2017 who were operated on for AA and who had preoperative AS and AIRS results were evaluated retrospectively. Age, sex, pathological details (severity, the presence of local peritonitis or a fecaloid, the diameter of the appendix), and surgical details (operation type and presence of drainage) were evaluated using the AS and the AIRS.

The AS consists of the symptoms of pain migration to the right iliac fossa (RIF), anorexia, nausea and vomiting, examination findings of RIF tenderness, rebound tenderness, and fever, as well as laboratory results indicating leukocytosis and a shift of the WBC to the left. The AIRS uses the symptoms of vomiting, pain in the RIF, signs of abdominal defense, and a temperature $>38.8^{\circ}\text{C}$, in addition to laboratory values indicating

Table 1. Alvarado scoring system for acute appendicitis

Diagnosis	Score
Symptoms	
Pain migration to right iliac fossa	1
Anorexia	1
Nausea & vomiting	1
Signs	
Right iliac fossa tenderness	2
Rebound tenderness	1
Fever	1
Laboratory	
Leukocytosis	2
Shift of the white blood cell count to the left	1
Total	10

Score: <4 unlikely probability, $4-7$ suspected probability, >7 definite probability.

Table 2. Acute Inflammatory Response Score for acute appendicitis

Diagnosis	Score
Vomiting	1
Pain in right iliac fossa	1
Abdominal defense	
Low	1
Medium	2
Severe	3
Temperature $>38.8^{\circ}\text{C}$	1
Segmented neutrophils	
70%–84%	1
$\geq 85\%$	2
Leukocytes ($\times 10^9/\text{L}$)	
10.0–14.9	1
≥ 15.0	2
C-reactive protein (g/L)	
10–49	1
≥ 50	2
Total	12

Score: 0–4 low probability, 5–8 mild probability, 9–12 high probability.

segmented neutrophils, and leukocyte and CRP values.^[7] The AS and the AIRS criteria are illustrated in Table 1 and Table 2.

Pathological severity was evaluated by the pathology department using the categories of lymphoid hyperplasia, appendicitis, phlegmonous/suppurative appendix, and perforation. Perforated appendicitis was considered complicated, while the remainders were classified as uncomplicated. The appendix diameter measurement was separated into 4 groups: <6 mm, 7–10 mm, 11–20 mm, and >21 mm. Appendectomies were performed laparoscopically or as open surgery.

The statistical analysis was performed using SPSS for Windows, Version 16.0 (SPSS Inc., Chicago, IL, USA). A single sample t-test was used for age (mean \pm SD). The ratio of male to female patients, and the operation type were calculated as percentages. The Kruskal-Wallis and Mann-Whitney U tests were used to evaluate the AS and AIRS results. Pearson's correlation test was used to evaluate the correlation between the scores and the findings.

RESULTS

A total of 578 patients were included in the study. The mean age was 30.2 ± 12.9 years. In all, 34% of patients were female and 66% were male. A laparoscopic procedure was performed in 55.4% of the cases, while an open technique was used in 44.6%. Drainage was required in 11.6%. The pathological severity classification was lymphoid hyperplasia in 2.8%,

appendicitis in 44.4%, phlegmonous/suppurative appendix in 41.9%, and perforation in 10.9%. The diameter of the appendix was <6 mm in 11.6% of the cases, 7–10 mm in 59.2%, 11–20 mm in 27.5%, and 1.7% of the appendices measured >21 mm. Local peritonitis was present in 62.3% of the patients and a fecaloid was present in 63% (Table 3).

The results of evaluation of pathological severity using the AS and the AIRS are shown in Table 4. Both the AS and the AIRS demonstrated statistically significant differences in determining all of the severity groups (both: p=0.0001). The differences in the determination of lymphoid hyperplasia with appendicitis, phlegmonous/suppurative classification, and perforation were also statistically significant (AS: p=0.008, p=0.0001,

Table 3. Demographic data, surgical details, and pathological results of patients (n=578)

	n	%
Age (years), Mean±SD	30.2±12.9	
Sex		
Female	197	34
Male	381	66
Operation		
Open	258	44.6
Laparoscopic	320	55.4
Drainage		
Yes	67	11.6
No	511	88.4
Pathological severity 1		
Lymphoid hyperplasia	16	2.8
Appendicitis	257	44.4
Phlegmonous/suppurative	242	41.9
Perforation	63	10.9
Pathological severity 2		
Uncomplicated	515	89.1
Complicated	63	10.9
Diameter		
<6 mm	67	11.6
7–10 mm	342	59.2
11–20 mm	159	27.5
>20 mm	10	1.7
Local peritonitis		
Yes	360	62.3
No	218	37.7
Fecaloid		
Yes	364	63
No	214	37

SD: Standard deviation.

Table 4. AS and AIRS evaluation according to pathological severity, appendix diameter, local peritonitis, and drainage

Findings	AS		AIRS	
	Mean Rank	p	Mean Rank	p
Pathologic severity				
Lymphoid hyperplasia	160.56	0.0001	158.91	0.0001
Appendicitis	270.00		245.51	
Phlegmonous/suppurative	312.14		318.43	
Perforation	314.82		390.99	
Lymphoid hyperplasia	89.38	0.008	97.91	0.038
Appendicitis	139.96		139.43	
Lymphoid hyperplasia	65.47	0.0001	61.66	0.0001
Phlegmonous/suppurative	133.73		133.99	
Lymphoid hyperplasia	22.72	0.0001	16.34	0.0001
Perforation	44.39		46.01	
Appendicitis	232.48	0.003	218.99	0.0001
Phlegmonous/suppurative	268.61		282.93	
Appendicitis	155.56	0.038	145.09	0.0001
Perforation	180.65		223.38	
Phlegmonous/suppurative	152.80	0.932	144.51	0.001
Perforation	153.78		185.60	
Uncomplicated	286.40	0.17	277.08	0.0001
Complicated	314.82		390.99	
Appendix diameter				
<6 mm	288.15	0.464	239.60	0.001
7–10 mm	281.95		279.48	
11–20 mm	304.80		328.02	
>21 mm	311.30		349.00	
<6 mm	208.17	0.764	180.95	0.069
7–10 mm	203.78		209.13	
<6 mm	109.37	0.460	89.60	0.0001
11–20 mm	115.94		124.22	
<6 mm	38.60	0.665	37.06	0.044
>21 mm	41.65		52.00	
7–10 mm	244.69	0.125	237.59	0.002
11–20 mm	264.45		279.57	
7–10 mm	175.48	0.548	174.76	0.174
>21 mm	193.65		218.25	
11–20 mm	85.41	0.915	85.23	0.775
>21 mm	87.00		89.75	
Other				
Local peritonitis +	298.55	0.072	299.84	0.052
Local peritonitis –	274.56		272.42	
Drainage +	282.17	0.002	271.32	0.0001
Drainage –	345.43		428.14	

AS: Alvarado score; AIRS: Appendicitis Inflammatory Response score.

p=0.0001, respectively; AIRS: p=0.038, p=0.0001, p=0.0001, respectively). In addition, differences between appendicitis with a phlegmonous/suppurative appendix and perforation were statistically significant (AS: p=0.003, p=0.038, respectively; AIRS: p=0.0001, p=0.0001, respectively). The difference between a phlegmonous/suppurative evaluation and perforation was not statistically significant for the AS (p=0.932), but was statistically significant for the AIRS (p=0.001). The difference between uncomplicated and complicated appendicitis results was not statistically significant for the AS (p=0.17), but was statistically significant for the AIRS (p=0.0001).

The results of the AS and the AIRS evaluation of appendix diameter are also demonstrated in Table 4. The AS did not yield a statistically significant differences between diameter categories (p=0.464); however, the AIRS result was statistically significant (p=0.001). With the AIRS, differences between <6 mm and 11–20 mm, <6 mm and >21 mm, and 7–10 mm and 11–20 mm were statistically significant (p=0.0001, p=0.044 and 0.002, respectively). Other differences between diameters were not statistically significant (p>0.05).

The results of the AS and AIRS evaluation of other findings are also shown in Table 4. The presence of local peritonitis was not statistically significant for the AS or the AIRS (p=0.072, p=0.052 respectively). Drainage, however, was a statistically significant result for both the AS and the AIRS (p=0.002, p=0.0001, respectively) (Figs. 1 and 2).

The correlation between scores and findings is demonstrated in Table 5. The correlation with pathological severity was statistically significant for both scoring systems (both p=0.0001). The AS result for distinguishing between uncomplicated/complicated was not statistically significant (p=0.085) but the AIRS correlation was statistically significant (p=0.001). Similarly, the AS correlation for appendix diameter was not statistically significant (p=0.307), but the AIRS result was sta-

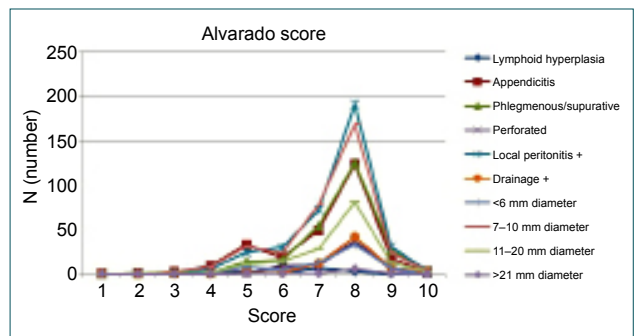


Figure 1. Distribution of Alvarado score according to findings.

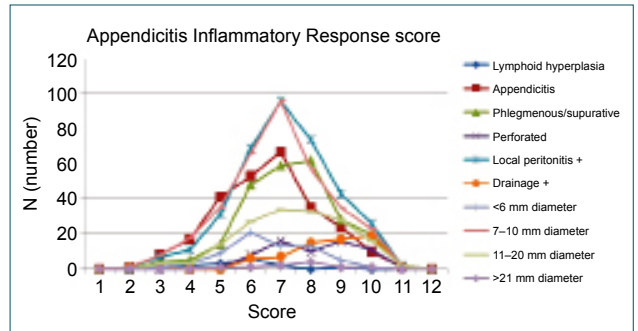


Figure 2. Distribution of Appendicitis Inflammatory Response score according to findings.

tistically significant (p=0.0001). The AS determination of local peritonitis was statistically significant (p=0.035), while the AIRS was not (p=0.066). The correlation for both the AS and the AIRS was statistically significant for the subsequent need for drainage (p=0.001, p=0.0001 respectively).

DISCUSSION

Though imaging modalities facilitate the accurate diagnosis of severity in AA, it can still be difficult in geriatric, pediatric, and female patients, and pregnant patients, in particular. This can be a cause of delayed diagnosis. Some 28% to 29% of AA cases have been found to be complicated with a perforation or gangrene, and postoperative morbidity rates have increased to between 9% and 18%.^[13] Therefore, many clinical, laboratory, and radiological studies have been performed to better determine the severity of AA.

Both the AS and the AIRS systems consist of symptoms, signs, and laboratory results. Symptoms are more in the foreground in the AS, while the AIRS includes a CRP value. De Castro et al.^[14] and Kollár et al.^[15] reported that the AIRS had greater discriminative power than the AS in diagnosing AA as a result of the addition of the CRP component.

Kalliakmanis et al.^[16] evaluated AA symptoms, and reported that pain migration to the right lower quadrant, loss of appetite, periumbilical pain, fever, rebound tenderness, and local rigidity were statistically correlated with histopathological severity (p<0.05).

Table 5. Correlation of findings and scores

Findings	Scores	Pearson correlation	p
Pathological severity	AS	0.196	0.0001
	AIRS	0.325	0.0001
Complicated/uncomplicated	AS	0.72	0.085
	AIRS	0.221	0.0001
Diameter	AS	0.043	0.307
	AIRS	0.171	0.0001
Local peritonitis	AS	0.88	0.035
	AIRS	0.76	0.066
Drainage	AS	0.137	0.001
	AIRS	0.298	0.0001

AS: Alvarado score; AIRS: Appendicitis Inflammatory Response score.

Andersson et al.^[17] reviewed the clinical and laboratory diagnosis of appendicitis. They found that duration of right quadrant pain >24 hours; fever (>37.7 °C); pain migration; direct, indirect, and rebound tenderness; and guarding were significant clinical signs for AA ($p < 0.05$). A WBC count of ≥ 10 ($\times 10^9/L$), granulocyte count ≥ 7 ($\times 10^9/L$), polymorphonuclear neutrophil proportion >75%, and CRP level >10 (mg/L) were significant laboratory results for AA ($p < 0.05$); however, only WBC and CRP were significant for complicated appendicitis. Xharra et al.^[18] reported that the diagnostic accuracy of CRP, WBC, and the percentile of neutrophils (PN) was 83.2%, 82.6%, and 77.5%, respectively. The combination of CRP+, WBC+, and PN increased the accuracy to 91.9%.^[18] Sevinç et al.^[19] reported that WBC >11.900 mm³, serum bilirubin >1.0 mg/dL, and a neutrophil-lymphocyte ratio (NLR) >3.0 were significantly associated with an AA diagnosis. In patients with AA, serum bilirubin >1.0 mg/dL or NLR >4.8 was significantly associated with the presence of perforation.

USG is the least expensive imaging modality, and it is easily applicable and harmless, but requires a radiologist. The sensitivity of a USG diagnosis of AA has been reported as 83.7%, with a specificity of 95.9%. USG is ineffective if the appendix is <6 mm in diameter. CT has been reported to have a 98.5% sensitivity and a 98% specificity in the diagnosis of AA. The sensitivity was 64.3%–96.4% and the specificity was 100% for the severity of AA. The negative appendectomy rate was 8.7% versus 16.7% based on a clinical evaluation. The most important disadvantage of CT is the exposure to radiation (not suitable for children or pregnant woman) and long-term risks of cancer.^[3,7,20]

We evaluated the pathological severity, appendix diameter, and the presence of local peritonitis and drainage in the assessment of the severity of AA.

Pathological severity was evaluated as complicated/uncomplicated with a more detailed classification as appropriate.^[21] Our pathology department evaluated AA using the categories of lymphoid hyperplasia, appendicitis, phlegmonous/suppurative appendix, and perforation. Transmural inflammation, ulceration, or thrombosis, with or without extramural suppuration, may appear in the pathology of uncomplicated appendicitis. Necrosis and perforation appear in complicated cases. Our study findings of 89.2% uncomplicated and 10.9% complicated was lower than reports in the literature.^[13] Both the AS and the AIRS demonstrated statistically significant results in predicting the pathological severity of AA; however, only the AIRS could differentiate between uncomplicated and complicated cases.

The appendix diameter is an important sign for radiological diagnosis, and >6 mm is accepted as indicating AA. However the diameter may also be <6 mm in cases of AA and USG is ineffective for diagnosing an appendix <6 mm in diameter.

^[7,22,23] In our group, 11.6% of the patients had an appendix diameter measured at <6 mm. The results of our study showed that the AS cannot predict appendix diameter, but the AIRS was successful, especially those <6 mm and >21 mm.

Local peritonitis is a pathological finding that is an indicator of the severity of AA. In this study, the results of local peritonitis rate were evaluated as 6.25% for lymphoid hyperplasia, 44% for appendicitis, 76.8% for phlegmonous/suppurative, and 95.2% for perforated; the local peritonitis percentage increased with the severity of AA and was statistically significant ($p < 0.005$). The items included in both scores are not affected by local peritonitis, and while these 2 scoring systems cannot predict local peritonitis, the AS was significantly correlated with local peritonitis findings.

The use of drainage is an operative approach associated with perforation or infected periappendiceal fluid and is an indicator of the severity of AA. Drainage was performed in 7.5% of the uncomplicated cases and increased to 44.4% in complicated AA. Both scoring systems can predict the need for drainage.

In conclusion, complicated or perforated appendicitis is still the most important complication of delayed or misdiagnosed AA. The scoring systems used symptoms, signs, and laboratory results. They are easy and inexpensive to administer, harmless, and offer a 78.41% sensitivity and 91.67% specificity for the diagnosis of AA while also being useful for determining severity. The AIRS results were more significant for the prediction of complicated appendicitis and appendix diameter compared with the AS. CRP is the most important differential item for the AIRS. The use of the AIRS can decrease unnecessary radiological and surgical interventions. A prospective, randomized, controlled trial is needed for further evaluation of these scores and imaging modalities, such as USG, CT, or diagnostic laparoscopy.

Conflict of interest: None declared.

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ORJİNAL ÇALIŞMA - ÖZET

Alvarado ve Apandisit İnflamatuvar Yanıt skorlamaları akut apandisit şiddetini değerlendirebilir mi?

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AMAÇ: Alvarado (AS) ve apandisit inflamatuvar yanıt (AİYS) skorları akut apandisit (AA) tanısı için geliştirilmiş skorlardır. Bu çalışmanın amacı AA şiddetinin AS ve AİYS ile değerlendirilmesidir.

GEREÇ VE YÖNTEM: Ocak 2016–Aralık 2017 tarihleri arasında AA nedeni ile ameliyat edilen ve ameliyat öncesi AS ve AİYS yapılan hastalar geriye dönük değerlendirildi. Yaş, cinsiyet, patolojik şiddet, lokal peritonit, fekaloid, drenaj, apandiks çapı ve operasyon şekli AS ve AİYS'ye göre değerlendirildi.

BULGULAR: Çalışmaya 578 hasta dâhil edildi. Apandisit %44.4 ile en sık görülen patolojydi. En sık ölçülen apandiks çapı ise %59.2 ile 7-10 mm idi. Bütün patolojiler arasındaki AS ve AİYS istatistiksel olarak anlamlı bulundu ($p<0.05$). Komplike ve komplike olmayan apandisitler arasındaki sadece AİYS istatistiksel olarak anlamlı bulundu ($p<0.05$). Apandiks çapları arasındaki sadece AİYS istatistiksel olarak anlamlı bulundu ($p<0.05$). Drenaj yapılan hastalarda AS ve AİYS istatistiksel olarak anlamlı farklılık saptandı ($p<0.05$). AS ile patolojik şiddet, lokal peritonit ve drenajın korelasyonu, AİYS ile patolojik şiddet, komplike/komplike olmayan, apandiks çapı ve drenajın korelasyonu istatistiksel olarak anlamlı bulundu ($p<0.05$).

TARTIŞMA: Alvarado skoru ve AİYS her ikisi de patolojik şiddeti değerlendirebilmekte iken sadece AİYS komplike ve komplike olmayan apandisitleri, apandiks çapının daha anlamlı değerlendirebilmektedir. Bu skorları kullanarak gereksiz radyolojik ve cerrahi girişimlerini azaltabilecektir.

Anahtar sözcükler: Akut apandisit; Alvarado skoru; apandisit inflamatuvar yanıt skoru; drenaj; lokal peritonit; patoloji.

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