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Validation and Efficiency of a Scoring System Used in the Differentiation of Uncomplicated Appendicitis

Komplike Olmayan Apandisit Ayırımında Kullanılan Bir Puanlama Sisteminin Geçerliliği ve Etkinliği

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ABSTRACT

Objective: Various parameters are used to differentiate between complicated and uncomplicated appendicitis cases, and scoring systems are even created where these parameters are used together. The aim of this study was to evaluate the effectiveness of one of these scoring systems by external validation.
Methodology: Retrospective evaluation was performed on the clinical, radiological and laboratory findings of patients who underwent an appendectomy between January 2018 and January 2021. Scoring was performed using the previously described scoring systems for each patient considered to have acute appendicitis as a result of imaging. They were divided into complicated appendicitis and uncomplicated appendicitis groups, according to clinical and pathological evaluation results.
Results: While evaluating 425 patients, ultrasonography was used in 48% and tomography in 52% of the patients. Significant effectiveness of the score of ≤6 was observed in the group using tomography (p<0.001, AUC: 0.838, Sensitivity 83.3%, positive predictive value 50.8%, specificity 84.3%, negative predictive value 96.3%). Significant effectiveness of the score of ≤5 was observed in the ultrasonography group (p<0.001, AUC: 0.790, Sensitivity 85.7%, positive predictive value 39.0%, specificity 72.2%, negative predictive value 96.1%).
Conclusion: The scoring system created for the selection of uncomplicated appendicitis cases has been shown to be effective and has been externally validated. Since each of the parameters used in the scoring system has higher efficiency than its independent effectiveness, scoring systems that evaluate clinical, radiological and laboratory variables together, give better results in clinical practice.

Keywords: Acute appendicitis, Complicated appendicitis, Uncomplicated appendicitis, Scoring system, Ultrasonography, Tomography

ÖZ

Amaç: Komplike-komplike olmayan apandisit vakalarını ayırt etmek için çeşitli parametreler kullanılmakta ve hatta bu parametrelerin birlikte kullanıldığı skorlama sistemleri oluşturulmaktadır. Bu çalışmanın amacı, bu puanlama sistemlerinden birinin etkinliğini dış doğrulama ile değerlendirmektir.
Yöntemler: Ocak 2018-Ocak 2021 tarihleri arasında apendektomi yapılan hastaların klinik, radyolojik ve laboratuvar bulguları retrospektif olarak değerlendirildi. Görüntüleme sonucunda akut apandisit düşünülen her hasta için daha önce tanımlanan skorlama sistemleri kullanılarak skorlama yapıldı. Klinik ve patolojik değerlendirme sonuçlarına göre komplike apandisit ve komplike olmayan apandisit gruplarına ayrıldılar.
Bulgular: 425 hasta değerlendirilirken hastaların %48'inde ultrasonografi, %52'sinde tomografi kullanıldı. Tomografi kullanan grupta ≤6 puanın anlamlı etkinliği gözlendi (p<0,001, EAA: 0.838, Duyarlılık %83,3, pozitif öngörü değeri %50,8, özgüllük %84,3, negatif öngörü değeri %96,3). Ultrasonografi grubunda ≤5 skorunun anlamlı etkinliği gözlendi (p<0,001, EAA: 0.790, Duyarlılık %85,7, pozitif prediktif değer %39,0, spesifisite %72,2, negatif prediktif değer %96,1).
Sonuç: Komplike olmayan apandisit vakalarının seçimi için oluşturulan puanlama sisteminin etkili olduğu gösterilmiştir ve harici olarak doğrulanmıştır. Skorlama sisteminde kullanılan parametrelerin her biri bağımsız etkinliğinden daha yüksek verimliliğe sahip olduğundan; klinik, radyolojik ve laboratuvar değişkenlerini bir arada değerlendiren skorlama sistemleri klinik uygulamada daha iyi sonuçlar vermektedir.

Anahtar Kelimeler: Akut apandisit, Komplike apandisit, Komplike olmayan apandisit, Skorlama sistemi, Ultrasonografi, Tomografi

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INTRODUCTION

The usability of medical and minimally invasive treatment methods is being evaluated even in some diseases where surgery is preferred as the gold standard in the treatment [1,2]. One of these diseases is acute appendicitis (AA), which is one of the most common causes of emergency surgery in the adult patient group [3]. Perforation, gangrene and abscess are observed in some of the AA cases, and these cases are defined as complicated appendicitis [4]. The distinction between complicated acute appendicitis (CAA) and uncomplicated acute appendicitis (UCAA) gains importance, in particular in the planning of non-surgical treatment. There have been studies showing the success of conservative treatment in selected UCAA cases [5]. The selection criteria and treatment plans of the patient group should be more clearly defined, therefore it is necessary to achieve selectivity where the specificity is higher for the UCAA. The effectiveness of many clinical, laboratory and radiological parameters has been and is still being evaluated to be used in the differentiation of CAA/UCAA [6-9]. It has been stated that this distinction cannot reach a sufficient level with the use of imaging methods alone [10].

Scoring systems can prevent the low efficiency obtained when the parameters are evaluated alone. For this reason, they are quite frequently used in the healthcare system [11]. Evaluating the increasing numbers of parameters together increases the precision of the result. The scoring systems created by using the clinical, laboratory and radiological results of the patients were evaluated and the results were used in the differentiation of UCAA [12,13].

The aim of our study was to evaluate the usability and effectiveness of a scoring system designed to differentiate UCAA cases by using clinical, radiological and laboratory parameters in our patient group.

METHODOLOGY

A retrospective evaluation was performed on the files of patients (≥18 years) who underwent an appendectomy with the pre-diagnosis of acute appendicitis, from January 2018 to January 2021, at the Alanya Training and Research Hospital. Patient information, medical history, clinical findings, laboratory findings and pathology results were recorded.

While forming the study group, attention was paid to the fact that radiological examination was performed in the preoperative period, AA results were obtained via this imaging, and the laboratory and clinical results used in the study in the preoperative period were fully recorded. Patients with additional diseases that may have affected laboratory and/or clinical results, such as chronic inflammatory diseases (Crohn Disease, Familial Mediterranean Fever, Kawasaki disease, rheumatoid arthritis, systemic lupus erythematosus etc.) and hematological malignancies (leukemias etc.) that change CRP and WBC levels and pregnant patients, were all excluded from the study.

Patients were divided into ultrasonography (USG) group (Grp-USG) and computerized tomography (CT) group (Grp-CT) according to the imaging method used during diagnosis, and the study continued separately with these two groups. At the study center, there was no programmed approach that could affect the selection of imaging method at admission. The preferred imaging method in the center where the study was conducted is determined by emergency specialists according to the criteria of accessibility, cost and reliability. Those who carried out the study had no influence on this selection. According to the scoring system created by Atema et al.[13], scoring was performed on age, body temperature, duration of symptoms, leukocyte count (WBC), C-reactive protein level (CRP), Periappendiceal fluid on imaging, and Appendicolith on imaging criteria in Grp-USG patients (USG-Score - maximum 19 points) and on Age, Body temperature, Duration of symptoms, WBC, CRP, Extra-luminal free air on imaging, Periappendiceal fluid on imaging, and Appendicolith on imaging criteria in Grp-CT patients (CT-Score - maximum 22 points). (Table 1) As stated in the original article, a CT-Score of 6 or less and a USG-Score of 5 or less were considered to indicate UCAA. The efficacy of the scoring systems was compared with the final pathological outcome (CAA/UCAA) according to these cut-off points. The main purpose of the

scoring systems was to detect UCAA cases with greater precision.

All data collection and analysis were carried out with the approval of the Ethics Committee of Alaaddin Keykubat University (approval date/no: 13.01.2021/01-14). The study protocol confirmed the ethical guidelines of the 1975 Declaration of Helsinki, as reflected in the approval by the ethics committee.

Statistical method: mean, standard deviation, median, minimum, maximum value frequency and percentage were used for descriptive statistics. The distribution of variables was checked using the Kolmogorov-Simirnov test. The Mann-Whitney U test was used for the comparison of quantitative data. The Chi-Square test was used for the comparison of the comparison of qualitative data. ROC analysis was used to show the effect level. Logistic Regression was used to show the effect level. The SPSS version 27.0 (IBM SPSS Inc., Chicago, IL, USA) was used for statistical analyses.

RESULTS

The study commenced with 599 patients who underwent an appendectomy. Forty-three patients for whom no imaging method was used during diagnosis, fifty-five patients who were not diagnosed with acute appendicitis by imaging and eight patients whose laboratory results could not be accessed, were all excluded from the study group. Twenty patients who were diagnosed with non-acute appendicitis in the clinical and pathological examination or who underwent appendectomy in addition to the original disease, and forty-six patients who were not diagnosed with acute appendicitis in the pathological examination (negative appendectomy), were also excluded from the study.

The study resumed with the remaining 425 patients. Of the patients participating in the study, 64.9% (n=276) were male and 35.1% (n=149) were female. The mean age was 33.29±13.02 years. 48% (n=204) of the patients were evaluated by USG and 52% by CT (n=221). The study continued separately in these two groups. These two groups were divided into two subgroups, according to whether the patients were UCAA or CCAA, as a result of pathological evaluation and they were compared with each other (Table 2).

Table 1. Scoring system based on clinical and imaging features for both computerized tomography (CT) and ultrasonography (USG)

		Clinical and CT features	Clinical and USG features
Age≥45 years		2 points	2 points
Body temperature	≤37.0	0 point	0 point
	37.1-37.9	2 points	2 points
	≥38.0	4 points	4 points
Duration of symptoms ≥48 h		2 points	2 points
Leukocyte >13 × 10^9/l			2 points
C-reactive protein (mg/l)	≤50	0 point	0 point
	51-100	2 points	4 points
	>100	3 points	5 points
Extra-luminal free air on imaging		5 points	-
Periappendiceal fluid on imaging		2 points	2 points
Appendicolith on imaging		2 points	2 points
Maximum score		22 points	19 points

In patients evaluated by the scoring system using CT results (Grp-CT), in the CAA subgroup, Appendicolith on imaging (p=0.017), Periappendiceal fluid on imaging (p<0.001), Extra-luminal free air on imaging (p<0.001), Duration of symptoms ≥48 h (p<0.001) and Body temperature (p<0.001) were significantly higher compared to UCAA subgroup, and CRP was significantly higher (p<0.001). In the CAA subgroup, CT-Score (p<0.001) and the proportion of patients with a CT-Score >6 (p<0.001) was significantly higher compared to the UCAA subgroup (Table 2).

In patients evaluated by the scoring system using USG results (Grp-USG), in the CAA subgroup, Periappendiceal fluid on imaging (p<0.001), Duration of symptoms ≥48 h (p<0.001) and Body temperature (p<0.001) were significantly higher compared to UCAA subgroup, and CRP was significantly higher (p<0.001). In the CAA subgroup, USG-Score (p<0.001) and the proportion of patients with a USG-Score >5 (p<0.001) was significantly higher compared to the UCAA subgroup (Table 2).

In Grp-CT, in univariate model for CAA-UCAA differentiation, Body temperature (p<0.001), Appendicolith on imaging (p=0.019), Periappendiceal fluid on imaging (p<0.001), Duration of symptoms ≥48 h (p<0.001) and WBC (p=0.038), CRP (p<0.001), CT-Score (p<0.001)

showed significant efficacy. Age (p=0.001), body temperature (p<0.001), periappendiceal fluid on imaging (p=0.001), duration of symptoms ≥48 h (p<0.001), CRP(p<0.001), and USG-Score (p<0.001) showed significant efficacy in univariate model for CAA-UCAA differentiation, in Grp-USG (Table 3).

As a result of the Roc analysis, a significant (p<0.001, AUC: 0.923) CT-Score and a significant (p<0.001, AUC: 0.838) cut-off value of CT-Score ≤6 were observed in Grp-CT in the differentiation of CAA-UCAA. Sensitivity was 83.3%, positive predictive value (PPV) was 50.8%, specificity was 84.3%, and negative predictive value (NPV) was 96.3% (Table 4).

In Grp-USG, significant effectiveness of USG-Score (p<0.001, AUC: 0.867) and significant (p<0.001, AUC: 0.790) cut-off value of USG-Score ≤5 was observed in the differentiation of CAA-UCAA. Sensitivity was 85.7%, PPV was 39.0%, specificity was 72.2%, and NPV was 96.1% (Table 4).

DISCUSSION

In this study, external validation was performed on a scoring system based on clinical, laboratory and imaging results in the preoperative period, to differentiate between CAA and UCAA, in order to evaluate its effectiveness [13]. An important part of the recent studies on AA in the literature is related to the conservative treatment of UCAA cases. Therefore, preoperative differentiation of UCAA cases gains importance. In this study, the rate of CAA was 16.7% and this was consistent with the literature [14,15].

Although radiological evaluations maintain their importance in the diagnosis of AA, studies have shown that only 14.0% of cases classified as UCAA in the evaluation by CT are actually CAA [15]. In patients who were considered to be UCAA as a result of evaluation with CT alone, there was a 2% increase in the risk of perforation for every 1 hour delayed in surgery, while this was associated with only a 5% increase at the end of the 7th hour in patients with low scores, when evaluated with the Atema's scoring system [15]. Yeh et al. state that this delay caused by the diagnosis-surgery interval in the hospital setting is not a risk factor for CAA [16].

Existing scoring systems such as the Alvarado scoring or the Appendicitis inflammatory response scoring (AIRS) are used to differentiate acute appendicitis cases from other abdominal pathologies, rather than to differentiate CAA and UCAA. It has been stated that AIRS may be effective in predicting the severity of appendicitis, but the Alvarado scoring is far from effective [17]. For their part, Kose et al. deemed that the effectiveness of clinical evidence-weighted scoring systems is debatable [18]. It was stated that diagnostic scoring systems could not reach the desired level of effectiveness when used in differentiation of severity [19].

Atema et al. used clinical, laboratory and imaging results to differentiate between CAA and UCAA in their scoring system presented in their study. This study included two different models using USG or CT results based on imaging method preferences [13]. The difference in these scoring systems, which are actually similar to each other, is that the presence of free air is also a parameter in imaging in Grp-CT and the score value is given according to CRP levels. A score of 5/19 and below was accepted as significant in the scoring system designed with USG results for UCAA differentiation. In the scoring system designed with CT results, this value was accepted as 6/22 and below because it is an extra parameter [13].

When a new forecasting model is introduced, it should be evaluated in the quality-safety-efficiency triangle. For this reason, it is important to externally validate the model in cohorts with different characteristics, than the cohort with which it was created [20]. Scoring system by Atema et al., on which our study is based, is also created in a limited number of patient groups in a limited area, like many other scoring systems and nomograms. Although statistical significance and internal validation have been performed, such scientific interpretations need to be tested in larger populations and different regions to demonstrate their usability. Geerdink et al. performed external validation of the model using USG results [14]. Our study presented the external validation of both the model using USG results and the model using CT results. In the original study, c-index values were

Tablo 2. Comparison of parameters in uncomplicated acute appendicitis (UCAA) and complicated acute appendicitis (CAA) subgroups when computerized tomography (CT) and ultrasonography (USG) groups were separated

		Group evaluated by CT			Group evaluated by USG		
		UCAA	CAA	p	UCAA	CAA	p
		Mean±sd / n (%)	Mean±sd / n (%)		Mean±sd / n (%)	Mean±sd / n (%)	
Age	<45 years	152 (82.16%)	26 (72.22%)	0.168[x]	140 (82.84%)	23 (65.71%)	0.021[x]
	≥45 years	33 (17.84%)	10 (27.78%)		29 (17.16%)	12 (34.29%)	
Sex	Male	123 (66.49%)	25 (69.44%)	0.730[x]	105 (62.13%)	23 (65.71%)	0.690[x]
	Female	62 (33.51%)	11 (30.56%)		64 (37.87%)	12 (34.29%)	
Appendicolith	(-)	155 (83.78%)	24 (66.67%)	0.017[x]	153 (90.53%)	29 (82.86%)	0.183[x]
	(+)	30 (16.22%)	12 (33.33%)		16 (9.47%)	6 (17.14%)	
Periappendiceal fluid	(-)	153 (82.70%)	8 (22.22%)	<0.001[x]	109 (64.50%)	12 (34.29%)	<0.001[x]
	(+)	32 (17.30%)	28 (77.78%)		60 (35.50%)	23 (65.71%)	
Extra-luminal free air	(-)	185 (100.00%)	28 (77.78%)	<0.001[x]			
	(+)	0 (0.00%)	8 (22.22%)				
Duration of Symptoms ≥48h	(-)	129 (69.73%)	8 (22.22%)	<0.001[x]	117 (69.23%)	10 (28.57%)	<0.001[x]
	(+)	56 (30.27%)	28 (77.78%)		52 (30.77%)	25 (71.43%)	
Body Temp.	≤ 37	139 (75.14%)	15 (41.67%)	<0.001[x]	134 (79.29%)	14 (40.00%)	<0.001[x]
	37.1-37.9	34 (18.38%)	12 (33.33%)		30 (17.75%)	13 (37.14%)	
	≥ 38	12 (6.49%)	9 (25.00%)		5 (2.96%)	8 (22.86%)	
WBC (109/l)	<13	69 (37.30%)	9 (25.00%)	0.158[x]	81 (47.93%)	14 (40.00%)	0.392[x]
	≥13	116 (62.70%)	27 (75.00%)		88 (52.07%)	21 (60.00%)	
CRP (mg/l)		28.72 ± 42.42	109.25 ± 90.69	<0.001[m]	22.34 ± 34.52	60.91 ± 58.14	<0.001[m]
CRP (mg/l)	≤ 50	148 (80.00%)	13 (36.11%)	<0.001[x]	147 (86.98%)	17 (48.57%)	<0.001[x]
	51-100	21 (11.35%)	7 (19.44%)		11 (6.51%)	9 (25.71%)	
	>100	16 (8.65%)	16 (44.44%)		11 (6.51%)	9 (25.71%)	
CT-Score		4.00 ± 2.73	10.33 ± 3.68	<0.001[x]			
CT-Score	≤6	156 (84.32%)	6 (16.67%)	<0.001[x]			
	>6	29 (15.68%)	30 (83.33%)				
USG-Score					3.95 ± 2.73	8.91 ± 3.43	<0.001[x]
USG-Score	≤5				122 (72.19%)	5 (14.29%)	<0.001[x]
	>5				47 (27.81%)	30 (85.71%)	

Table abbreviations: X Chi-Square test, m Mann-Whitney U test , Temp.: Temperature, CRP: c-reactive protein, WBC: leukocyte

Table 3. Univariate and multivariate analysis of the groups evaluated by computerized tomography (CT) and ultrasonography (USG)

	Group evaluated by CT						Group evaluated by USG					
	Univariate Model			Multivariate Model			Univariate Model			Multivariate Model		
	OR	% 95 CI	p	OR	% 95 CI	p	OR	% 95 CI	p	OR	% 95 CI	p
Age	1.014	0.986-1.042	0.337				1.044	1.017-1.071	0.001			
Sex	0.873	0.403-1.889	0.730				0.856	0.399-1.838	0.690			
Body Temperature	3.537	1.988-6.291	<0.001				4.348	2.155 8.775	<0.001			
Appendicolith	2.583	1.166-5.724	0.019				1.978	0.714-5.480	0.189			
Periappendiceal fluid	16.734	6.988-40.073	<0.001				3.482	1.619-7.488	0.001			
Dur. of Symptoms ≥48 h	8.062	3.460-18.789	<0.001	3.140	1.042-9.462	0.042	5.625	2.520-12.554	<0.001	3.513	1.279-9.647	0.015
Leukocyte	1.094	1.005-1.191					1.040	0.951-1.137	0.387			
C-reactive protein	1.019	1.012-1.026	<0.001	0.038			1.018	1.010-1.026	<0.001			
CT-Score	1.781	1.493-2.124	<0.001	1.677	1.388-2.025	<0.001						
USG-Score							1.608	1.385-1.867	<0.001	1.583	1.339-1.873	<0.001

0.82 for the scoring system using USG results and 0.88 for the scoring system using CT results [13]. In the external validation study by Geerdink et al., the c-index values for the scoring system using USG results were 0.83 [14]. In our study, we found the c-index values to be 0.87 for the scoring system using USG results and 0.92 for the scoring system using CT results.

Table 4. ROC Analyses of the groups evaluated by USG and computerized tomography (CT)

	Group evaluated by USG			Group evaluated by CT		
	AUC	95% CI	p	AUC	95% CI	p
USG-Score ≤5	0.790	0.711-0.869	<0.001			
USG-Score	0.867	0.805-0.928	<0.001			
C-reactive protein	0.710	0.610-0.811	<0.001	0.840	0.774-0.906	<0.001
Leukocyte	0.546	0.449-0.643	0.391	0.595	0.495-0.695	
CT-Score ≤6				0.838	0.762-0.915	<0.001
CT-Score				0.923	0.884-0.963	<0.001

Within the score limits specified by Atema et al., the NPV was 94.7% for CAA in Grp-CT and 97.1% for CAA in Grp-USG [13]. In the validation study conducted by Geerdink et al., a NPV of 93.8% was achieved in Grp-USG [14]. In our study, 162 of 222 patients evaluated by CT had a score of 6 or lower, and 6 of them had CAA. The NPV was 96.3%. Of the 204 patients evaluated by USG, 127 had a score of 5 or lower, and 5 of them had CAA. The NPV was 96.1%.

Despite high NPV results, in Grp-USG, 2.5% of patients who had CAA according to the pathological evaluation were misclassified as UCAA and 23.0% of patients who had UCAA according to the pathological evaluation were misclassified as CAA by the scoring system. In Grp-CT, 2.7% of patients who had CAA according to the pathological evaluation were misclassified as UCAA and 13.1% of patients who had UCAA according to the pathological evaluation were misclassified as CAA by the scoring system. Due to the selective design of scoring systems, especially on UCAA patients, the false positive (complicated) rate is high.

In another model presented by Kim et al. to differentiate CAA-UCAA, CT results and percentage of segmented neutrophil were used. This model was considered as effective with AUC of 0.81, NPV of 0.81 [12]. In the scoring systems that formed the basis of our study, clinical, laboratory and radiological results were evaluated together and the effectiveness was found to be higher. We think that adding clinical parameters to the evaluations will result in a more personalized evaluation, without any additional costs. The most important reason why we achieved a higher NPV in this study was that the study in which the scoring was presented and the alternative disease group included in the validation study were not included in our study, since the diagnosis of AA was confirmed pathologically, while the patient groups were being prepared.

In another study, Eddema et al. created a model with logistic regression equation [21]. In a study externally validating this model, it is stated that the scoring system is effective, but this level of effectiveness is close to CRP. Therefore, the usability of this model, which requires an advanced mathematical equation, is not considered to be advantageous [22]. The greatest advantage of the scoring system created by Atema et al., which we used in our study, is that it leads to a decision with a simple calculation and evaluation.

The efficacy of many laboratory results alone in the CAA-UCAA differentiation was evaluated. In a study by Şengül et al., WBC and neutrophil count (NEU) seem to be significant in the diagnosis of CAA [9]. However, in this study, instead of comparing the CAA-UCAA groups, the groups were compared with negative appendectomy. In another study, WBC was found to be effective in diagnosing acute appendicitis, but insufficient in predicting CAA [8]. In our study, we found that WBC did not differ significantly between groups (AUC: 0.549, AUC: 0.595). In the external validation study by Gerrdink et al. [14], we saw that they reached a similar result with AUC of 0.55.

CRP level in CAA-UCAA differentiation was also examined and it was found to be significant as a result [6]. We found it similarly significant and observed that it correlated with the severity of inflammation. Although there are publications

stating that CRP is not sufficient in this differentiation [7].

In our study, we found that the scoring system created with CT had a higher AUC and was more effective compared to the scoring system created with USG. It is a known fact that CT is a more effective method in the diagnosis of AA compared to USG [23]. All of the imaging method parameters used in the scoring systems created in the study by Atema et al. are effective in differentiating CAA and UCAA [13]. Similarly, we observed the effectiveness of many of the parameters in our study. However, there was no significant difference between the CAA-UCAA groups for the "Appendicolith on imaging" parameter in Grp-USG (p=0.183).

Our study has a few limitations. First of all, the data were obtained retrospectively from the hospital data processing system. CT and USG evaluations were performed by different physicians. Results that were not mentioned in the reports were accepted as “nonexistent” because a standard imaging form was not used. Another limitation stems from the definition of CAA. There are publications stating that gangrenous appendicitis is not complicated appendicitis and can be treated like simple appendicitis [24]. In our study, cases that were determined to be gangrenous and perforated as a result of clinical evaluation and pathological examination were accepted as CAA.

Conclusion: Neither radiological imaging nor laboratory results alone can reach the desired level of effectiveness in the differentiation of CAA-UCAA. It would be more accurate to evaluate patients by an integrated approach. We have seen that the scoring systems created for this purpose are more effective compared to all other parameters. Being easily applicable and calculable is the reason for preference for scoring systems in clinical practice. It can be thought that acute appendicitis cases for which conservative treatment is planned can be selected more confidently with the help of these scoring systems. In the CAA-UCAA distinction, the scoring system prepared using CT gives better results than the one prepared using USG.

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REFERENCES

1. Vons C, Barry C, Maitre S, Pautrat K, Leconte M, Costaglioli B, et al. Amoxicillin plus clavulanic acid versus appendicectomy for treatment of acute uncomplicated appendicitis: an open-label, non-inferiority, randomised controlled trial. Lancet. 2011;377(9777):1573-9. PMID: 21550483.
2. Santos D, Ledet CR, Limmer A, Gibson H, Badgwell B. Use of non-operative treatment and interval cholecystectomy for cholecystitis in patients with cancer. Trauma Surg Acute Care Open. 2020;5(1):e000439. PMID: 32420452.
3. Ruffolo C, Fiorot A, Pagura G, Antoniutti M, Massani M, Caratozzolo E, et al. Acute appendicitis: what is the gold standard of treatment? World J Gastroenterol 2013;19(47):8799-807. PMID: 24379603.
4. Gorter RR, Eker HH, Gorter-Stam MA, Abis GS, Acharya A, Ankersmit M, et al. Diagnosis and management of acute appendicitis. EAES consensus development conference 2015. Surg Endosc. 2016;30(11):4668-90. PMID: 27660247.
5. Sallinen V, Akl E, You J, Agarwal A, Shoucair S, Vandvik P, et al. Meta‐analysis of antibiotics versus appendicectomy for non‐perforated acute appendicitis. Br J Surg 2016;103(6):656-67. PMID: 26990957.
6. Parekh D, Jain D, Mohite S, Phalgune D. Comparison of outer diameter of appendix, c-reactive protein, and serum bilirubin levels in complicated versus uncomplicated appendicitis. Indian J Surg. 2020;82(3):314-8. doi: 10.1007/s12262-019-01931-2.
7. Çelik B, Nalcacioglu H, Ozcatal M, Altuner Torun Y. Role of neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio in identifying complicated appendicitis in the pediatric emergency department. Ulus Travma Acil Cerrahi Derg 2019;25(3):222-8. PMID: 31135939.
8. Shin DH, Cho YS, Kim YS, Ahn HC, Oh YT, Park SO, et al. Delta neutrophil index: A reliable marker to differentiate perforated appendicitis from non‐perforated appendicitis in the elderly. J Clin Lab Anal. 2018;32(1):e22177. PMID: 28238210.
9. Sengul S, Guler Y, Calis H, Karabulut Z. The Role of Serum Laboratory Biomarkers for Complicated and Uncomplicated Appendicitis in Adolescents. J Coll Physicians Surg Pak. 2020;30(4):420-4. PMID: 32513365.
10. Bom W, Bolmers M, Gans S, van Rossem C, van Geloven A, Bossuyt P, et al. Discriminating complicated from uncomplicated appendicitis by ultrasound imaging, computed tomography or magnetic resonance imaging: systematic review and meta-analysis of diagnostic accuracy. BJS Open. 2020;5(1):zraa030. PMID: 33688952.
11. Frountzas M, Stergios K, Kopsini D, Schizas D, Kontzoglou K, Toutouzas K. Alvarado or RIPASA score for diagnosis of acute appendicitis? A meta-analysis of randomized trials. Int J Surg. 2018;56:307-14. PMID: 30017607.
12. Kim HY, Park JH, Lee SS, Jeon J-J, Yoon CJ, Lee KH. Differentiation between complicated and uncomplicated appendicitis: diagnostic model development and validation study. Abdom Radiol (NY). 2021;46(3):948-59. PMID: 32914350.
13. Atema JJ, van Rossem CC, Leeuwenburgh MM, Stoker J, Boermeester MA. Scoring system to distinguish uncomplicated from complicated acute appendicitis. Br J Surg. 2015;102(8):979-90. PMID: 25963411.
14. Geerdink T, Augustinus S, Atema J, Jensch S, Vrouenraets B, de Castro S. Validation of a Scoring System to Distinguish Uncomplicated from Complicated Appendicitis. J Surg Res. 2021;258:231-8. PMID: 33038600.

15. Lastunen K, Leppäniemi A, Mentula P. Perforation rate after a diagnosis of uncomplicated appendicitis on CT. BJS open. 2021;5(1):zraa034. PMID: 33609386.

16. Yeh DD, Eid AI, Young KA, Wild J, Kaafarani HM, Ray-Zack M, et al. Multicenter study of the treatment of appendicitis in America: acute, perforated, and gangrenous (MUSTANG), an EAST multicenter study. Ann Surg. 2021;273(3):548-56. PMID: 31663966.

17. Yeşiltaş M, Karakaş DÖ, Gökçek B, Hot S, Eğin S. Can Alvarado and Appendicitis Inflammatory Response scores evaluate the severity of acute appendicitis? Ulus Travma Acil Cerrahi Derg. 2018;24(6):557-62. PMID: 30516256.

18. Köse E, Hasbahçeci M, Aydın MC, Toy C, Saydam T, Özsoy A, et al. Is it beneficial to use clinical scoring systems for acute appendicitis in adults? Ulus Travma Acil Cerrahi Derg. 2019;25(1):12-9. PMID: 30742281.

19. Deiters A, Drozd A, Parikh P, Markert R, Shim JK. Use of the Alvarado score in elderly patients with complicated and uncomplicated appendicitis. Am Surg. 2019;85(4):397-402. PMID: 31043201.

20. Collins GS, de Groot JA, Dutton S, Omar O, Shanyinde M, Tajar A, et al. External validation of multivariable prediction models: a systematic review of methodological conduct and reporting. BMC Med Res Methodol. 2014;14:40. PMID: 24645774.

21. Eddama M, Fragkos K, Renshaw S, Aldridge M, Bough G, Bonthala L, et al. Logistic regression model to predict acute uncomplicated and complicated appendicitis. Ann R Coll Surg Engl. 2019;101(2):107-18. PMID: 30286649.

22. Birben B, Sönmez BM, Er S, Özden S, Kösa MT, Tez M. External validation of the AppendistatTM score and comparison with CRP levels for the prediction of complicated appendicitis. Ulus Travma Acil Cerrahi Derg. 2021;27(2):187-91. PMID: 33630294.

23. Terasawa T, Blackmore CC, Bent S, Kohlwes RJ. Systematic review: computed tomography and ultrasonography to detect acute appendicitis in adults and adolescents. Ann Intern Med. 2004;141(7):537-46. PMID: 15466771.

24. Nordin AB, Diefenbach K, Sales SP, Christensen J, Besner GE, Kenney BD. Gangrenous appendicitis: No longer complicated. J Pediatr Surg. 2019;54(4):718-22. PMID: 30551843.