

# Comparison of major appendicitis scoring systems on the clinical-histopathological correlation

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## Abstract

**Aim:** We aimed to investigate the predictive value of the four most popular scoring systems, such as Modified Alvarado, Raja Isteri Pengiran Anak Saleha Appendicitis, Tzanakis, and Lintula, for histopathologically proven acute, phlegmonous, and gangrenous/perforated appendicitis.

**Materials and Methods:** We retrospectively reviewed the results of 239 patients who underwent appendectomy between 2016 and 2019 in our department. The patients' demographic data, surgery method, histopathological results of the specimens (uncomplicated acute appendicitis, phlegmonous, and gangrenous/perforated appendicitis) were recorded. The predictivity of Modified Alvarado, Raja Isteri Pengiran Anak Saleha Appendicitis, Tzanakis, and Lintula scoring systems according to the histopathological results was compared.

**Results:** The modified Alvarado scoring system showed statistically significant efficacy in the preoperative distinction of acute, phlegmonous, and gangrenous/perforated appendicitis. Although the Raja Isteri Pengiran Anak Saleha Appendicitis and Tzanakis score systems are effective in acute and gangrenous/perforated differentiation, they did not show statistically significant efficacy between acute and phlegmonous appendicitis. The Lintula scoring system was the weakest among the four and did not show statistically significant efficacy in the distinction of all three diagnoses.

**Conclusion:** The diagnosis of acute appendicitis is easier with the use of scoring systems. Scoring systems can also help signal advanced stage and complicated forms of acute appendicitis, such as phlegmonous and gangrenous/perforated appendicitis. The modified Alvarado was the most correlated scoring system with histopathological results.

**Keywords:** Acute appendicitis; modified alvarado; scoring systems

## INTRODUCTION

The preoperative diagnosis of acute appendicitis remains difficult because any patient presenting with an acute abdomen should be assessed for appendicitis, and clinical signs or positive blood results can be absent in 55% of patients (1,2). In recent years, aside from advanced imaging techniques, scoring systems have been developed to facilitate and diagnose acute appendicitis. Scoring systems aim to prevent delay in diagnosis, as a delay or a misdiagnosis of appendicitis can result in severe complications, such as perforation, abscess formation, sepsis, and intra-abdominal adhesions. Another benefit is that they can distinguish complicated from uncomplicated appendicitis preoperatively for definitive treatment (2-6).

In this study, we determined the predictive competence of four scoring systems recommended for the diagnosis of

acute appendicitis in our patient series. In particular, we examined the effectiveness of these four scoring systems in distinguishing between complicated and uncomplicated appendicitis.

## MATERIALS and METHODS

The data of patients who underwent appendectomy for acute appendicitis were scanned retrospectively after the Ethics Committee approval (Date: March 17, 2020, Number: 83045809-604). Two hundred thirty-nine patients operated with the diagnosis of acute appendicitis between 2016 and 2019 in our hospital were included in the study. The demographic data, preoperative symptoms, laboratory findings, imaging findings surgical approaches (open or laparoscopic surgery), intraoperative-postoperative findings and the histopathological results of the patients were recorded. All data were evaluated in terms of the

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Modified Alvarado (MASS), Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA; RSS), Tzanakis (TSS), and Lintula scoring systems (LSS) (Table 1) (7-10). The predictive values of these scoring systems were compared according to the diagnosis of acute appendicitis and the discrimination of disease severity and pathological results (non-complicated acute, phlegmonous, and gangrenous/perforated). This study was approved by the ethics committee of our university.

### Statistical analysis

The mean, standard deviation, median, minimum, and maximum value frequencies and percentages were used for the descriptive statistics. The distribution of variables was checked using the Kolmogorov-Smirnov test. Kruskal-Wallis was used for the comparison of quantitative data. The Chi-square test was used for the comparison of qualitative data. The receiver operating characteristic (ROC) analysis was used to show the effect level. SPSS 26.0 was used for statistical analysis.

**Table 1. Criteries and scores of Modified Alvarado Scoring System, Raja Isteri Pengiran Anak Saleha Appendicitis, Tzanakis, and Lintula scoring systems in the diagnosis of acute appendicitis**

	MASS	RIPASA	Tzanakis	Lintula
<b>Demography</b>				
Female		0.5		
Male		1		2
Age<39.9 years		1		
Age>40 years		0.5		
<b>Symptoms</b>				
Migratory right iliac fossa pain	1	0.5		4
Nausea/Vomiting	1	1		2
Anorexia	1	1		
Right iliac fossa pain		0.5		2
Duration of symptoms<48 hours		1		
Duration of symptoms>48 hours.		0.5		
<b>Signs</b>				
Tenderness in right iliac fossa	2	1	4	4
Rebound tenderness in right iliac fossa	1	1	3	7
Fever > 37°C <39°C	1	1		3
Guarding		2		4
Rovsing sign		2		
Abnormal bowel sounds				4
<b>Laboratory findings</b>				
Leucocytosis	2	1	2	
Negative urine analysis		1		
Screening				
Signs of appendicitis in ultrasound			6	
Additional score				
Foreign nationality		1		
<b>Total</b>	<b>9</b>	<b>16.5</b>	<b>15</b>	<b>32</b>
<b>LPoints≥ 8 acute appendicitis for MASS; Points ≥ 12 for RIPASA; Points≥ 8 for Tzanakis; Points≥ 15 for Lintula</b>				

## RESULTS

Among the 239 patients, 97 were female (40.6%), and 142 were male (59.4%). The mean age of patients was 36.70±14.20 (8-94) years. A total of 26 patients underwent open appendectomy (10.8%), 31 were converted to open surgery from laparoscopy (13%), and 182 underwent laparoscopic appendectomy (76.2%). According to histopathological results, 110 of the cases were reported

as uncomplicated acute appendicitis (AA) (46%), 100 of them phlegmonous (PA) (41.8%), and 29 of gangrene / perforated appendicitis (G / P) (12.2%).

In the AA, PA, and G/P groups, the age and gender distribution of the patients did not differ significantly ( $p>0.05$ ). The mean MASS score of the patients was 5.2±1.5, the RSS score was 7.4±1.4, the TSS was 10.8±3.0, and the LSS was 15.1±5.3 (Table 2).

**Table 2. Demographic characteristics, pre-operative scores and post-operative histopathological results of patients**

Age in years, mean±SD	36.70±14.20
Gender n, (%)	
Female	97 (40.6%)
Male	142 (59.4%)
Pre-operative point of scores, mean±SD	
MASS	5.21±1.52
RIPASA	7.40±1.41
Tzanakis	10.80±3.02
Lintula	15.10±5.30
Histopathological results n, (%)	
Acute Appendicitis	110 (46%)
Phlegmonous	100 (41.8%)
Gangrene-Perforated	29 (12.2%)

The MASS score was significantly higher in the G/P group than in the AA and PA groups. The MASS score was also significantly higher in the PA group than in the AA group. The RSS score was significantly higher in the G/P group than those in the AA and G/P groups. The RSS scores of the patients did not differ significantly in the AA and PA groups. The TSS score was significantly higher in the G/P group than those in the AA and PA groups. The TSS scores of the patients did not differ significantly in the AA and PA groups ( $p>0.05$ ). In the AA, PA, and G/P groups, the LSS score did not show a significant difference (Table 3).

In the AA and G/P groups, the MASS, RSS, and TSS differed significantly. Conversely, the LSS did not differ significantly. In the PA and G/P groups, the MASS, RSS, and TSS differed significantly. Conversely, the LSS did not differ significantly. Only the MASS was statistically significant in the differential diagnosis of non-complicated acute and phlegmonous appendicitis (Table 4).

**Table 3. Comparison of scoring systems according to histopathological results**

	Acute Appendicitis <sup>1</sup>	Phlegmoneus <sup>2</sup>	Gangrene-Perforated <sup>3</sup>	p	post hoc analyzes		
Points of Scoring Systems, mean±SD							
MASS	4.84±1.46 <sup>2,3</sup>	5.33±1.37 <sup>3</sup>	6.00±1.28	<0.001	0.028 <sup>1,2</sup>	<0.001 <sup>1,3</sup>	0.016 <sup>2,3</sup>
RIPASA	7.30±1.52 <sup>3</sup>	7.20±1.29 <sup>3</sup>	8.28±1.24	0.001	0.500 <sup>1,2</sup>	0.001 <sup>1,3</sup>	<0.001 <sup>2,3</sup>
Tzanakis	10.32±3.19 <sup>3</sup>	10.84±2.76 <sup>3</sup>	12.41±2.50	0.006	0.272 <sup>1,2</sup>	0.002 <sup>1,3</sup>	0.011 <sup>2,3</sup>
Lintula	14.43±5.57	15.35±5.41	16.93±3.43	0.101	0.229 <sup>1,2</sup>	0.040 <sup>1,3</sup>	0.213 <sup>2,3</sup>

Kruskal-wallis (Mann-whitney u test)

**Table 4. Comparison of scoring systems in the distinction of acute appendicitis / gangrene-perforated appendicitis and phlegmonous / gangrene-perforated appendicitis**

	AUC	%95 CI	p
Acute Appendicitis / Gangrene-Perforated			
MASS	0.726	0.622 – 0.831	<0.001
RIPASA	0.701	0.596 – 0.805	0.001
Tzanakis	0.687	0.579 – 0.794	0.002
Lintula	0.614	0.499 – 0.724	0.052
Phlegmoneus / Gangrene-Perforated			
MASS	0.644	0.532 – 0.756	0.018
RIPASA	0.724	0.623 – 0.825	<0.001
Tzanakis	0.652	0.536 – 0.769	0.013
Lintula	0.576	0.475 – 0.676	0.216

ROC Analysis

## DISCUSSION

Acute appendicitis is one of the most common surgical emergencies worldwide. The standard treatment of acute appendicitis is surgical appendectomy (11,12). In complicated cases, such as the presence of phlegmon, perforation, or abscess, performing a

curative appendectomy is more difficult because of the heightened inflammatory state and distorted local anatomy. Complications such as surgical site infections, perforations are also seen more than usual after complicated appendicitis surgery (12,13). Therefore, the diagnosis and intervention of the disease at an early stage are very important.

In clinical practice, difficulties may be encountered in the diagnosis of acute appendicitis in young people, older people, and women of reproductive age. Besides, it is also challenging to distinguish uncomplicated and complicated disease preoperatively. Although CT is widely used in the diagnosis of acute appendicitis in most centers, its use is limited, especially due to radiation exposure in children and young patients (14). However, high sensitivity of CT in the diagnosis of acute appendicitis leads to unnecessary operation of simple or early-stage acute appendicitis cases that can be overcome spontaneously or with antibiotics. For this purpose, to diagnose the disease and prediction of complications, scoring systems have been developed by combining clinical findings, laboratory test results, and imaging features (1,3,4,15). In this study, we compared the MASS, RSS, TSS, and LSS, which are the most used scoring systems in the diagnosis and differentiation of complicated–uncomplicated appendicitis.

MASS is a scoring system based on simple clinical examination findings and leukocytosis, which was applied most in practice; it is simple to implement. RSS is a more detailed and complicated system with the evaluation of age, gender, duration of symptoms, and urine test in addition to these clinical and laboratory findings. TSS is a system based on sonographic features in addition to classical clinical and laboratory findings. However, TSS may not count as a standardized scoring system because the sonographic evaluation changes according to the patient, radiologist, stage of the disease, and device. On the other hand, LSS is a system generally used in young and pediatric patients, and the severity of pain is also evaluated (9,16-18).

There are many studies in the literature comparing these different scoring systems according to various parameters. Most of the studies in adults have focused on RSS and MASS. In studies comparing multiple scoring systems similar to our research, the diagnostic performances of the Alvarado scoring system, MASS, and RSS are prominent (9-13,15,19-23). Generally, studies have reported that the MASS and RSS is a good assistant method for the diagnosis of acute appendicitis but that clinical judgment is at the forefront (7,19,20). The LSS, which was developed for the pediatric patient population, has also been shown to be useful for the diagnosis of acute appendicitis in adults (22). In our study, all methods were significant in the diagnosis of acute appendicitis. Moreover, studies have shown that the RSS gives better results in acute appendicitis complications than the Alvarado and MASS (14,21). However, on the distinction between complicated and uncomplicated appendicitis, the effectiveness of scoring systems is limited. Deiters et al. found the Alvarado score to be insufficient in this distinction in their study (24). In the scoring systems considered as diagnostic aids in the diagnosis of acute appendicitis, a combination of imaging methods may also be required, especially in predicting complicated appendicitis (3,25). In our study, all methods except LSS

were predictive for complications such as phlegmonous or gangrenous/perforated appendicitis. However, only MASS was found significant in the phlegmonous and gangrenous/perforated distinctions. Early diagnosis and intervention of acute appendicitis are important as it reduces complication and mortality rates.

Nowadays, all scoring systems are used in diagnosis as an aid to clinical examination and radiological imaging. When scoring systems are combined with clinical experience, radiological imaging (computed tomography) may not be performed. In this way, it can reduce the radiation exposure of patients.

## CONCLUSION

The scoring systems to be effective in the diagnosis of acute appendicitis, and the distinction of complicated and uncomplicated appendicitis in our study. In this way, the operation indication can be determined, or the right operation timing can be planned, the appropriate treatment method or surgical approach to be applied can be decided.

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