

# Can clinical scoring systems overcome the limitations of diagnostic methods for acute appendicitis in pregnancy?

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## ABSTRACT

**BACKGROUND:** Acute appendicitis during pregnancy is the most common indication for non-obstetric emergency surgery. However, physiological changes associated with pregnancy can reduce the sensitivity of its clinical signs and symptoms. This study aimed to compare the diagnostic performance of the Alvarado, Appendicitis Inflammatory Response (AIR), Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA), and Tzanakis scoring systems in pregnant patients, as well as to evaluate surgical outcomes.

**METHODS:** A total of 39 pregnant patients who underwent surgery for acute appendicitis between January 2017 and January 2025 were retrospectively analyzed. Demographic characteristics, gestational age, clinical presentation, laboratory parameters (white blood cell count [WBC], C-reactive protein [CRP]), ultrasonography findings, surgical approach (open vs. laparoscopic), histopathological results, and maternal and fetal outcomes were recorded. Alvarado, AIR, RIPASA, and Tzanakis scores were calculated for each patient. Patients were stratified into risk categories based on established cut-off values from the literature, and diagnostic performance was assessed against histopathological findings.

**RESULTS:** The mean age was  $26.0 \pm 5.3$  years, and the mean gestational age was  $19.6 \pm 7.9$  weeks; 53.8% of patients were in the second trimester. Open appendectomy was performed in 61.5% of cases, while 38.5% underwent laparoscopic appendectomy. High-risk classification rates were 66.7% for Alvarado, 69.2% for AIR, and 79.5% for both RIPASA and Tzanakis scores. Histopathology confirmed acute appendicitis in 66.7% of patients, perforated appendicitis in 15.4%, and a normal appendix in 17.9%. WBC and CRP levels were significantly higher in patients with confirmed appendicitis ( $p < 0.05$ ). The highest sensitivity and specificity were observed with the RIPASA (93.7% and 85.7%, respectively) and Tzanakis (90.6% and 71.4%) scoring systems. Laparoscopic surgery was associated with a shorter hospital stay compared to open surgery ( $p < 0.001$ ), with comparable maternal and fetal safety outcomes.

**CONCLUSION:** Clinical scoring systems are effective and reliable tools for diagnosing acute appendicitis in pregnant patients, with the RIPASA score demonstrating the highest diagnostic accuracy. Elevated CRP levels and leukocytosis may further support diagnosis. Laparoscopic appendectomy is a safe option associated with a shorter hospital stay compared with open surgery. These findings support the safe use of both clinical scoring systems and laparoscopic surgery in pregnant patients.

**Keywords:** Acute appendicitis; pregnancy; RIPASA.

## INTRODUCTION

Abdominal pain accounts for approximately 10% of all emergency department admissions, and acute appendicitis is the most common diagnosis among patients hospitalized with this complaint. Acute appendicitis (AA) is one of the most

frequent general surgical emergencies worldwide, with a lifetime risk of 7–8%.<sup>[1]</sup> Excluding obstetric and gynecological causes, acute appendicitis is the most common condition requiring emergency surgical intervention during pregnancy. Acute appendicitis most commonly occurs in the second and third decades of life, corresponding to the reproduc-

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tive years, and is therefore frequently encountered during pregnancy. The incidence of AA in pregnancy has been reported to range from 1 in 500 to 1 in 2,000 pregnancies.<sup>[2]</sup> Physiological changes during pregnancy may alter the clinical presentation of acute appendicitis, with symptoms and physical examination findings varying according to gestational age. As the uterus enlarges, displacement of the appendix from McBurney's point toward a more superolateral position can further complicate diagnosis. Reported rates of fetal loss are approximately 1.5% in uncomplicated cases but may increase to as high as 36% in cases involving perforation, underscoring the critical importance of early diagnosis and timely treatment in pregnant women.<sup>[3]</sup>

The standard approach to the treatment of acute appendicitis in pregnancy is surgical intervention. However, several reports in the literature suggest that uncomplicated cases may be managed conservatively.<sup>[4,5]</sup> In one study in which 25% of pregnant women diagnosed with uncomplicated acute appendicitis were managed conservatively, the treatment failure rate was reported as 15%, and the rate of recurrence (re-diagnosis during the same gestational period) was 12%.<sup>[6]</sup> Although there is no clear consensus on the optimal surgical technique in pregnant patients, laparoscopic appendectomy has been increasingly recommended in recent years for the treatment of AA during pregnancy. This study aimed to evaluate the clinical findings, diagnostic methods, and scoring

systems used in pregnant women with acute appendicitis at a single center, and to compare open and laparoscopic surgical techniques.

## MATERIALS AND METHODS

A total of 39 pregnant patients who were admitted from the emergency department to our clinic and underwent surgery for acute appendicitis between January 2017 and January 2025 were retrospectively analyzed using the hospital information management system and patient records. All patients were evaluated by the obstetrics clinic prior to surgery to confirm pregnancy status, and fetal assessment was performed postoperatively. The following data were recorded: age, gestational week, presenting symptoms, laboratory parameters, radiological findings, surgical technique (open vs. laparoscopic appendectomy), histopathological results, and maternal and fetal complications. Additionally, the Alvarado score, Appendicitis Inflammatory Response (AIR) score, Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score, and Tzanakis score at admission were calculated for all patients. These scoring systems are summarized in Tables 1 and 2. Patients were stratified into risk groups based on literature-defined cutoff values: >7 for Alvarado, >9 for AIR,  $\geq 7.5$  for RIPASA, and  $\geq 8$  for Tzanakis scores, with values above these thresholds indicating high risk for AA.<sup>[7-9]</sup> All procedures were conducted in accordance with the ethical standards of the

**Table 1.** Alvarado and AIR scoring systems

	Alvarado score		AIR score	
Symptoms and findings (assigned score)	Migration of pain	1	Pain in right lower quadrant	1
	Anorexia	1	Nausea	1
	Nausea	1		
	Right lower quadrant tenderness	2	Rebound	
			Light	1
	Rebound tenderness	1	Moderate	2
			Strong	3
	Elevated temperature	1	Elevated temperature	1
	WBC count	2	WBC count	1
	> 10,000 cells/mcL		10,000–14,900 cells/mcL	
		>15,000 cells/mcL	2	
		PMN: 70–84%	1	
		PMN: >85%	2	
		CRP: 10–49 g/dL	1	
		CRP: >50 g/dL	2	
Total possible score		10		12
Low risk		1–4		0–4
Moderate risk		5–6		5–8
High risk		7–10		9–12

**Table 2.** RIPASA and Tzanakis scoring systems

	RIPASA score		Tzanakis score	
Symptoms and findings (assigned score)	Right lower quadrant pain	0.5	Right lower quadrant tenderness	4
	Migration of pain	0.5	Nausea	1
	Anorexia	1		
	Nausea	1		
	Right lower quadrant			
	Rebound	3		
	Tenderness	1		
	Rebound	1		
	Guarding	2		
	Rovsing's sign	2		
	Elevated temperature	1		
	WBC count >10,000 cells/mcL	1	WBC count >12,000 cells/mcL	2
	Negative urinalysis	1		
	Male	1		
	Female	0.5		
	Age <40 years	1		
	Age >40 years	0.5	Positive ultrasound findings of appendicitis	6
	Duration of symptoms			
	<48 hours	1		
	>48 hours	0.5		
Foreign national	1			
Total possible score	16	15		
Low risk	<7.5	<8		
High risk	≥ 7.5	≥8		

RIPASA: Raja Isteri Pengiran Anak Saleha Appendicitis

institutional and national research committees, as well as the 1964 Declaration of Helsinki and its subsequent amendments. Ethical approval was obtained from the This study was approved by the Gülhane Training and Research Hospital Local Ethics Committee (Date: 31.08.2023, Decision no: 2023/192).

### Statistical Analysis

Descriptive statistics were presented as numbers, percentages, mean  $\pm$  standard deviation, and median (interquartile range). After assessing normality of distribution, continuous variables with normal distribution (age, gestational week, length of hospital stay, white blood cell count [WBC], and Alvarado, AIR, RIPASA, and Tzanakis scores) were compared between groups using the Student's t-test. Continuous variables with non-normal distribution (C-reactive protein [CRP]) were analyzed using the Mann-Whitney U test. Nominal data were compared using the chi-square test or Fisher's exact test. For diagnostic performance evaluation, conventional cutoff values reported in the literature were

used. A 2×2 table was constructed based on histopathological confirmation of acute appendicitis. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated and expressed as percentages. Receiver operating characteristic (ROC) curve analysis was not performed due to the limited sample size. A p value <0.05 was considered statistically significant. All analyses were conducted using IBM SPSS Statistics® version 25 (IBM Corporation, 1 New Orchard Road, Armonk, New York, United States).

## RESULTS

The mean age of the 39 patients included in the study was 26.0±5.3 years (range: 18–39 years). Regarding gestational age, 28.2% of patients were in the first trimester, 53.8% in the second trimester, and 17.9% in the third trimester. Open appendectomy was performed in 61.5% of patients, while 38.5% underwent laparoscopic appendectomy. The mean length of hospital stay was 2.8±1.2 days (range: 1–6 days).

**Table 3.** Descriptive characteristics of the patients

	n (%)
Age (years)	26.0±5.3
Gestational week	19.6±7.9
Trimester	
I	11 (28.2)
II	21 (53.8)
III	7 (17.9)
Positive ultrasound findings	19 (48.7)
Surgical technique	
Open appendectomy	24 (61.5)
Laparoscopic appendectomy	15 (38.5)
WBC (×10 <sup>9</sup> /L)	15.2±3.0
CRP (mg/dL)	42 (18-122)
Length of hospital stay (days)	2.8±1.2
Maternal complications	11 (28.2)
Surgical site infection	11 (100.0)
Preterm delivery	1 (2.6)
Alvarado score	6.9±1.4
Low	4 (10.3)
Moderate	9 (23.1)
High	26 (66.7)
AIR score	8.5±2.1
Low	2 (5.1)
Moderate	10 (25.6)
High	27 (69.2)
RIPASA score	10.0±2.7
Low	8 (20.5)
High	31 (79.5)
Tzanakis score	9.7±2.6
Low	8 (20.5)
High	31 (79.5)
Pathology	
Appendicitis	26 (66.7)
Perforated appendicitis	6 (15.4)
Normal appendix	7 (17.9)
Neoplasia	0

\*Mean ± standard deviation (SD); \*\*Median (min-max). WBC: White blood cell count; CRP: C-reactive protein; AIR: Appendicitis Inflammatory Response; RIPASA: Raja Isteri Pengiran Anak Saleha Appendicitis.

Maternal complications were observed in 11 patients, all of which were wound infections. Preterm labor occurred in one patient. According to clinical scoring systems, 66.7% of patients were classified as high risk for acute appendicitis based on the Alvarado score, 69.2% based on the AIR score, and 79.5% based on both the RIPASA and Tzanakis scores. His-

topathological examination revealed a normal appendix in 17.9% of cases, acute appendicitis in 66.7%, and perforated appendicitis in 15.4% (Table 3).

According to histopathological findings, cases were categorized into two groups: histopathology-confirmed acute appendicitis (n=32) and normal appendix (n=7). WBC (p=0.032) and CRP (p=0.004) levels were higher in the acute appendicitis group. All maternal complications occurred in the acute appendicitis group; however, this difference did not reach statistical significance due to the small sample size. The Alvarado (p=0.033), AIR (p=0.001), RIPASA (p=0.004), and Tzanakis (p=0.003) scores were also higher in the acute appendicitis group. No significant differences were observed between groups with respect to other variables (Table 4).

The diagnostic performance of the scoring systems for histopathologically confirmed AA was evaluated. The Alvarado score demonstrated a sensitivity of 71.8% and specificity of 57.1%. The AIR score showed 81.2% sensitivity and 85.7% specificity, while the RIPASA score demonstrated 93.7% sensitivity and 85.7% specificity. The Tzanakis score yielded 90.6% sensitivity and 71.4% specificity. The highest accuracy rates were observed with the RIPASA (92.3%) and Tzanakis (87.1%) scores, whereas the Alvarado score had a lower accuracy (69.2%) (Table 5).

A comparison between patients who underwent open and laparoscopic appendectomy revealed that the length of hospital stay was significantly longer in the open appendectomy group (p<0.001), while AIR scores were lower in this group (p=0.038). Although the maternal complication rate was higher (37.5%) in the open appendectomy group compared to the laparoscopic group (13.3%), this difference was not statistically significant. No differences were found between the open and laparoscopic groups in terms of other clinical and demographic characteristics, Alvarado, RIPASA, and Tzanakis scores, or histopathological outcomes (Table 5 and 6).

## DISCUSSION

Acute appendicitis is the most common non-obstetric surgical condition encountered during pregnancy. Although the diagnosis is primarily based on clinical findings, it can be challenging due to the physiological changes associated with pregnancy. Pregnant women with acute appendicitis are often initially admitted to obstetrics and gynecology clinics, where pregnancy-related conditions are primarily considered, potentially complicating the diagnosis.<sup>[10]</sup> Previous studies have reported that acute appendicitis is more common in pregnant women aged 20–30 years. In the present study, the mean age of patients diagnosed with acute appendicitis was 25.8 years (range: 18–39), consistent with the literature. Similarly, in line with reports indicating that appendicitis occurs most frequently during the second trimester, 53.1% of cases in our cohort were observed in this period.<sup>[11]</sup>

Baer et al.<sup>[12]</sup> demonstrated that, as the uterus enlarges in

**Table 4.** Comparison of patients according to histopathological findings

	Acute appendicitis (+) (n=32) n (%)	Normal appendix (-) (n=7) n (%)	p
Age	25.8±5.7	27.0±3.6	0.605 <sup>+</sup>
Gestational week	19.6±8.2	19.2±7.4	0.906 <sup>+</sup>
Trimester			0.566 <sup>++</sup>
I	10 (31.2)	1 (14.3)	
II	17 (53.1)	4 (57.1)	
III	5 (15.6)	2 (28.6)	
Positive ultrasound findings	17 (53.1)	2 (28.6)	0.407 <sup>+++</sup>
Surgical technique			0.216 <sup>+++</sup>
Open appendectomy	18 (56.2)	6 (85.7)	
Laparoscopic appendectomy	14 (43.8)	1 (14.3)	
WBC (×10 <sup>9</sup> /L)	15.7±3.1	13.0±1.3	<b>0.032<sup>+</sup></b>
CRP (mg/dL)	47.5 (18-122)	26 (18-41)	<b>0.004<sup>++++</sup></b>
Length of hospital stay (days)	2.9±1.2	2.2±0.7	0.201 <sup>+</sup>
Maternal complications	11 (34.4)	0	0.159 <sup>+++</sup>
Preterm delivery	1 (3.1)	0	0.821 <sup>+++</sup>
Alvarado score	7.1±1.3	5.8±1.5	<b>0.033<sup>+</sup></b>
Low	2 (6.2)	2 (28.6)	
Moderate	7 (21.9)	2 (28.6)	
High	23 (71.9)	3 (42.9)	
AIR score	9.0±1.7	6.2±2.0	<b>0.001<sup>+</sup></b>
Low	1 (3.1)	1 (14.3)	
Moderate	5 (15.6)	5 (71.4)	
High	26 (81.2)	1 (14.3)	
RIPASA score	10.6±2.4	7.5±2.2	<b>0.004<sup>+</sup></b>
Low	2 (6.2)	6 (85.7)	
High score	30 (93.8)	1 (14.3)	
Tzanakis	10.3±2.5	7.1±0.6	<b>0.003<sup>+</sup></b>
Low	3 (9.4)	5 (71.4)	
High	29 (90.6)	2 (28.6)	

\*Mean ± standard deviation (SD); \*\*Median (min-max). WBC: White blood cell count; CRP: C-reactive protein; AIR: Appendicitis Inflammatory Response; RIPASA: Raja Isteri Pengiran Anak Saleha Appendicitis. <sup>+</sup>Student's t-test; <sup>++</sup>Chi-square test; <sup>+++</sup>Fisher's exact test; <sup>++++</sup>Mann-Whitney U test.

**Table 5.** Diagnostic performance of scoring systems for acute appendicitis

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Alvarado	71.8	57.1	88.4	30.7	69.2
AIR	81.2	85.7	96.3	50.0	82.0
RIPASA	93.7	85.7	96.7	75.0	92.3
Tzanakis	90.6	71.4	93.5	62.5	87.1

AIR: Appendicitis Inflammatory Response; RIPASA: Raja Isteri Pengiran Anak Saleha Appendicitis; PPV: Positive predictive value; NPV: Negative predictive value.

**Table 6.** Comparison of patients undergoing open and laparoscopic appendectomy

	Open (n=24) n (%)	Laparoscopic (n=15) n (%)	p
Age	26.2±4.9	25.7±6.2	0.793 <sup>+</sup>
Gestational week	20.9±8.6	17.5±6.4	0.202 <sup>+</sup>
Trimester			0.345 <sup>++</sup>
I	6 (25.0)	5 (33.3)	
II	12 (50.0)	9 (60.0)	
III	6 (25.0)	1 (6.7)	
Positive ultrasound findings	10 (41.7)	9 (60.0)	0.265 <sup>++</sup>
WBC (×10 <sup>9</sup> /L)	15.0±2.8	15.5±3.4	0.639 <sup>+</sup>
CRP (mg/dL)	40.5 (18-116)	51 (18-122)	0.773 <sup>+++</sup>
Length of hospital stay (days)	3.3±1.1	2.0±0.7	<0.001 <sup>+</sup>
Maternal complications	9 (37.5)	2 (13.3)	0.150 <sup>++</sup>
Preterm delivery	1 (4.2)	0	0.615 <sup>++</sup>
Alvarado score	6.7±1.7	7.2±0.8	0.193 <sup>+</sup>
Low	4 (16.7)	0	
Moderate	5 (20.8)	4 (26.7)	
High	15 (62.5)	11 (73.3)	
AIR score	8.1±2.5	9.3±0.8	0.038 <sup>+</sup>
Low	2 (8.3)	0	
Moderate	9 (37.5)	1 (6.7)	
High	13 (54.2)	14 (93.3)	
RIPASA score	9.7±2.8	10.6±2.3	0.346 <sup>+</sup>
Low	7 (29.2)	1 (6.7)	
High	17 (70.8)	14 (93.3)	
Tzanakis score	9.4±2.7	10.2±2.3	0.397 <sup>+</sup>
Low	7 (29.2)	1 (6.7)	
High	17 (70.8)	14 (93.3)	
Pathology			0.294 <sup>++</sup>
Appendicitis	14 (58.3)	12 (80.0)	
Perforated appendicitis	4 (16.7)	2 (13.3)	
Normal appendix	6 (25.0)	1 (6.7)	

\*Mean ± standard deviation (SD); \*\*Median (min-max). WBC: White blood cell count; CRP: C-reactive protein; AIR: Appendicitis Inflammatory Response; RIPASA: Raja Isteri Pengiran Anak Saleha Appendicitis. <sup>+</sup>Student's t-test; <sup>++</sup>Chi-square test; <sup>+++</sup>Mann-Whitney U test.

later stages of pregnancy, the appendix is displaced in a superolateral direction. This positional change may result in abdominal pain occurring outside the right lower quadrant, thereby complicating the clinical diagnosis of acute appendicitis. Additionally, the increased distance between the appendix and the anterior abdominal wall during pregnancy may reduce the prominence of rebound and guarding, further limiting the reliability of physical examination findings.<sup>[13]</sup> Despite

changes in pain localization during pregnancy, Burcu et al.<sup>[14]</sup> reported that abdominal pain continues to be the predominant complaint among pregnant patients with acute appendicitis. Although ultrasonography is the most commonly used imaging modality for diagnosing AA in the general population, a meta-analysis including 1,593 patients reported sensitivity and specificity of 77.6% and 75.3%, respectively, in pregnant women. While the sensitivity of ultrasonography for diag-

nosing appendicitis in the non-pregnant population is 86%, it gradually decreases during pregnancy, reaching as low as 50% in the third trimester, highlighting the increased difficulty of diagnosing acute appendicitis in pregnant patients.<sup>[15]</sup> In our study, the sensitivity of ultrasonography for detecting acute appendicitis in pregnant patients was 53.1%. Considering that 71.3% of the patients were in the second and third trimesters, when ultrasonographic sensitivity is known to decline, these findings are consistent with the literature.

Studies have shown that leukocytosis during pregnancy results from an increase in the number of neutrophils in the bloodstream, particularly in the second trimester, when levels may reach approximately 15,000 cells/mm<sup>3</sup>.<sup>[16]</sup> Since this physiological leukocytosis cannot be distinguished from that seen in acute appendicitis, the diagnosis becomes more challenging in the pregnant population. Although some studies report that leukocytosis is not a reliable marker during pregnancy, others suggest that it contributes to the diagnosis of appendicitis in pregnant women.<sup>[17]</sup> Peksoz et al.<sup>[18]</sup> reported that WBC is a sensitive laboratory marker for diagnosing acute appendicitis during pregnancy and for identifying complicated cases. While many studies have demonstrated the high sensitivity of WBC in diagnosing acute appendicitis during pregnancy, some recommend its combined use with neutrophil and lymphocyte levels rather than as a standalone marker due to its low specificity.<sup>[19]</sup> In our study, the mean leukocyte level in pregnant patients with histopathologically confirmed acute appendicitis (15,700 cells/mm<sup>3</sup>) was significantly higher than in those without appendicitis (13,000 cells/mm<sup>3</sup>). In our study, the significantly higher leukocyte levels observed in patients with appendicitis, together with the fact that 84.3% of patients were in the first and second trimesters, may explain the reduced sensitivity of leukocytosis, particularly in the later weeks of pregnancy.

C-reactive protein is another commonly used laboratory parameter in the evaluation of suspected acute appendicitis. However, as pregnancy is characterized by low-grade systemic inflammation and an associated immune response, the diagnostic value of acute-phase reactants may be limited during this period. Several studies have reported that CRP levels are higher in healthy pregnant women compared to the non-pregnant population.<sup>[20]</sup> Conversely, Sezıkil et al.<sup>[21]</sup> reported that CRP levels were significantly higher in pregnant women diagnosed with AA compared to healthy pregnant women. In our study, the significantly elevated CRP levels in pregnant women with histopathologically confirmed AA support its potential contribution to diagnosis in this patient group.

The diagnostic process is further complicated by imaging limitations. Increased uterine volume during pregnancy reduces the sensitivity of ultrasonography, while computed tomography is generally avoided due to concerns regarding teratogenic effects. Lehnert et al.<sup>[22]</sup> evaluated 99 pregnant patients with suspected AA in the second and third trimesters and reported that the appendix could not be visualized by ultraso-

nography in 97% of cases, indicating limited diagnostic utility in this population. In pregnant patients in whom the appendix cannot be evaluated by ultrasonography, computed tomography and magnetic resonance imaging (MRI), which have similar sensitivity and specificity, are recommended; however, the rate of non-visualization of the appendix on MRI has been reported to increase to as high as 43% due to anatomical changes in the later stages of pregnancy.<sup>[23]</sup> In our study, the appendix could not be visualized on ultrasonography in 51.3% of pregnant patients with suspected acute appendicitis, and only 53.1% of patients with pathologically confirmed appendicitis demonstrated positive ultrasonographic findings. Although the diagnostic contribution of ultrasonography in our study was higher than that reported in some previous studies in the literature, the inability to detect appendicitis in 46.9% of patients with a condition requiring emergency surgery suggests that ultrasonography alone is insufficient as a diagnostic modality. These factors make the diagnosis of acute appendicitis in pregnant women more complex and difficult compared to the non-pregnant population. In this context, clinical scoring systems may serve as useful adjuncts in the diagnostic process.

Various scoring systems have been developed for the diagnosis of acute appendicitis. Kularatna et al.<sup>[24]</sup> compared these systems and reported that the AIR score had the highest diagnostic performance, with 92% sensitivity and 63% specificity. The Alvarado score, the most well-known scoring system, demonstrated high sensitivity (99%) but relatively low specificity. Therefore, it has been suggested that it may help shorten waiting times in the emergency department and reduce unnecessary computed tomography use in patients with suspected acute appendicitis.<sup>[25]</sup> Several studies comparing the AIR and Alvarado scores have reported that the AIR score performs better than the Alvarado score.<sup>[26]</sup> In a meta-analysis including 12 studies and 2,161 patients, the RIPASA score showed higher sensitivity than the Alvarado score.<sup>[27]</sup> Similarly, a prospective study of 300 patients found the RIPASA score to be superior to the Alvarado score in terms of accuracy, sensitivity, and specificity for the diagnosis of acute appendicitis.<sup>[28]</sup> Another meta-analysis including 14 studies and 2,235 patients reported that the Tzanakis scoring system demonstrated higher sensitivity than the Alvarado score.<sup>[29]</sup> Although several studies in the literature have compared the diagnostic performance of these scoring systems or evaluated them in specific populations, such as pediatric patients, data on their use in pregnant populations are limited. In the present study, commonly used clinical scoring systems were compared to assess their contribution to diagnosis in pregnant patients, a group in which conventional diagnostic methods have notable limitations.

In our study, the Alvarado, AIR, RIPASA, and Tzanakis scores were significantly higher in pregnant patients with pathologically confirmed appendicitis compared to those without appendicitis. In a study by Mantoglu et al.<sup>[9]</sup> comparing nine

scoring systems, the RIPASA score demonstrated the best performance in pregnant women, followed by the AIR and Tzanakis scores. Similarly, in our study, the RIPASA score showed the highest diagnostic performance, while the Tzanakis and AIR scores ranked second and third, respectively. Consistent with the findings of Bardakçi et al.,<sup>[30]</sup> our results showed that the AIR score performed better than the Alvarado score in pregnant patients with acute appendicitis, with the Alvarado score demonstrating the lowest diagnostic performance. This observation is also supported by Çomçali et al.,<sup>[31]</sup> who reported the superiority of the Tzanakis score over the Alvarado score in diagnosing acute appendicitis in this population. Although some studies have reported higher sensitivity and specificity of the Alvarado score in pregnant patients with acute appendicitis, its diagnostic accuracy appears to be higher in the first trimester and decreases in later trimesters; this variation may be related to differences in gestational age among study populations.<sup>[32]</sup> In another study comparing diagnostic imaging with the AIR score in pregnant patients, the sensitivity of imaging methods was reported as 47%, whereas the AIR score demonstrated a sensitivity of 97%.<sup>[33]</sup> In another study evaluating the clinical scores of 180 pregnant patients who underwent MRI for suspected AA, the sensitivity of MRI was found to be higher than that of the Alvarado, Tzanakis, RIPASA, and AIR scoring systems. In that study, scoring systems yielded false-negative results in up to 84% of pregnant women diagnosed with acute appendicitis. However, considering that these patients had inconclusive clinical findings, could not be diagnosed by ultrasonography, and subsequently underwent MRI, the relatively low diagnostic performance of the scoring systems in this group is expected.<sup>[34]</sup>

Although some studies recommend conservative management in selected cases of acute appendicitis during pregnancy, the standard approach remains surgical treatment.<sup>[5]</sup> While laparoscopic surgery has become the standard approach in the general population, its use during pregnancy is controversial. Although some studies have associated laparoscopic surgery with an increased risk of fetal loss, many others have reported no significant difference between laparoscopic and open surgery in pregnant women in terms of surgical complications and obstetric outcomes.<sup>[35]</sup> In our study, no fetal loss was observed, and no significant difference was found between laparoscopic and open appendectomy in terms of preterm labor. However, the length of hospital stay was significantly shorter in patients who underwent laparoscopic appendectomy compared to those who underwent open surgery. This finding is consistent with a meta-analysis including 22 studies and 4,694 cases of appendicitis in pregnancy, which reported that laparoscopic surgery was associated with shorter hospital stay and lower rates of wound infection compared to open surgery.<sup>[36]</sup> In our study, no significant difference was found between the laparoscopic and open surgery groups in terms of maternal complications, including wound infection. Despite ongoing debate, current evidence

from the literature, together with our findings, suggests that laparoscopic surgery maintains its advantages in both the general and pregnant population and can be used safely. This should be taken into consideration by clinicians when selecting surgical techniques in pregnant patients.

Our study has several limitations, including a small sample size and a retrospective design.

## CONCLUSION

The findings of our study indicate that clinical scoring systems are effective tools in the diagnosis of acute appendicitis in pregnant women, with the RIPASA score demonstrating higher sensitivity and specificity compared to other scoring systems. Additionally, elevated CRP levels and leukocytosis may contribute to the diagnostic process in this population. While laparoscopic appendectomy is associated with a shorter hospital stay compared to open surgery, it demonstrates a similar safety profile in terms of obstetric and surgical complications. These results support the safe and appropriate use of both clinical scoring systems and laparoscopic surgery in pregnant patients with suspected appendicitis. Further large-scale, prospective, and more homogeneous studies are needed to clarify remaining uncertainties and guide clinical decision-making.

**Ethics Committee Approval:** This study was approved by the Gülhane Training and Research Hospital Ethics Committee (Date: 31.08.2023, Decision No: 2023/192).

**Peer-review:** Externally peer-reviewed.

**Informed Consent:** Retrospective study.

**Authorship Contributions:** Concept: M.Ö., M.M.H.; Design: M.Ö., M.M.H.; Supervision: M.Ö., M.M.H.; Resource: M.Ö.; Materials: M.Ö.; Data collection and/or processing: M.M.H.; Analysis and/or interpretation: M.M.H.; Literature review: M.M.H.; Writing: M.Ö.; Critical review: M.Ö., M.M.H.

**Conflict of Interest:** None declared.

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ORİJİNAL ÇALIŞMA - ÖZ

## Gebelikte akut apandisit tanı yöntemlerinin kısıtlılıkları klinik skorlama sistemleri ile aşılabilir mi?

**AMAÇ:** Gebelikte akut apandisit, obstetrik patolojiler dışında en sık acil cerrahi nedenidir. Gebelikteki fizyolojik değişimler akut apandisit semptom ve bulgularının duyarlılığını azaltmaktadır. Bu çalışmanın amacı, gebe hastalarda Alvarado, Appendicitis Inflammatory Response (AIR), Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) ve Tzanakis skorlama sistemlerinin etkinliğini karşılaştırmak ve cerrahi tekniklerin sonuçlarını değerlendirmektir.

**GEREÇ VE YÖNTEM:** Ocak 2017-Ocak 2025 tarihleri arasında, akut apandisit tanısı ile ameliyat edilen 39 gebe hasta retrospektif olarak incelendi. Hastaların demografik verileri, gestasyonel haftaları, semptom ve bulguları, laboratuvar parametreleri (WBC, CRP), ultrasonografi bulguları, uygulanan cerrahi teknikler (açık/laparoskopik), histopatolojik sonuçlar, maternal ve fetal komplikasyonlar kaydedildi. Alvarado, AIR, RIPASA ve Tzanakis skorları hesaplanarak hastalar literatürde belirlenen kestirim değerlerine göre risk gruplarına ayrıldı ve histopatolojik tanı ile karşılaştırıldı.

**BULGULAR:** Hastaların yaş ortalaması  $26.0 \pm 5.3$  yıl, gestasyonel haftaları  $19.6 \pm 7.9$  idi; %53.8'i II. trimesterdeydi. Hastaların %61.5'ine açık apendektomi, %38.5'ine laparoskopik apendektomi yapıldı. Hastaların Alvarado skoruna göre %66.7'si, AIR skoruna göre %69.2'si, RIPASA ve Tzanakis skorlarına göre %79.5'i yüksek risk grubundaydı. Histopatolojik olarak olguların %66.7'si akut apandisit, %15.4'ü perforasyonlu apandisit, %17.9'u normal apandiks olarak değerlendirildi. Akut apandisit tanılı hastalarda WBC ve CRP düzeyleri anlamlı şekilde yüksek bulundu ( $p < 0.05$ ). Skorlama sistemlerinin duyarlılık ve özgüllük oranları RIPASA (%93.7 ve %85.7) ve Tzanakis (%90.6 ve %71.4) skorlarında en yüksek olarak izlendi. Laparoskopik cerrahi, açık cerrahiye kıyasla daha kısa hastanede kalış süresi sağladı ( $p < 0.001$ ) ve maternal/fetal komplikasyonlar açısından benzer güvenlik profiline sahipti.

**SONUÇ:** Gebelerde akut apandisit tanısında klinik skorlama sistemleri etkin ve güvenilir bir araçtır; RIPASA skoru en yüksek tanısal performansı göstermektedir. CRP yüksekliği ve lökositoz, tanıya katkı sağlayabilir. Laparoskopik apendektomi, açık cerrahiye kıyasla kısa hastanede kalış süresi ile güvenli bir seçenektir. Bu bulgular, gebe hastalarda hem klinik skorlama sistemlerinin hem de laparoskopik cerrahinin güvenle kullanılabileceğini desteklemektedir.

**Anahtar sözcükler:** Akut apandisit; gebelik; RIPASA.

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