Is There Need a Specific Scoring System for Acute Appendicitis During Pregnancy?

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Abstract

Background

Acute appendicitis is the most common non-gynecological emergency during pregnancy. The diagnosis of appendicitis during pregnancy is challenging due to both physiological and laboratory changes. As such, the surgeon needs additional guidance, other than imaging methods, before deciding a surgical intervention. Various scoring methods have been defined and evaluated for the diagnosis of acute appendicitis for a long time. There is no definition of a score for the gestation period, and the comparison of the currently applied scoring methods during the gestation period is not available in the literature.

The purpose of our study is to evaluate the efficacy of the most popular scoring systems applied in the diagnosis of acute appendicitis in pregnancy and the tips for introduction to a scoring method for the pregnancy period.

Methods

This single-center retrospective study consists of 79 pregnant patients who were admitted to the emergency department with abdominal pain between May 2014, May 2019 and were diagnosed with acute appendicitis and underwent an appendectomy together with 79 non-pregnant control group who underwent appendectomy for the last 1.5 years. Both laboratory and examination findings required for the scoring methods of the patients were obtained and calculated separately for each patient. Negative appendectomy rates were evaluated according to pathology results. Categorical variables were compared by the Chi-Square test. Categorical variables were presented as a count and percentage. A p-value <0.05 was considered significant. Receiver operator characteristic (ROC) curve analysis was used to identify the best cut-off value and assess the performance of the test score for appendicitis.

Results

The Tzanakis Score is the strongest among the scoring systems used in non-pregnant women. The positive predictive value (PPV = 90.60) of the Tzanakis Score is 90.6% while the negative predictive value (NPV = 46.7) is 46.7%. RIPASA seems to be the strongest among the scoring systems used in pregnant women. While PPV of this scoring method is 94.40%, NPV is 44%, its sensitivity and specificity are 78.46% and 78.57%, respectively.

Conclusions

Although the RIPASA score is considerable effective in pregnancy in the diagnosis of acute appendicitis among all scoring systems, a specific scoring system is necessitated for the gestation period.

Background

Acute appendicitis is the most common cause of non-obstetric emergency surgery in pregnant women. Appendicitis known to occur once in every 1,500 pregnant women (1). Besides, negative appendectomy rates in females of reproductive age reported at values reaching 26% (2). The differential diagnosis of acute abdominal pain during pregnancy is more complicated than a regular physiological patient in many aspects. In addition to symptoms such as nausea, vomiting, and abdominal pain that occurs during pregnancy, physiologically increasing white blood cell (WBC) count and limited radiological methods make the diagnosis of acute appendicitis complicated during pregnancy (3–5). It is unfortunately not possible to reset the negative appendectomy rate despite all the tests, whether pregnant or not (6–10). High suspicion in diagnosis is important, the delay that will occur causes both maternal (< 1–4%) and fetal (1.5–35%) mortality due to appendix perforation (11). In the diagnosis of appendicitis, the main object is permanent to reduce negative appendicitis rates, avoid perforation, and to protect the patient from unnecessary surgical intervention, moreover for this purpose, various scoring methods described in addition to imaging methods, clinical findings and laboratory correlation (12–20). This study aims to evaluate the extent to which of these scoring methods can support us in the diagnosis of appendicitis in pregnancy.

Methods

This study consists of 79 pregnant patients who were admitted to Sakarya University Faculty of Medicine with abdominal pain between May 2014 and May 2019 and were diagnosed with acute appendicitis and underwent appendectomy and 79 non-pregnant control group who underwent appendectomy for the last 1.5 years. In the control group; patients under the age of 20 and older than 45 and those with chronic co-morbid diseases (i.e. hypertension, Diabetes Mellitus, chronic renal failure or chronic pulmonary disease) were excluded. All pregnant patients were examined by the obstetrician both before and after surgery. The laboratory and examination findings required for the scoring methods of the patients were obtained separately for each patient, including formulas were written for each scoring method in the Excel file, furthermore, the results of each score calculated by entering the data. The patients' pain related data were evaluated using the VAS score. Negative appendectomy rates were evaluated according to pathology results. The ethics committee approval of our study was provided by the ethics committee of our university.

Statistical Analysis

Descriptive analyses were performed to provide information on general characteristics of the study population. Kolmogorov-Smirnov test was used to evaluate whether the distributions of numerical variables were normal. Accordingly, either independent sample t test or Mann Whitney U test were used to compare the numeric variables between pregnant and non-pregnant. The numeric variables were presented as mean ± standard deviation or median [interquartile range]. Categorical variables were compared by Chi-Square test. Categorical variables were presented as a count and percentage. A p-value < 0.05 was considered significant. Receiver operator characteristic (ROC) curve analysis was used to identify the best cut-off value and assess the performance of test score for appendicitis. Analyses were performed using SPSS statistical software (IBM SPSS Statistics, Version 22.0. Armonk, NY: IBM Corp.)

Results

The median age in pregnant and non-pregnant groups is 28 [6] and 26 [10]. WBC values are 14.07 ± 4.5, 13.43 ± 4.5 and CRP values are 16.2 [55.03], 7.64 [41, 69] respectively. The left shift in the neutrophil count was statistically significant in the pregnant group compared to the non-pregnant group, and the data were 47 (59.5%) and 23 (29.1%) < 0.001, respectively also total bilirubin values were statistically high in the non-pregnant group 0.47 [0.33] 0.59 [0.75] p < 0,001. (Table 1) When evaluation made according to the pathology results, 65 (82.3%) appendicitis encountered in the pregnant group, 14 (17.7%) patients were not appendicitis, and these consequences were similar in the non-pregnant group, and 66 (83.5%), 13 (16.5%) respectively. When the severity of pain between the groups evaluated, the moderate pain prominent in the non-pregnant group, 54 (68.4%), the high degree of pain was prominent in the pregnant group 57 (72.2%), and statistically significant < 0.001. While there is a difference in the spread of pain from umbilicus in favor of the pregnant group, both groups show similar findings in terms of nausea, vomiting, and anorexia. Pregnant patients applied to the hospital in less than 24 hours from the onset of symptoms. Besides, in the examination of this patient group, the guarding and rebound were statistically significantly higher than the other group. (Table 2)

Table 1 Distribution of features related to pregnant and non-pregnant women.

Variable	Pregnent (n = 79)	Non-pregnant (n = 79)	p Value	Effect Size *
Neutrophil	10,6 [5, 6]	10 [5, 7]	0,559	-0,046
MPV*	7,96 ± 1,49	8,74 ± 1,48	0,001	-0,524
Total bilirubin	0,47 [0, 33]	0,59 [0, 75]	< 0,001	-0,324
Age	28 [6]	26 [10]	0,236	-0,094
CRP**	16,2 [55, 03]	7,64 [41, 69]	0,28	-0,175
WBC***	14,07 ± 4,5	13,43 ± 4,5	0,376	0,141
PMN**** Ratio	81,8 [12, 2]	78,6 [11, 8]	0,078	-0,140
*MPV: mean platelet volume, ** C-reactive protein, *** White blood count,				
****polymorphonuclear leukocyte				

Table 2 Distribution of features related to pregnant and non-pregnant women.

Variable	Pregnant	Non-pregnant	P value	Effect Size *
Pathology				
Appendicitis	65 (%82,3)	66 (%83,5)	1	-0,17
Non-Appendicitis	14 (%17,7)	13 (%16,5)		
USG Appendicitis				
Positive	57 (%72,2)	38 (%48,1)	0,002	0,246
Negative	22 (%27,8)	41 (%51,9)		
Pain Severity				
Mild	1 (%1,3)	17 (%21,5)	< 0,001	0,691
Moderate	21 (%26,6)	54 (%68,4)		
High	57 (%72,2)	5 (%6,3)		
Severe	0 (%0)	3 (%3,8)		
Pain outside the right lower quadrant				
Positive	5 (%6,3)	11 (%13,9)	0,186	-0,126
Negative	74 (%93,7)	68 (%86,1)		
Increased pain in follow-up				
Positive	25 (%31,6)	35 (%44,3)	0,101	-0,13
Negative	54 (%68,4)	44 (%55,7)		
The spread of pain from the umbilicus				
Positive	26 (%32,9)	48 (%60,8)	< 0,001	-0,279
Negative	53 (%67,1)	31 (%39,2)		
Vomiting				
Positive	28 (%35,4)	11 (%13,9)	0,003	0,25
Negative	51 (%64,6)	68 (%86,1)		
Anorexia				
Positive	31 (%39,2)	48 (%60,8)	0,007	-0,215

The data are shown in number and percentage format. * Phi or Cramer V coefficient is given as the effect size measure.

Variable	Pregnant	Non-pregnant	P value	Effect Size *
Negative	48 (%60,8)	31 (%39,2)		
Duration of symptoms				
< 24 hours	60 (%75,9)	23 (%29,1)	< 0,001	0,471
24–48 hours	12 (%15,2)	40 (%50,6)		
> 48 hours	7 (%8,9)	14 (%20,3)		
Lower right quadrant pain with cough				
Positive	36 (%45,6)	48 (%60,8)	0,560	-0,152
Negative	43 (%54,4)	31 (%39,2)		
Bowel sounds				
Increased/metalic	1 (%1,3)	4 (%5,1)	< 0,001	0,537
Normal	39 (%49,4)	73 (%94,2)		
Absent	39 (%49,4)	2 (%2,5)		
Defense				
Absent	0 (%0)	24 (%30,4)	< 0,001	0,693
Mild	1 (%1,3)	10 (%12,7)		
Moderate	26 (%32,9)	41 (%51,9)		
Severe	52 (%65,8)	4 (%5,1)		
Right lower quadrant sensitivity				
Positive	79 (%100)	78 (%98,7)	1	0,08
Negative	0 (%0)	1 (%1,3)		
Rebound				
Positive	75 (%94,8)	58 (%73,4)	< 0,001	0,295
Negative	4 (%5,1)	21 (%26,6)		
Rovsing’s sign				
Positive	37 (%46,8)	16 (%20,3)	0,001	0,282
Negative	42 (%53,2)	63 (%79,7)		

The data are shown in number and percentage format. * Phi or Cramer V coefficient is given as the effect size measure.

Variable	Pregnant	Non-pregnant	P value	Effect Size *
Pyrexia				
Positive	16 (%20,3)	12 (%15,2)	0,532	0,066
Negative	63 (%79,7)	67 (%84,8)		
Left shift in neutrophils				
Positive	47 (%59,5)	23 (%29,1)	< 0,001	0,306
Negative	32 (%40,5)	56 (%70,9)		
Negative urinalysis				
Positive	79 (%100)	44 (%55,7)	< 0,001	0,533
Negative	0 (%0)	35 (%44,3)		
Follow-up Time				
1 day	69 (%87,3)	53 (%67,1)	0,003	0,247
2 days	9 (%11,4)	25 (%31,6)		
3 days	1 (%1,3)	1 (%1,3)		

The data are shown in number and percentage format. * Phi or Cramer V coefficient is given as the effect size measure.

When the scoring systems are adapted to pregnant and non-pregnant groups;

The Tzanakis Score is the strongest among the scoring systems used in non-pregnant women. The positive predictive value (PPV = 90.60) of the Tzanakis Score is 90.6% while the negative predictive value (NPV = 46.7) is 46.7%. The sensitivity of the Tzanakis score was 87.8% and the specificity was 53.8%. As assessment continues with area under curve (AUC), appendicitis predictive power, the Tzanakis score was followed by the AIR score and Alvarado score in the non-pregnant group. (Table 3)

Table 3 Distribution of appendicitis diagnostic performance criteria of scoring systems used in non-pregnant women.

Variable(s)	AUC	P	PPV	NPV	Sensitivity	Specificity	Cut Off
KARAMAN	0,752	0,004	90,90	43,70	86,36	53,85	0,00
ALVARADO	0,772	0,002	91,90	47,10	86,36	61,54	4,00
RIPASA	0,757	0,004	90,60	46,70	87,80	53,85	6,00
Tzanakis	0,794	0,001	90,60	46,70	87,80	53,85	6,00
AIR	0,787	0,001	94,20	37,00	74,24	76,92	4,00
Eskelinen	0,735	0,008	92,20	53,30	89,39	61,54	56,73
Ohmann	0,734	0,008	91,80	44,40	84,85	61,54	10,50
Lintula	0,675	0,047	89,60	50,00	90,91	46,15	8,00
Fenyo-Lindberg	0,705	0,020	91,70	42,10	83,33	61,54	-33,00

RIPASA seems to be the strongest among the scoring systems used in pregnant women. While PPV of this scoring method is 94.40%, NPV is 44%, its sensitivity and specificity are 78.46% and 78.57%, respectively. The RIPASA score is followed by the AIR score and the Tzanakis score. In pregnant patients, PPV of AIR score was 92.9%, sensitivity was 80%, specificity was 71.4%, while the Tzanakis score was 97.1%, sensitivity was 52.3%, and specificity was 92.8% respectively. (Table 4)

Table 4 Distribution of appendicitis diagnostic performance criteria of scoring systems used in pregnant women.

Variable(s)	AUC	P	PPV	NPV	Sensitivity	Specificity	Cut Off
KARAMAN	0,638	0,106	87,20	25,00	63,08	57,14	3,00
ALVARADO	0,724	0,009	92,70	28,90	58,46	78,57	6,00
RIPASA	0,806	0,000	94,40	44,00	78,46	78,57	8,50
Tzanakis	0,786	0,001	97,10	29,50	52,31	92,86	13,00
AIR	0,795	0,001	92,90	43,50	80,00	71,43	6,00
Eskelinen	0,688	0,028	89,80	40,00	81,54	57,14	65,47
Ohmann	0,613	0,186	88,70	41,20	84,62	50,00	12,50
Lintula	0,723	0,009	91,80	33,30	69,23	71,43	19,00
FenyoLindberg	0,498	0,980	25,00	14,70	1,54	78,57	-36,00

Discussion

The diagnosis of appendicitis generally performed in the light of clinical and laboratory findings, including the help of imaging methods. However, with the presence of numerous gynecological pathologies in female patients, the diagnosis of acute appendicitis becomes challenging, and the diagnosis becomes even more complicated when pregnancy added to the condition (21). In our pregnant patient group, besides the findings inherent in pregnancy, such as nausea and vomiting, there were laboratory findings similar to acute appendicitis and pregnancy.

Radiological examinations have high diagnostic value in the diagnosis of acute appendicitis (22). The teratogenic effect and high cost of computed tomography (CT) in imaging are its major disadvantages (23,24). Having positive abdominal ultrasonography (USG) findings in pregnant women with suspected appendicitis does not require additional testing to confirm the condition. Besides, cases where appendicitis cannot be diagnosed in USG, magnetic resonance imaging (MRI) is the recommended imaging method that provides a high diagnostic rate and accuracy in pregnant patients (25–27). When using new scoring systems that combine clinical and imaging features, 95% of patients considered uncomplicated appendicitis correctly identified (28).

Delay in diagnosis and treatment of the disease has been shown to result in more complicated appendicitis and increased preterm labor, perinatal morbidity, mortality, and fetal loss rates (6–10). The use of scoring systems helps to support imaging methods (29,30). The goal of applying clinical scoring systems (CSS) in acute appendicitis is assist early diagnosis of the disease and prevent morbidity, including cost increases due to delay and the Alvarado score is the one of the most common used clinical scoring system in this respect (22). Although the Alvarado score meant for pregnant patients, its use extensively validated in the non-pregnant population (31).

CSS mainly aims to predict the diagnosis of appendicitis by enumerating signs, symptoms, and laboratory results. In this context, parameters in some CSS are not available in others. An example of this is the presence of USG in the Tzanakis score, gender in the Lintula and Fenyo-Lindberg scores, moreover negative urinary symptoms in the Ripasa and Ohmann scores can be counted among them. In our study, we adopted nine different scoring systems which are used commonly in worldwide in the diagnosis of appendicitis in pregnant and non-pregnant appendicitis groups.

Both the presence of nausea, vomiting, and physiological leukocytosis during pregnancy and changing the position of the appendix with the gestational week, make the diagnosis of appendicitis challenging in this period (21). Precisely at this point, negative appendectomy rates are around 35% in pregnant patients (32). Currently, no suitable and valid scoring system in the literature evaluates appendicitis during pregnancy. Therefore, we evaluated the accuracy of the previously defined scoring systems for the pregnancy period. Considering the AUC in non-pregnant women for this CSS, the most valuable scoring systems were Tzanakis, AIR, and Alvarado scores, respectively. Lintula and Fenyo-Lindberg scoring systems have the lowest AUC value among the nine scoring systems. Considering those who have high scores in the non-pregnant group, it is thought that the advantage of USG reflected in the Tzanakis scoring system in patients who are not pregnant. In pregnant women, the AUC value of the Ripasa score is determined to be high, followed by the AIR and Tzanakis scores. CSS, heavily based on signs and detailed laboratory findings, were observed to be more predictive in the pregnant group. Although we determined the RIPASA score as the strongest score in pregnancy, its sensitivity and specificity are below 80%. As it turns out, there is a requirement for a CSS to be applied during pregnancy. Under the supervision of our data, we plan to conduct a CSS study for the gestation period.

In other words, in scoring; systems that include data, such as left shifting in the neutrophil, negative urinary findings, rovsing's sign, rebound, severe defense, absence of bowel sounds, short symptom duration, and severe abdominal pain are beneficial in pregnant patients. (table 2) Apart from what we have written above, the value of CSS decreases, especially in pregnant patients in the case that gender, and displacement of pain, are included in the scoring. Notably, with the progression of pregnancy, the gravid uterus may affect the migration of pain.

Conclusions

Among defined CSSs, the RIPASA score in pregnancy was found to be the most precious, and this data may additionally benefit the imaging methods in pregnant patients in the clinic. Besides, a scoring system that can be defined for acute appendicitis during pregnancy will be beneficial for the surgical necessity of both mother and fetus.

Abbreviations

ROC: Receiver operator characteristics

PPV: Positive predictive value

NPV: Negative predictive value

WBC: White blood count

VAS: Visual analogue scale

AUC: Area under curve

CT: Computed tomography

USG: Abdominal ultrasonography

MRI: Magnetic resonance imaging

CSS: Clinical scoring systems

Declarations

Availability of data and materials

There is no additional data available to share with the readers.

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Contributions

BM: design, data collection, data analysis + interpretation, writing and revision. YA: Data collection, data interpretation, and revision. MY: Data analysis, interpretation, and writing. FA: Interpretation and revision. EG: study design, data interpretation, and revision. EA: study design, writing/revision. UE: data interpretation, revision. NF: interpretation and revision. All authors read and approved the final manuscript.

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Ethics approval and consent to participate

Sakarya Univercity Ethics Committee has approved this research project.

Consent for publication

All patients or their caregivers signed a consent form giving permission to use their anonymous data for research.

Competing interests

The authors have no conflicts of interest. The authors are responsible for the content of the paper.

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Figures

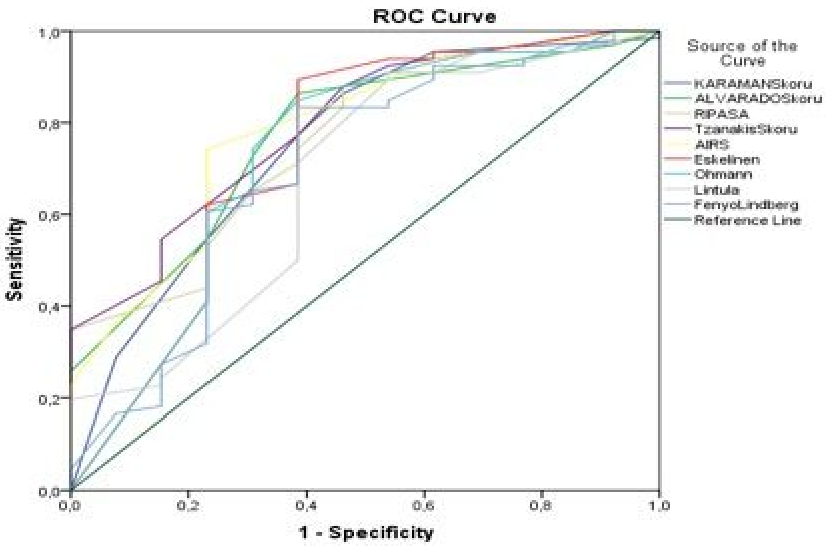

Figure 1

ROC curves for diagnostic performance of appendicitis scoring systems for non-pregnant women.

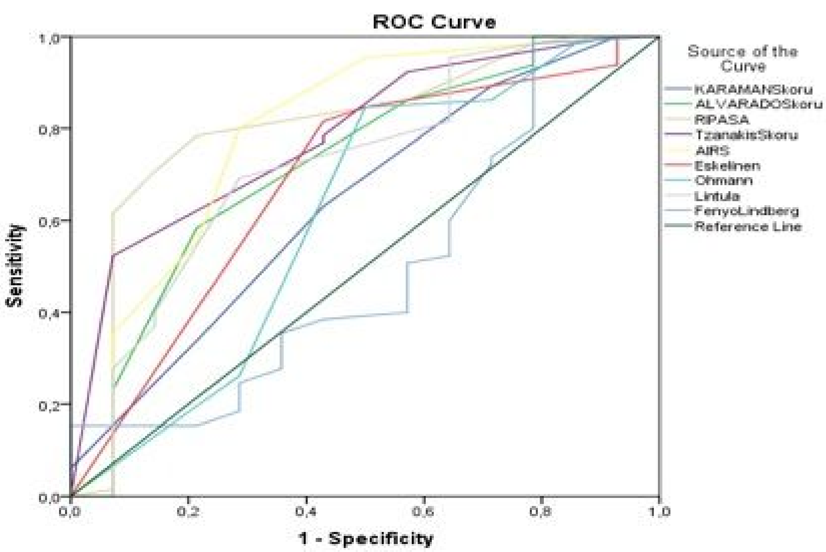

Figure 2

ROC curves for diagnostic performance of appendicitis scoring systems in pregnant women.