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ORIGINAL ARTICLE

Predictive role of neutrophil-to-lymphocyte and platelet-to-lymphocyte ratios for diagnosis of acute appendicitis during pregnancy

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Abstract Acute appendicitis (AA) is not uncommon during pregnancy but can be difficult to diagnose. This study evaluated the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) in addition to conventional diagnostic indicators of the disease to diagnose AA during pregnancy. Age, gestational age, white blood cell (WBC) count, Alvarado scores, C-reactive protein (CRP), lymphocyte count, NLR and PLR were compared among 28 pregnant women who underwent surgery for AA, 35 pregnant women wrongly suspected as having AA, 29 healthy pregnant women, and 30 nonpregnant healthy women. Mean WBC counts and CRP levels were higher in women with proven AA than in those of control groups (all $p < 0.05$). Among all the groups, the median NLR and PLR were significantly different in women with proven AA (all $p < 0.05$). Receiver operating characteristic analysis was used to determine cut-off values for WBC count, CRP, lymphocyte count, NLR and PLR, and multiple logistic regression analysis showed that NLR and PLR used with routine methods could diagnose AA with 90.5% accuracy. Used in addition to routine diagnostic methods, NLR and PLR increased the accuracy of the diagnosis of AA in pregnant women.

Conflicts of interest: All authors declare no conflicts of interest.

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Introduction

Acute appendicitis (AA) is the most common general surgery emergency. It is also the most common nonobstetric/nongynecological surgical emergency in pregnant women with a reported incidence ranging from 1 in 766 to 1 in 1440 pregnancies [1]. Although reports vary, the incidence of AA appears to increase in the second trimester [2,3]. Diagnosis of AA in pregnancy is challenging because symptoms of nausea, vomiting, and abdominal pain can be difficult to distinguish from pregnancy-related symptoms. In addition, the use of imaging modalities is limited during pregnancy. Importantly, delays in diagnosis because of these difficulties may place both the mother and fetus at risk, potentially leading to abortion or preterm delivery [4].

Although there is no specific laboratory parameter for AA, the white blood cell (WBC) count and C-reactive protein (CRP) level are commonly used in the diagnosis of AA [5]. However, physiological leukocytosis occurs in pregnancy, and the WBC count increases with gestational week to reach a peak during labor. Therefore, an increased WBC count is not a specific parameter for the diagnosis of AA in pregnancy [5,6]. The level of CRP, an acute phase reactant, increases in many inflammatory conditions and can be used in the diagnosis of AA [7]; however, the CRP level may also be increased in healthy pregnant women [8]. Ultrasonography is the most frequently used imaging modality to diagnose AA, but the appendix may be difficult to visualize in pregnancy because of anatomical changes [6]. Magnetic resonance imaging (MRI) and computed tomography (CT) are of limited use in pregnancy because MRI is not widely available and CT involves exposure to ionizing radiation [6,9]. The Alvarado scoring system, first described in 1986 [10] and based on clinical and laboratory data, is recommended for use in the diagnosis of AA. However, the findings of a recent prospective study indicated that the Alvarado scoring system alone is not sufficient to accurately diagnose AA [11].

Neutrophils are the most abundant WBCs and are important cells in the immune defense system. They also regulate other cells, including mast cells, epithelial cells and macrophages, and play an active role in inflammatory events. Changes in the neutrophil-to-lymphocyte ratio (NLR) can be an early sign of bacterial and viral infections. Another parameter that has been used in the diagnosis of infection is the platelet-to-lymphocyte ratio (PLR) [12]. Platelets are cells that help in modulating various inflammatory conditions; therefore, changes in PLR may be a useful indicator of acute infection, including AA.

Although AA is the most common infection requiring emergency surgery, accurate and timely diagnosis is potentially challenging. Unnecessary or delayed surgery is of particular concern in patients suspected as having AA. The situation becomes even more challenging and complex in pregnant women presenting with AA symptoms. Therefore, the aim of this study was to assess the use of NLR and PLR in combination with conventional methods to facilitate accurate and timely diagnosis of AA in pregnant women.

Materials and methods

This retrospective study included 78 pregnant women admitted to our clinic between January 2005 and January 2015 suspected as having AA. Of these, 36 women with confirmed AA underwent surgery (the appendectomy group). Forty-two patients were found not to have AA and did not proceed to surgery (the expectant group). The study controls included 29 pregnant women who presented to our clinic for routine examinations during the same period (the healthy pregnant control group) and 30 nonpregnant women who presented to our polyclinic with breast pain during the same period but had no pathology on examination (the healthy women control group).

Exclusion criteria included the following: hematological disorders; chronic liver or kidney disease; chronic obstructive pulmonary disease; asthma; any viral, bacterial or parasitic infection; cancer or autoimmune disease; and history of smoking and/or alcohol consumption. Patients with incomplete records were also excluded. Based on these criteria, eight of the 36 patients in the appendectomy group were excluded: four had systemic diseases (hypertension in two patients, chronic obstructive pulmonary disease in one patient and diabetes mellitus in one patient), one patient had incomplete records and three patients had no histology results to confirm the diagnosis of AA. The remaining 28 patients in the appendectomy group were included in the analysis. Seven of the 42 patients in the expectant group were excluded: two had diabetes mellitus, one had asthma, two were smokers, one had hypertension, and one had tonsillopharyngitis. The remaining 35 patients in the expectant group were included in the analysis. Age, gestational age, WBC count, lymphocyte count, Alvarado score, CRP levels, NLR, and PLR were recorded for patients in the appendectomy and expectant groups. All parameters except the Alvarado score and CRP were recorded for patients in the healthy pregnant and healthy women control groups. The scientific research ethics committee of the Kahramanmaraş Sütçü İmam University Medical Faculty approved the study protocol.

All statistical analysis was performed using SPSS 22.0 software (IBM Corporation, Armonk, NY, USA). The Shapiro–Wilk test was used to determine the compliance of the data to a normal distribution, and the Levene test was used to determine the homogeneity of variances among the groups. The independent samples *t* test with bootstrap results was used to compare two independent groups, whereas the Mann–Whitney *U* test was used with the Monte Carlo simulation technique. One-way analysis of variance (robust test: Brown–Forsythe) was used together with bootstrap results to compare more than two groups with other groups. The Kruskal–Wallis *H* test, least-significant differences and Games–Howell tests were used for *post hoc* analysis. Correlation between classification of the patient groups separated by cut-off values was calculated according to the variables, and real classification was expressed by examination of sensitivity and specificity using receiver operating characteristic (ROC) curve analysis. A logistic regression test was used to define the cause–effect relationship of the categorical response variable with explanatory variables in binomial and multinomial categories. Quantitative data are expressed as mean ± standard deviation, median ± interquartile range, or median and range (maximum–minimum). Categorical data are expressed as *n* (number) or percentage (%). Data