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Original Contribution

Mean platelet volume and the ratio of mean platelet volume to platelet count in the diagnosis of acute appendicitis

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ABSTRACT

Background: Mean platelet volume (MPV) is an inflammatory marker. Recent studies have shown that there is a negative correlation between platelet count (PC) and MPV and that the ratio of these two values may be more meaningful. The aim of our study was to investigate the diagnostic value of MPV and the MPV/PC ratio in acute appendicitis.

Methods: Patients who were admitted to the emergency department and underwent appendectomy for acute appendicitis between January 2013 and May 2016 were evaluated retrospectively.

The patients were divided into three groups based on their histopathological findings: the control group (negative appendicectomy) and the uncomplicated and complicated appendicitis groups. Leukocyte count, CRP (C-reactive protein) levels, PC, MPV and the MPV/PC ratio were compared among the groups.

Results: A total of 424 patients, including 231 men, were included in the study. The average age of all patients was 34.9 ± 13.2 years. There was no statistically significant difference between the uncomplicated appendicitis, complicated appendicitis and control groups in terms of MPV, PC and the MPV/PC ratio. Leukocyte count had a strong discriminatory property based on the area under curve (AUC) 0.73, ($p < 0.001$). CRP levels, MPV, PC and the MPV/PC ratio had weak discriminatory power with AUC values <0.65. Using receiver operating characteristic (ROC) analysis, the sensitivity and specificity of MPV were 83.79% and 23.21%, respectively, and 66.48% and 48.21%, respectively, for the MPV/PC ratio.

Conclusions: In our study, MPV and the MPV/PC ratio were not useful in the diagnosis of acute appendicitis.

1. Introduction

Appendicitis is the most common cause of acute surgical abdominal pain and is usually seen in patients in the second and third decades of life. In the United States, lifetime prevalence of appendicitis is a 1 in 15. Men generally have a higher rate of appendicitis, and there is a male-to-female ratio of approximately 1.4:1. One-third of appendicitis cases referred to the hospital are perforated appendicitis. Making an accurate diagnosis of acute appendicitis is important for physicians practicing emergency medicine. Despite the available laboratory tests and imaging techniques, the negative appendectomy rate is 10% due to misdiagnosis. [1-4].

A large number of biomarkers including procalcitonin, IL-6, urinary serotonin, and bilirubin have been studied for their use in confirming the diagnosis of appendicitis. Leukocyte count and CRP (C-reactive protein) levels are commonly used markers for the diagnosis of acute appendicitis in the emergency department. Nevertheless, despite extensive research and debate, the correct diagnosis of acute appendicitis is still difficult. For this reason, new supporting laboratory tests are needed [1,5].

Recently, platelet indices (platelet count, mean platelet volume) have been frequently investigated for the diagnosis of acute appendicitis, but there are no definite results about their diagnostic value. Studies have shown that there is an inverse relationship between platelet count (PC) and the mean platelet volume (MPV), suggesting that these two variables should be interpreted as a ratio instead of being used alone [6,7]. To the best of our knowledge, there is no literature about the MPV/PC ratio for diagnosing acute appendicitis.

The aim of our study was to investigate the diagnostic value of mean platelet volume and the ratio of mean platelet volume to platelet count for acute appendicitis.

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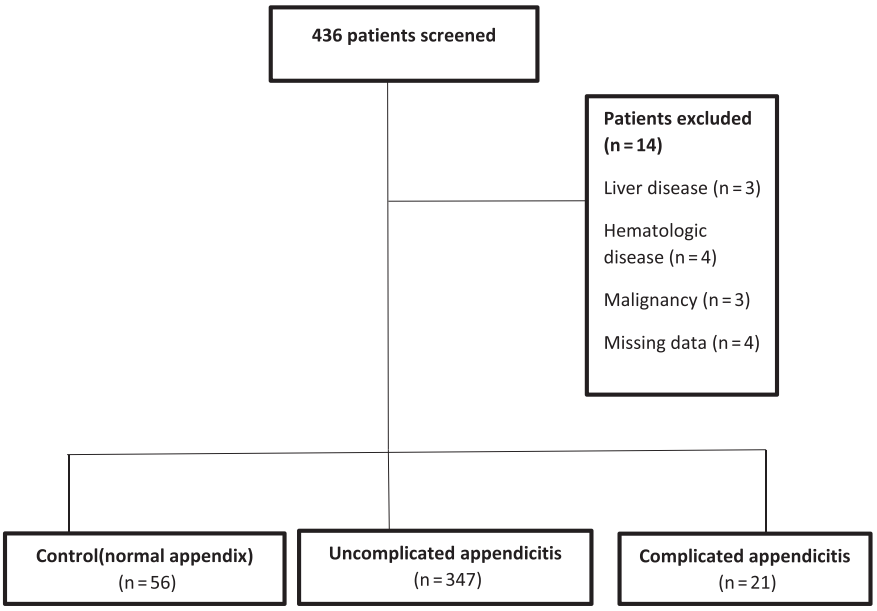

Fig. 1. The patient flow diagram.

2. Methods

2.1. Patients and study design

This study was retrospectively performed between January 2013 and May 2016 at Mersin University Faculty of Medicine in the Department of Emergency Medicine in Turkey. Patients >18 years who presented to the emergency department and underwent surgery for acute appendicitis were included in the study.

The study was carried out by searching the hospital electronic medical information system. Ethics committee approval (No: 2016/315, Date: 06/10/2016) was obtained.

Patients were divided into three groups according to their histopathological findings: a control group; a group of patients with a normal appendix, uncomplicated appendicitis; a group of patients with acute appendicitis, phlegmatic appendicitis, complicated appendicitis; perforation or plastron appendicitis.

Patients who had heart failure, hematologic disease, cancer, chronic infectious disease, liver disease, vascular disease, infections or inflammatory disease, who were missing data, or who were taking medications that can affect platelet count and volume were excluded from the study. Fourteen patients were excluded, and the study was completed with 424 patients. The patient flow diagram for the study protocol is shown in Fig. 1.

Demographic data, leukocyte count, CRP levels, PC, MPV, and the MPV/PC ratio were recorded for all patients.

2.2. Laboratory examination

After blood sampling in EDTA blood tubes for obtaining measurements of leukocyte count, platelet count and MPV, the analysis of these values was performed using the electrical impedance method (Beckman Coulter LH 780). Serum CRP levels were measured by the turbidimetric method (Roche Cobas C 501). The normal reference values for the parameters measured in our study were as follows: leukocyte count (4.5–10.0 × 10^3/L), platelet count (150–400 × 10^3/L), MPV (7.4–10.4 fL), and CRP levels (0–5 mg/dL).

2.3. Statistical analysis

The normal controls for continuous measurements were tested by the Shapiro-Wilk test. One-way ANOVA was used to compare differences between groups and the Student Newman Keuls (S-N-K) test was used for binary comparisons among the control, appendicitis and complicated appendicitis groups. Student's *t*-test was to compare differences between the control group and the appendicitis groups. The Kruskal Wallis test was used to compare differences between groups, and the Mann-Whitney *U* test was used for binary comparisons. The homogeneity of variance was tested using the Levene test. Descriptive statistics are reported as he mean and standard deviation. The Pearson correlation coefficient was used to evaluate the relationship between continuous variables. Descriptive statistics are reported as numbers and percentages. $p < 0.05$ was considered statistically significant.

Table 1
Comparison of demographic and laboratory values of the patients with control, uncomplicated and complicated appendicitis groups.

Characteristic	Control ($n = 56$)	Uncomplicated appendicitis ($n = 347$)	Complicated appendicitis ($n = 21$)	p
Age, years	32.9 ± 11.7	35.1 ± 13.3	35.9 ± 16.7	0.483
Gender	35 (18,1%)	152 (78,8%)	6 (3,1%)	0.009
Female n (%)				
Leucocyte (4.5–10.0 × 10^3/L)	10.4 ± 3.5	13.9 ± 4.3[a]	13.6 ± 5.1[a]	<0.001
CRP (0–5 mg/L)	11.5 (2.9–38.2)	13.6(3.6–38.2)	27.7(7.7–109.1)[b]	<0.05
MPV (7,4–10,4 fL)	9.9 ± 1.3	9.9 ± 1.2	9.6 ± 1.1	0.499
Platelet (150–400 × 10^3/μL)	250.1 ± 53.3	242.9 ± 62.5	245.1 ± 69.5	0.716
MPV/PC	0.0375 (0.0325–0.0487)	0.0409(0.0343–0.0502)	0.0382(0.0328–0.0536)	0.373

MPV/PC values was calculated as mean platelet volume divided by platelet count.
Abbreviations: CRP: C-reactive protein; MPV: mean platelet volüme; PC:platelet count.
[a] $p < 0.001$ differences with control group.
[b] $p < 0.05$ differences with control and uncomplicated appendicitis.

Table 2
Performance characteristics for parameters.

Parameter	Cut-off	AUC (p)	Sensitivity (%)	95% CI	Specificity (%)	95% CI
Leukocyte	>11.9 10^3/L	0.734 (0.0001)	66.58	61.5–71.4	71.43	57.8–82.7
CRP	>1.19 mg/L	0.527 (0.5099)	89.67	86.1–92.6	19.64	10.2–32.4
MPV	>8.7 fL	0.505 (0.8948)	83.79	79.6–87.4	23.21	13.0–36.4
PC	≤263 10^3/μL	0.556 (0.1823)	68.48	63.4–73.2	46.43	33.0–60.2
MPV/PC	>0.0367	0.556 (0.1616)	66.48	61.3–71.3	48.21	34.6–61.9

Abbreviations: CI, confidence interval;AUC: area under the curve; CRP: C-reactive protein; MPV: mean platelet volume; PC:platelet count.

3. Results

A total of 424 patients, including 231 men, were included in the study. The average age of all patients was 34.9 ± 13.2 years. The demographic and laboratory values of the patients are shown in Table 1.

There was a statistically significant difference between the appendicitis (uncomplicated and complicated) groups and the control group in terms of leukocyte count ($p < 0.001$). CRP levels were significantly higher in patients with complicated appendicitis than in those in the control group ($p < 0.05$). There were no statistically significant differences between the appendicitis (uncomplicated and complicated) groups and the control group in terms of MP, PC, and the MPV/PC ratio (Table 1).

In terms of the diagnostic performance of the leukocyte count, CRP levels, MPV, PC and the MPV/PC ratios, only leukocyte count (AUC 0.73) had strong discriminating characteristics ($p < 0.001$). The other variables had weak discriminating power, with AUC values below 0.65.

A cut-off value of 11.900/mm^3 for leukocyte count for predicting acute appendicitis with a specificity of 71.43%, a sensitivity of 66.58%, and an AUC of 0.734 ($p = 0.0001$) was determined. A cut-off value of >1.19 for CRP level for predicting acute appendicitis with a specificity of 19.64%, a sensitivity of 89.67%, and an AUC of 0.527 ($p = 0.5099$) was determined. ROC analysis revealed that a cut-off value for MPV of >8.7 had a sensitivity of 83.79%, a specificity of 23.21%, and an area under the curve (AUC) of 0.505 ($p = 0.8948$). ROC analysis revealed that a cut-off of 0.0367 for the MPV/PC ratio had a sensitivity of 66.48%, a specificity of 48.21%, and an area under the curve (AUC) of 0.556 ($p = 0.1616$) (Table 2) (Fig. 2).

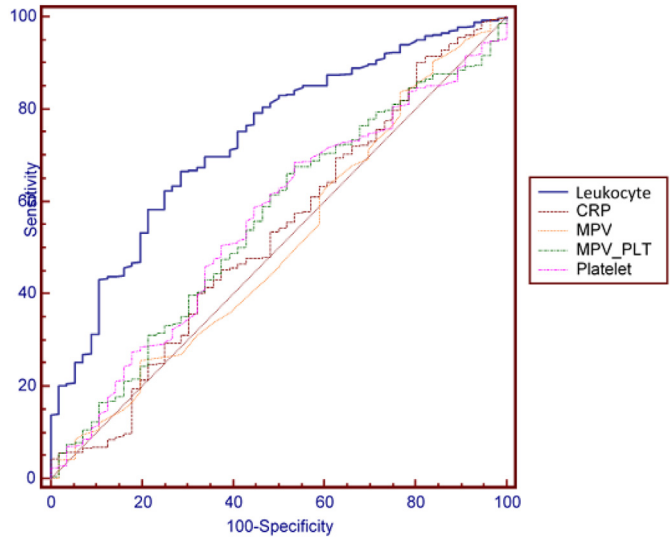

Fig. 2. Receiver operating characteristic curve of parameters.

Spearman correlation analysis showed that there was a positive correlation between MPV and the MPV/PC ratio ($r = 0.652$, $p < 0.001$) and a negative correlation between MPV and PC ($r = -0.326$, $p < 0.001$) (Table 3).

4. Discussion

When the important results of this study were evaluated, an increase in leukocyte count was useful in the diagnosis of acute appendicitis, whereas PC, MPV, and the MPV/PC ratio were not useful for diagnosis. CRP levels were found to be helpful and useful for predicting complicated appendicitis. Early detection of appendicitis can prevent perforation, abscess formation and postoperative complications and reduce costs by shortening hospitalization. Nevertheless, despite extensive research and debate, making an accurate diagnosis of acute appendicitis is still difficult; thus, new supporting tests are needed [1,5].

The diagnostic value of leukocyte count for acute appendicitis has been investigated in numerous studies. In a meta-analysis, leukocytosis was reported to have a sensitivity of 83% and a specificity of 67% for acute appendicitis [8]. In our study, the leukocyte count was significantly higher in patients with appendicitis (appendicitis and complicated appendicitis) than in those in the control group, and only leukocyte count (AUC 0.73) had a strong distinguishing characteristic.

There are studies that have shown that CRP levels can be helpful in distinguishing pathological types of acute appendicitis and can be used as a reference for making surgical decisions. However, other studies contradict this finding [9,10,11,12]. In a meta-analysis, the sensitivity of CRP for diagnosing acute appendicitis was reported to be 65–85%, and the specificity was 59–73% [13]. In our study, CRP levels were significantly higher in patients with complicated appendicitis than in those with appendicitis and in those in the control group. Elevated CRP levels may guide clinicians in determining which patients havecomplicated appendicitis.

Platelet count is part of the complete blood count and is one of the most commonly used laboratory tests. Studies have shown high, low and normal PCs in patients with acute appendicitis and in controls [14-17]. According to the results of these studies, there are contradicting

Table 3
Spearman's rank correlation coefficient analysis.

Characteristics		Leukocyte	CRP	MPV	PC	MPV/PC
Age	r	−0,147	0,244	0	0	0,02
	p	**0,002**	**<0,001**	0,995	0,993	0,681
Leukocyte	r		0,005	0,051	0,154	−0,112
	p		0,921	0,298	**0,002**	**0,021**
CRP	r			0,048	−0,084	0,122
	p			0,323	0,085	**0,012**
MPV	r				−0,326	0,652
	p				**<0,001**	**<0,001**
PC	r					−0,846
	p					**<0,001**

Abbreviations: CRP: C-reactive protein; MPV: mean platelet volume; PC:platelet count.

platelet counts in patients with acute appendicitis. In our study, there was no significant difference in platelet count between the acute appendicitis group and the control group.

Mean platelet volume is an automated measurement of the mean volume of platelets as assessed by cell counters. An increased MPV may suggest either increased platelet activation or increased hyperaggregation of platelets. Because MPV increases during rapid platelet depletion, it may indicate that larger and younger platelets are being released into circulation. When MPV is low, thrombocytes are usually smaller [18]. MPV acts as a negative or positive acute-phase reactant in different inflammatory conditions. It may increase in high-grade inflammation due to large platelet depletion and sequestration in vascular segments in the inflamed area. Low MPV is associated with low grade inflammation, such as rheumatoid arthritis and attacks of familial Mediterranean fever. While MPV decreases in acute disease, it can rise in chronic disease [19]. In the literature, MPV value has been studied as a marker for the diagnosis of acute appendicitis and normal, increased and decreased levels have been reported in these patients [20,21,22]. In a meta-analysis, patients with acute appendicitis were found to have lower MPVs than the control group, and researchers have suggested that MPV may be a potential biomarker for the diagnosis of acute appendicitis. In our study, although the MPV value was low in the complicated appendicitis group, there was no significant difference compared to the other two groups. ROC analysis revealed that a cut-off value for MPV of >8.7 had a sensitivity of 83.79% and a specificity of 23.21%.

Studies have shown that there is a negative correlation between PC and MPV and that the ratio of these two values may be more meaningful. The MPV/PC ratio has been investigated in terms of its use in the diagnosis, prognosis and risk characterization in various diseases, such as myocardial infarction, sepsis, deep vein thrombosis and stroke [23-26]. In the literature, we did not find any studies evaluating the diagnostic value of the MPV/PC ratio for acute appendicitis. In our study, there was no significant difference in the MPV/PC ratio in between patients in the appendicitis and control groups. ROC analysis revealed that a cut-off value for the MPV/PC ratio of 0.0367 had a sensitivity of 66.48% and a specificity of 48.21%. There was an inverse correlation between MPV and PC. Although the MPV/PC ratio was found to be significant in the above mentioned studies, it seems far from being a guiding parameter for clinicians for the diagnosis of acute appendicitis.

A significant limitation of this study is its retrospective nature. It is also a single-center study, and the number of included patients is small.

5. Conclusions

This study demonstrated that MPV and the MPV/PC ratio were not useful for the diagnosis of acute appendicitis. Further prospective studies with large sample sizes are needed in this field.

Support

There is no source of support.

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