

The importance of laboratory tests and Body Mass Index in the diagnosis of acute appendicitis

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ABSTRACT:

Background: Acute appendicitis is the most common cause of acute abdomen. Delay in diagnosis increases the mortality and morbidity.

Aim: In this study, we aimed to investigate whether the body mass index is useful in diagnosis and whether the neutrophil/lymphocyte and platelet/lymphocyte ratios can help in determining the inflammation level of acute appendicitis.

Material and Methods: Cases of appendectomy performed between June 2012 and December 2018 in our clinic were analyzed retrospectively. Based on the pathology results of the cases included in the study, 4 groups were formed, i.e.: Group 1 (initial stage), Group 2 (catarrhal stage), Group 3 (phlegmonous-gangrenous stage) and Group 4 (perforation). The study compared age, body mass index, leukocyte values, red cell distribution width (RDW), neutrophil/lymphocyte ratio (NLR), platelet/lymphocyte ratio (PLR), and mean platelet volume (MPV) between groups.

Results: 828 cases were included in the study. When compared between groups, the values of Group 3 and Group 4 were higher than those of Group 1 and Group 2 for PLR and NLR. There was no difference in RDW and MPV values in the blood. When Body Mass Index (BMI) was compared between groups, it was found to be significantly higher with increasing histopathological stage.

Conclusion: In acute appendicitis, the blood leukocyte value, elevated PLR and NLR are helpful in diagnosis. We aimed to emphasize that the diagnosis of acute appendicitis is delayed in patients with a BMI above 30 and/or at age of over 40 years, with the perforation rate being determined more frequently.

KEYWORDS:

acute abdomen, acute appendicitis, appendectomy, obesity

ABBREVIATIONS

BMI – Body Mass Index

MPV – mean platelet volume

NLR – neutrophil/lymphocyte ratio

PLR – platelet/lymphocyte ratio

RDW – red cell distribution width

SD – standard deviation

SPSS – statistical package for the social sciences

INTRODUCTION

The most common cause of acute abdominal surgeries is acute appendicitis and this is an important issue in emergency surgery [1]. The risk of appendicitis throughout life is 8.6% in men and 6.7% in women [2]. Approximately 56% of acute appendicitis cases are male, and 44% are female, and the disease is more common in the age group of 20–35 years [3]. Morbidity and mortality increase with late diagnosis and treatment [4]. On the other hand, the negative appendicitis rate still remains at a level of 15–30% [5].

Acute appendicitis can be classified pathologically as baseline, catarrhal (appendix hyperemic, edematous), phlegmonous, and perforated [6].

With delayed diagnosis and treatment, the risk of perforation increases. Urinary infection, ovarian cyst rupture, and gastroenteritis can be counted as diseases most frequently confounding the diagnosis [7]. It is known that in perforated appendicitis cases, complications such as wound infection, intra-abdominal abscess, and mortality

increase, and the duration of hospital stay is longer [8]. In different studies, the neutrophil/lymphocyte ratio (NLR) and platelet/lymphocyte ratio (PLR) have been shown to be acute phase reactants in different inflammatory pathologies [9].

Physical examination and imaging tests may be less informative in cases with a higher body mass index (BMI) than in those with a low BMI [10] and this delays the diagnosis. We think that while obesity cases have higher morbidity and mortality than the ones with a normal BMI, this delay in diagnosis may increase these rates even more. Histopathological stages of appendectomy specimens of patients with a high BMI and normal or low BMI were compared. No research on obesity was found in the literature. Studies have shown that NLR and PLR, which are now accepted as indicators of inflammation, are high in acute appendicitis [11]. However, no publication investigating the relationship between the stage of acute appendicitis, and these rates was found in the literature. In our study, the relationship between NLR and PLR, and acute appendicitis stage was also investigated.

In our study, we aimed to investigate whether the body mass index value had an effect on the diagnosis of acute appendicitis. Another aim was to examine red cell distribution width (RDW) in blood, mean platelet volume (MPV), neutrophil/lymphocyte ratio and platelet/lymphocyte ratio and their correlation with the histopathological stage.

MATERIALS AND METHODS

This study was conducted following the recommendations of the Declaration of Helsinki, which define the conduction of biomedical

research involving human subjects. The ethics committee approval was obtained for a retrospective study (KAEK-50-Decision No: 1931).

Cases of appendectomy performed between June 2012 and December 2018 in our clinic were analyzed retrospectively. The criteria for inclusion in the study were as follows: patients between 18 and 70 years old who had an open or laparoscopic appendectomy with a diagnosis of acute appendicitis, and complete blood count, height, and weight data. Cases subjected to appendectomy with a diagnosis other than acute appendicitis being cause, those with neoplasia in the pathological examination, blood diseases that cause a high or low platelet value, using anticoagulants, those with previous abdominal surgeries, and cancer cases were excluded from the study. In histopathology, preparations were dyed with hematoxylin-eosin and evaluated with a magnification of 4 x 10, 10 x 10, and 40 x 10. According to the histopathological finding, appendicitis was divided into four groups:

1. Initial stage: with a mucosal neutrophil-lymphocyte collection in the focal areas;
2. Catarrhal stage: with an extensive neutrophil-lymphocytic infiltration limited to the mucosal areas;
3. Gangrenous stage: with a neutrophil-lymphocyte infiltration crossing the mucosa and entering the muscular layer and spreading to the periappendicular area;
4. Perforation stage: with a neutrophil-lymphocyte infiltration in the periappendicular areas that is very intense and with a possible abscess, lipogranuloma and/or fibrosis.

According to the pathology results of the cases included in the study, patients at initial stage were classified as Group 1, catarrhal – Group 2, phlegmonous-gangrenous – Group 3 and perforation – Group 4. The study compared age, body mass index, leukocyte values, RDW, NLR, PLR and MPV between groups.

Statistical Analysis

The statistical analysis was performed using the statistical package for the social sciences (SPSS) (Version 21.0, SPSS Inc., Chicago, IL, USA). Categorical variables were analyzed using the Chi-square test (χ^2). Continuous variables were presented as mean \pm standard deviation (SD). Differences among the 4 groups were analyzed with the one-way ANOVA with post hoc Tukey test. The P-value of less than 0.05 was considered statistically significant.

RESULTS

As many as 828 of 1087 appendectomy cases performed in our clinic between June 2012 and December 2018 were included in the study. In total, 259 cases were not included in the study because they had not met the study criteria specified in the materials and methods section. There were 72 cases in Group 1, 148 cases in Group 2, 579 cases in Group 3, and 29 cases in Group 4, classified based on pathology results. In terms of gender, there were 344 women and 484 men. There was no statistically significant difference between the groups in terms of gender ($P = 0.082$).

The mean age in Group 4 was found to be significantly higher than in other groups ($P < 0.001$, $P = 0.013$, $P < 0.001$, respectively). For leukocyte values: leukocyte value in Group 3 was significantly higher than in Group 1 and Group 2 ($P = 0.028$, $P = 0.016$), leukocyte value in Group 4 was significantly higher than in Group 1 and Group 2 ($P = 0.036$, $P = 0.024$).

The NLR value in Group 3 was significantly higher than in Group 1 and Group 2 ($P < 0.001$, $P = 0.007$). The NLR value in Group 4 was significantly higher than in Group 1 and Group 2 ($P = 0.003$, $P = 0.004$). There was no significant difference between Group 3 and Group 4 ($P = 0.976$). For PLR: the value in Group 1 was significantly lower than in Group 2, Group 3 and Group 4 ($P = 0.02$, $P = 0.004$, $P = 0.002$). The PLR value in Group 2 was significantly lower than in Group 3 and Group 4 ($P = 0.016$, $P = 0.009$). In Group 3 it was significantly lower than in Group 4 ($P = 0.019$).

When the MPV and RDW values were compared between the groups, there was no statistically significant difference ($P = 0.073$, $P = 0.946$, $P = 0.0992$, $P = 0.950$, $P = 0.486$, $P = 0.997$) (Tab. I).

When BMI was compared, there was no difference between Group 1 and Group 2 ($P = 0.248$); Group 2 was significantly lower than Group 3 and Group 4 ($P < 0.001$, $P < 0.001$), and Group 3 was significantly lower than Group 4 ($P < 0.001$).

DISCUSSION

Early diagnosis in acute appendicitis meaning diagnosis and treatment before gangrene or perforations is very important in terms of morbidity and even mortality [12]. In our study it was found that patients with a high BMI had a more delayed diagnosis. With an increasing stage of acute appendicitis (meaning the level of inflammation), NLR and especially PLR increased as well. Acute appendicitis is more common in male sex [13]. In our study, no difference was found between the groups (formed based on histopathological examination) in terms of gender.

Although acute appendicitis can be seen at any age, it is more common in the age range of 20–40 [14]. In our study, the results were consistent with the literature, except for the perforation group. The mean age of the group with perforated appendicitis was significantly higher than of the other groups. Although acute appendicitis is mostly seen at a younger age, it should always be considered in the differential diagnosis in patients over 40 years of age with abdominal pain. In elderly patients, there may be a delay in diagnosis due to additional diseases and this increases the possibility of complicated appendicitis.

Publications have investigated RDW and MPV as inflammatory markers [13, 14]. In our study, no difference was detected in changes of MPV and RDW values between histopathological stages in acute appendicitis. Leukocytosis was present in our study as in many studies in acute appendicitis [15, 11]. In our study, with an increasing inflammatory level (i.e. in patients whose histopathological examination showed gangrenous or perforated appendicitis), the leukocyte value was also significantly higher than in baseline and the catarrhal stages. According to the literature, the increase of leukocytosis is an indication that the inflammatory process increases.

Tab. I. The values of the parameters examined according to the groups.

	GROUP 1 (N = 72)	GROUP 2 (N = 148)	GROUP 3 (N = 579)	GROUP 4 (N = 29)	TEST (P)
Gender (male/female)	32/40	88/60	349/230	15/14	$\chi^2 = 7.213$ ($p = 0.065$)
The mean age	34.22 ± 11.34	34.08 ± 14.4	35.91 ± 14.52	48 ± 16.6	F = 8.584 ($P < 0.001$)
Leukocyte value (/mm³)	11.195 ± 3.8	10.978 ± 4.4	14.540 ± 7.6	14.741 ± 9.7	F = 3.339 P = 0.028, P = 0.016 P = 0.036, P = 0.024
NLR	3.5 ± 3.5	3.9 ± 4.6	5.16 ± 8.7	5.61 ± 8.2	F = 6.128 P < 0.001, P = 0.007 P = 0.003, P = 0.004
PLR	129 ± 50.4	132 ± 45.7	156 ± 98.7	178 ± 112.4	F = 10.457 P = 0.02, P = 0.004, P = 0.002 P = 0.016, P = 0.009, P = 0.019
MPV (fL)	9.005 ± 1.7	11.4 ± 1.6	8.5 ± 1.8	8.5 ± 1.3	F = 7.121 P = 0.073, P = 0.946, P = 0.0992
RDW (%)	12.07 ± 0.9	12.6 ± 1.8	13.3 ± 2.2	12.3 ± 1.07	F = 0.854 P = 0.950, P = 0.486, P = 0.997
BMI (kg/m)	22.69 ± 2.13	23.81 ± 2.65	27.75 ± 4.64	30.82 ± 4.5	F = 67.205 (P < 0.001)

NLR – Neutrophil/Lymphocyte ratio, PLR – Platelet/Lymphocyte ratio, BMI – Body mass index, RDW – Red cell distribution width, MPV – mean platelet volume

Publications have shown that blood NLR and PLR levels increase in the inflammatory process [11, 16]. In our study, the NLR and PLR rates of cases with gangrene and perforations were higher than in the early catarrhal period. While there was no difference between NLR levels in gangrenous and perforated appendicitis, the PLR level was significantly higher in perforated appendicitis. It was found that the PLR level was more sensitive than leukocyte level and NLR as a marker of the inflammatory state.

In our study, the rate of acute appendicitis diagnoses was higher among patients with a BMI below 25 in the early period of acute appendicitis, i.e. in the early stage and catarrhal period. In patients with a BMI of more than 30, the rate of detection of perforated appendicitis was significantly higher. We think obesity is an important factor in the late diagnosis of acute

appendicitis. Excess subcutaneous adipose tissue decreases the sensitivity of physical examination and imaging methods. We found that a high BMI generally caused a delay in the diagnosis. No such study on obesity was found in the literature. We think that this finding is one of the most interesting aspects of our study. We also think that blood NLR and PLR should always be evaluated in emergency surgery, especially in cases with inflammatory findings such as acute appendicitis.

In conclusion, it is important to detect acute appendicitis early. In blood tests, besides leukocyte value and NLR, PLR is also very helpful. We should not forget that cases over 40 years old are diagnosed later than younger cases which increases the risk of perforation. We wanted to underscore the problem that physicians should be more careful and skeptical in order not to delay the diagnosis in patients with a high BMI and/or patients with advanced age and abdominal pain.

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