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THE RELATIONSHIP OF NEUTROPHIL AND PLATELET MARKERS WITH CLINICAL VARIABLES AND DISEASE ACTIVITY IN PATIENTS WITH ANKYLOSING SPONDYLITIS

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Abstract

Objectives: The aim of this study is to show the relationship between neutrophil and platelet levels and clinical criteria such as disease activity and pain in ankylosing spondylitis (AS) patients.

Materials and Methods: The study included 48 AS patients (Group 1) and 47 healthy controls (Group 2). Clinical and laboratory evaluations, including the measurement of the hemogram, neutrophil to lymphocyte ratio (NLR), platelet to lymphocyte ratio (PLR), C-reactive protein (CRP), and erythrocyte sedimentation rate (ESR), were performed. The AS patients were divided into two subgroups according to their disease activity was evaluated by using the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) score (≥4 high activity, <4 low activity).

Results: Mean age of the patients was 42.44 ±12.32 years in Group 1 and 46.30 ± 9.10 years in Group 2 and showed no significant difference between groups (All p values >0.05). The ESR, CRP, NLR, PLR, and plateletcrit (PCT) values were significantly higher in Group 1, while the hemoglobin values were significantly lower in Group 2 (All p values <0.05). The platelet count was significantly higher in the subgroup with high disease activity according to the BASDAI score (All p values <0.05). A significantly negative weak correlation was found between MPV and BASMI and MPV and ESR (r=-0.303, p=0.037; r=-0.492, p<0.001, respectively). According to the receiver operating characteristic (ROC) analysis, PLR and MPV had diagnostic value in demonstrating disease activity.

Conclusion: While NLR, PLR, and PCT can be used in the initial evaluation of inflammation in AS patients, PLR and MPV were found effective in demonstrating disease activity.

Keywords: Ankylosing spondylitis, mean platelet volume, neutrophil to lymphocyte ratio, platelet to lymphocyte ratio, plateletcrit.

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Introduction

Ankylosing spondylitis (AS) is a chronic inflammatory rheumatic disease that primarily affects the sacroiliac joint and spinal segment and is characterized by joint and extra-articular involvements.[1] While its etiopathogenesis is unknown, the disease is usually seen in young men, with a prevalence varying between 0.15-1.4% in the general population.[1,2]

In addition to clinical findings and imaging methods, the acute phase reactants C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) are frequently used to determine disease activity and inflammatory progression in rheumatic diseases.[1] It has been reported that CRP and ESR levels may increase in approximately 50 to 70% of AS patients.[2] In addition, it is known that some cytokines and biological markers used in determining the disease activity and prognosis in AS increase with inflammation. However, these markers are not routinely used since they are difficult and expensive to obtain.[3]

Recently, an association between the neutrophil, lymphocyte, platelet, neutrophil to lymphocyte ratio (NLR), platelet to lymphocyte ratio (PLR), mean platelet volume (MPV), platelet distribution width (PDW), and plateletcrit (PCT) count (an indicator of the number of platelets in a unit volume of blood) and inflammation has been established.[4-6] It has been reported that MPV is decreased in active clinical conditions of rheumatological diseases and can be used as a negative acute phase reactant[7,8], while NLR is effective in demonstrating systemic inflammation in rheumatic diseases such as rheumatoid arthritis.[9] In addition, it has been proposed that the NLR can be used as a subclinical inflammatory marker in familial Mediterranean fever and in predicting the development of amyloidosis.[10] In line with this information, the number of studies evaluating the relationship of NLR and PLR with disease activity in rheumatic diseases has increased, confirming the use of these parameters as an indicator of disease activity.[9-11]

In previous studies, the relationship of neutrophil and platelet parameters with disease activity and the functional index was evaluated, but the relationship of these parameters with quality of life, metrological index and enthesitis index in AS patients was not investigated. The aim of this study is to show the relationship between neutrophil and platelet levels and clinical criteria such as disease activity, pain, quality of life, enthesitis index, functional index, and metrological index in patients with AS.

Materials and Methods

Forty-eight patients who applied to the Department of Physical Medicine and Rehabilitation of our hospital between January 2016 and January 2020 and were previously diagnosed with AS according to the Modified New York criteria were included as the patient group (Group 1). The control group (Group 2) was comprised

of 47 age- and sex-matched healthy patients. Patient data were analyzed retrospectively. Ethical approval was obtained from the University Clinical Research Committee (Date: 23/12/2020, Decision No: 370) prior to the study. The study was conducted in accordance with the principles of the Declaration of Helsinki.

The patients who have been observed with the diagnosis of AS for at least one year were included in the study. Exclusion criteria: Patients with hypertension, diabetes mellitus, coronary artery disease, thyroid disease, chronic obstructive pulmonary disease, asthma, malignancy, liver or kidney failure, inflammatory bowel disease, or local or systemic infection, current smokers or with a history of smoking in the past year were not included in the study. Patient data regarding demographic features (age, gender, and body mass index), laboratory examination results, and the duration of the disease were recorded. Healthy controls were formed from the patient relatives who did not meet the exclusion criteria.

Hemoglobin (g/dL), leukocyte ($\times 10^9$/L), lymphocyte ($\times 10^9$/L), neutrophil ($\times 10^9$/L), thrombocyte ($\times 10^9$/L), MPV (fL), PCT (%), and PDW (fL) values were obtained simultaneously from complete blood count. NLR was determined by dividing the absolute neutrophil count by the absolute lymphocyte count and PLR was determined by dividing the absolute platelet count by the absolute lymphocyte count. The CRP (mg/L) and ESR (mm/hour) acute phase reactants were also evaluated. Clinical and laboratory evaluations of the patients were performed simultaneously on the same day.

BASDAI, BASFI, BASMI, enthesitis index, and ASQL scales are routinely performed in patients with Ankylosing Spondylitis, and data were obtained from patient files in a retrospective review. In the AS group, the disease activity was evaluated using the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), which consists of six questions, including fatigue, spinal pain, pain and/or swelling in peripheral joints, areas of localized tenderness, and the duration and severity of morning stiffness. The total score ranges from 0 (best) to 10 (worst).[12]

The functional status of the patients was checked with the Bath Ankylosing Spondylitis Functional Index (BASFI). The index is evaluated on a 10-cm-long visual analog scale (VAS), with a total of 10 questions, eight of which include activities of daily living and two questions evaluating the patients' ability to cope with daily life. The total score was calculated between 0 and 10.[13]

Spinal mobility of AS patients was evaluated using the Bath Ankylosing Spondylitis Metrology Index (BASMI), which includes measurements regarding cervical rotation, tragus to wall distance, lumbar lateral flexion, lumbar anterior flexion (modified Schober test), and intermalleolar distance. Total scores range from 0 to 10, with a lower score denoting better spinal mobility.[14]

Quality of life was assessed using the Ankylosing Spondylitis Quality of Life (ASQoL) questionnaire. This questionnaire consists of 18 yes/no items designed to measure the impact of AS on health-related quality of life, with lower scores indicating better quality of life.[15]

The Maastricht Ankylosing Spondylitis Enthesitis Score (MASES) was used to evaluate the degree of enthesitis in the patients. MASES bilaterally evaluates the first and seventh costochondral joints, posterior and anterior iliac spines, iliac crest, and Achilles attachment site and determines whether the fifth lumbar spinous process is sensitive to pressure. Tenderness in all regions was recorded as absent (0 points) or present (1 point), with the total score ranging between 0 and 13.[16]

Day and night pain evaluations of the patients were performed using a 10-cm-long VAS.

Comparison of the patient and control group data and intergroup comparison of the AS patients according to their BASDAI score (≥4 high activity, <4 low activity) were performed.

Statistical analyses

Power analysis and sample size calculation were performed using the PASS version 11.0 software (NCSS LLC, Kaysville, UT, USA). Accordingly, the study power was 0.990 with alpha=0.005, beta=0.00956, standard deviation 1 and 2=0.1, and, k=2, and a total of n=76. According to the power analysis, there should be at least 38 patients in each group. As we reached the target patient number at that point, we terminated the study, and in total, we completed recruitment. Totally 95 patients were included in the study.

Statistical analyses were performed using IBM SPSS (IBM SPSS Statistics Version 22.0. Armonk, NY: IBM Corp.) software. While descriptive statistics were used to determine the characteristics of the patients and controls, a comparison of the groups was carried out using Fisher's exact chi-square test, independent samples t-test, and the Mann-Whitney U test. Correlation analyses were performed using the Pearson correlation coefficient. Receiver operating characteristic (ROC) analysis was performed to examine the diagnostic values of the NLR, PLR, MPV, PCT, and PDW parameters. According to the ROC analysis, appropriate sensitivity and specificity values were determined and the according to threshold value was found by calculating the lowest value according to the $Distance=(1-sensitivity)^2+(1-specificity)^2$ formula based on the Pythagorean theorem. Since MPV and PDW were negatively correlated with BASDAI, ESR, and CRP, the analysis was performed by considering the decreasing values in the ROC analysis more significant for positive results. The results were expressed as number (percent) and mean±standard deviation (mean±SD). A p-value less than 0.05 was considered significant in the statistical analyses.

Results

The mean age of the patients was 42.44 ±12.32 years in Group 1 and 46.30 ± 9.10 years in Group 2. The groups showed similarity in terms of age, gender and body mass index. The mean duration of the disease was 12.92 ±11.91 years in the patient group. Group 1 had significantly higher ESR, CRP, NLR, PLR, and PCT values and significantly lower hemoglobin values than the control group (All p values <0.05). The comparison of the demographic data and laboratory findings of AS patients and healthy controls and their evaluations regarding disease activity index, quality of life, enthesitis, and pain are given in Table 1.

According to the BASDAI score, 29 patients had a high level of disease activity (BASDAI≥4), while 19 had a low level of activity (BASDAI<4). Platelet count was found to be significantly higher in the group with high activity (p=0.022). The comparison of the laboratory values of the AS patients divided into groups according to disease activity is given in Table 2.

The correlation analysis among the patients' NLR, PLR, and MPV values and their age, BASDAI, BASFI, BASMI, ASQoL, MASES, day VAS, night VAS, VAS patient's global assessment, VAS physician's global assessment, ESR, and CRP parameters demonstrated a statistically significant, negative weak correlation between MPV and BASMI and between MPV and ESR (r=-0.303, p=0.037 and r=-0.492, p=<0.001 respectively). There was no correlation between NLR and PLO with all the above-mentioned parameters and no correlation was found between MPV and the above parameters except BASMI and ESR (Table 3).

The ROC analysis results for the diagnostic values of NLR, PLR, MPV, PCT, and PDW based on the threshold values of BASDAI ≥4, ESR>20 mm/hour, and CRP >5 mg/dl are shown in Table 4. According to the ROC analysis results, the diagnostic value of PLR was 71.0% (area under the curve: 0.710) and the diagnostic value of MPV was 72.3% (area under the curve: 0.723) according to the ESR>20 mm/hour threshold. While PLR had a sensitivity of 68.8%, specificity of 81.3% and a cut-off value of>161.50, MPV had a sensitivity of 75.0%, specificity of 62.5%, and a cut-off value of<9.90. The diagnostic values of both parameters were statistically significant (p=0.019 and p=0.013, respectively). The results of the ROC analysis of other parameters revealed no statistical significance for their diagnostic values. The cut-off graph for platelet and lymphocyte parameters in patients with ankylosing spondylitis based on the threshold values of ESR>20 mm/hour is shown in Figure 1.

Table 1. Demographic data and laboratory findings of the study groups and the disease activity index, quality of life, enthesitis, and pain evaluation results of ankylosing spondylitis patients.

Parameters	AS patients n=48)	Controls (n=47)	p
Age (years)	42.44±12.32	46.30±9.10	0.056†
BMI (kg/m²)	26.84±5.10	27.76±5.01	0.377†
Sex (female/male)	13/35	10/37	0.509
Duration of the disease (years)	12.92±11.91	-	-
BASDAI	4.50±1.99	-	-
BASFI	3.55±2.49	-	-
BASMI	2.48±1.99	-	-
ASQoL	9.46±5.56	-	-
MASES	3.56±3.63	-	-
VAS night	3.54±3.56	-	-
VAS day	3.67±2.92	-	-
VAS patient GA	4.33±2.33	-	-
VAS physician GA	3.63±1.78		
ESR (mm/hour)	17.94±14.38	11.47±7.40	**0.035***
CRP (mg/L)	9.48±10.08	4.70±3.02	**<0.001***
Hemoglobin (g/dL)	13.94±1.85	14.80±1.44	**0.008***
Leukocyte (×10⁹/L)	8.06±1.90	7.77±1.45	0.655*
Neutrophil (×10⁹/L)	5.15±1.47	4.64±1.08	0.053†
Lymphocyte (×10⁹/L)	2.22±0.88	2.38±0.59	0.053*
Platelet(×10⁹/L)	288.67±61.64	270.72±66.87	0.177†
NLR	2.72±1.38	2.03±0.63	**0.017***
PLR	148.97±67.36	118.13±37.11	**0.014***
MPV (fL)	9.81±1.19	9.72±1.54	0.820*
PCT	0.27±0.05	0.25±0.06	**0.040†**
PDW (fL)	16.02±0.35	16.08±0.38	0.381†

(AS: ankylosing spondylitis, ASQoL: Ankylosing Spondylitis Quality of Life, BASDAI: Bath Ankylosing Spondylitis Disease Activity Index, BASFI: Bath Ankylosing Spondylitis Functional Index, BASMI: Bath Ankylosing Spondylitis Metrology Index, BMI: body mass index, CRP: C-reactive protein, ESR: erythrocyte sedimentation rate, MASES: Maastricht Ankylosing Spondylitis Enthesitis Score, MPV: mean platelet volume, NLR: neutrophil to lymphocyte ratio, PCT: plateletcrit, PLR: platelet to lymphocyte ratio, PDW: platelet distribution width, VAS: visual analog scale.)
*Mann-Whitney U test, †Student's t-test. The data are shown as n, % or mean±standard deviation. Significant p values are written in bold.

Table 2. Comparison of ankylosing spondylitis patients according to BASDAI values.

Parameters	BASDAI <4 (n=19)	BASDAI≥4 (n=29)	p
ESR (mm/hour)	14.21±9.35	20.38±16.59	0.268*
CRP (mg/L)	9.33±10.50	9.58±9.98	0.599*
Hemoglobin (g/dL)	14.33±1.93	13.69±1.78	0.249†
Leukocyte ($\times10^9$/L)	8.28±2.03	7.92±1.84	0.527†
Neutrophil($\times10^9$/L)	5.11±1.53	5.19±1.46	0.856†
Lymphocyte($\times10^9$/L)	2.37±0.99	2.12±0.80	0.877*
Platelet($\times10^9$/L)	265.74±43.50	303.69±67.61	**0.022**†
NLR	2.57±1.35	2.81±1.41	0.473*
PLR	129.59±51.89	161.66±73.92	0.132*
MPV (fL)	10.09±1.34	9.63±1.07	0.195†
PCT	0.27±0.05	0.28±0.06	0.405†
PDW (fL)	16.11±0.37	15.96±0.33	0.134†

(BASDAI: Bath Ankylosing Spondylitis Disease Activity Index, CRP: C-reactive protein, ESR: erythrocyte sedimentation rate, MPV: mean platelet volume, NLR: neutrophil to lymphocyte ratio, PCT: plateletcrit, PLR: platelet to lymphocyte ratio, PDW: platelet distribution width.)

*Mann-Whitney U test, †Student's t-test. The data are shown as mean±standard deviation. Significant p values are written in bold.

Table 3. Correlations of the clinical and laboratory parameters in ankylosing spondylitis patients.

		Age	BASDAI	BASFI	BASMI	ASQoL	MASES	VAS night	VAS day	VAS patient	VAS physician	ESR	CRP
NLR	r	-0,077	0.001	0.186	0.099	0.005	0.143	0.117	0.091	-0.101	0.081	0.176	0.249
	p	0.605	0.992	0.207	0.503	0.972	0.333	0.428	0.538	0.493	0.584	0.232	0.088
PLR	r	-0.069	0.064	0.076	0.179	0.102	0.140	0.217	0.098	-0.019	0.198	0.268	0.014
	p	0.643	0.666	0.606	0.223	0.488	0.344	0.139	0.509	0.896	0.177	0.066	0.927
MPV	r	-0.157	0.086	-0.077	-0.303	0.118	-0.053	-0.018	0.032	0.079	-0.015	-0.492	-0.046
	p	0.286	0.559	0.601	**0.037**	0.423	0.718	0.905	0.830	0.593	0.921	**<0.001**	0.756

(ASQoL: Ankylosing Spondylitis Quality of Life, BASDAI: Bath Ankylosing Spondylitis Disease Activity Index, BASFI: Bath Ankylosing Spondylitis Functional Index, BASMI: Bath Ankylosing Spondylitis Metrology Index, CRP: C-reactive protein, ESR: erythrocyte sedimentation rate, MASES: Maastricht Ankylosing Spondylitis Enthesitis Score, MPV: mean platelet volume, NLR: neutrophil to lymphocyte ratio, PLR: platelet to lymphocyte ratio, VAS: visual analog scale.)

Table 4. Receiver operating characteristic curve analysis results of platelet and lymphocyte parameters in patients with ankylosing spondylitis based on BASDAI, ESR, and CRP thresholds.

	Sensitivity	Specificity	AUC	Cut-off	Likelihood ratio	p
BASDAI						
NLR	0.586	0.526	0.542	>2.22	1.24	0.628
PLR	0.759	0.526	0.630	>120.99	1.60	0.132
MPV	0.621	0.579	0.588	<10.05	1.47	0.307
PCT	0.621	0.579	0.583	>0.26	1.47	0.337
PDW	0.586	0.579	0.620	<16.05	1.39	0.164
ESR						
NLR	0.750	0.594	0.646	>2.30	1.85	0.101
PLR	0.688	0.813	0.710	>161.50	3.67	**0.019**
MPV	0.750	0.625	0.723	<9.90	2.00	**0.013**
PCT	0.563	0.594	0.504	>0.27	1.38	0.089
PDW	0.563	0.719	0.633	<15.85	2.00	0.088
CRP						
NLR	0.650	0.571	0.584	>2.30	1.52	0.326
PLR	0.600	0.607	0.588	>144.95	1.53	0.301
MPV	0.650	0.607	0.621	<9.90	1.66	0.155
PCT	0.500	0.571	0.488	>0.27	1.17	0.884
PDW	0.400	0.643	0.535	<15.85	1.12	0.683

(AUC: area under the curve, BASDAI: Bath Ankylosing Spondylitis Disease Activity Index, CRP: C-reactive protein, ESR: erythrocyte sedimentation rate, MPV: mean platelet volume, NLR: neutrophil to lymphocyte ratio, PCT: plateletcrit, PLR: platelet to lymphocyte ratio, PDW: platelet distribution width.)

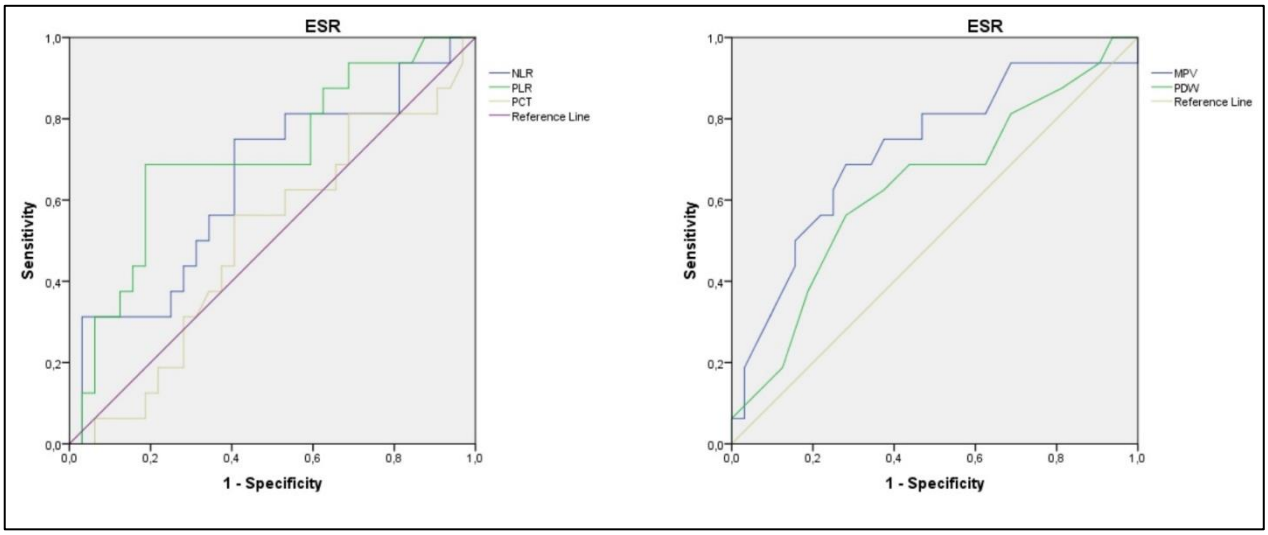

Figure 1. The cut-off graph for platelet and lymphocyte parameters in patients with ankylosing spondylitis based on the threshold values of ESR >20 mm/hour

Discussion

In the current study, AS patients had significantly higher ESR, CRP, NLR, PLR and PCT parameters but lower hemoglobin values than the control group. The platelet count was higher in the subgroup with high disease activity. A negative correlation was observed between MPV and BASMI and between MPV and ESR in the patient group. In addition, PLR and MPV had diagnostic value in demonstrating disease activity.

The literature on neutrophil and platelet markers in AS patients has presented inconsistent results. While NLR and TLR values were high in some studies[17-19], they were similar to those of the control group in others.[11,20] In a study of 30 AS patients and 35 healthy controls, Bozan et al. reported higher NLR values in the study group and similar PLR values.[18] Gokmen et al. also recounted higher NLR values in their patient group.[21] In another study of 103 AS patients, NLR and PLR values were found to be similar to those of the control group.[19] In studies examining the relationship of disease activity with NLR and PLR, it was reported that NLR and PLR values were higher in the group with high disease activity according to BASDAI.[19,20] The NLR and PLR values were found to be similar when 216 AS patients were divided into groups according to disease activity.[17] In our study, NLR and PLR values were found to be significantly higher in AS patients than in the control group. When we evaluated disease activity according to BASDAI, we found that 29 patients showed high activity. The group with high disease activity had higher NLR and PLR values than the group with low disease activity, but this elevation did not reach statistical significance.

In systemic inflammation, changes occur in circulating leukocytes, erythrocytes, and thrombocyte counts. The best known of these changes are normochromic anemia, thrombocytosis, and the relative decrease in lymphocyte count accompanying the increase in the neutrophil count.[11] In inflammatory conditions, platelets are stimulated and significant changes occur in their structure and function. Low MPV levels have been reported in patients with an increased inflammatory response, such as rheumatoid arthritis. In inflammatory diseases, large-size platelets migrate to and are consumed in the inflammation area, and, in addition to this, platelet production is stimulated by increasing the number of platelets in the circulation.[26] When we examined the relationship of these parameters to an acute inflammatory process in our study, MPV's threshold value was <9.4, sensitivity 71.9% and specificity 68.7%, while PLR's threshold value was 161.50, sensitivity 68.8% and specificity was 81.3%.

It has been reported that thrombocyte and MPV values are higher in AS patients than in non-AS patients.[22] In another study[23], platelet values were high in 30 AS patients, while MPV values were low. The same study also reported an increase in MPV values after TNF treatment. Sahin et al. reported that low MPV levels could be used as a negative acute phase reactant.[8] While some studies reported that MPV has a negative[23] or positive[24] correlation with BASDAI in AS patients, others stated otherwise.[21,25] Byun et al. reported that there was no

relationship between MPV values and BASDAI, BASFI, and ASDAS.[25] Al-Osami et al. reported that platelet count was high in the active group in 132 AS patients in comparison to the low activity group, classified according to BASDAI.[20] Similarly, the platelet count was high in the group with BASDAI ≥4 in another study.[7] In our study, platelet and MPV values were found to be similar between AS patients and the control group. While the platelet count was high in the group with high disease activity, MPV values were similar. However, there was a negative correlation between MPV and ESR, confirming that MPV is a negative acute phase reactant. We also found a negative correlation between MPV and BASMI. This situation explains the limitation of spine motion during the active disease period.

Platelet distribution width is an indicator of variability in platelet size.[27] Studies on PDW have mostly been conducted in rheumatoid arthritis patient groups.[28] In their study of 216 AS patients, Illeez et al. found that the PDW values were significantly lower in the AS group, while they were similar in active remissory AS patients.[17] In contrast to this study, PDW values were similar in the AS and control groups in our study, but similarly, there was no difference between the groups in terms of disease activity.

The number of studies on PCT in AS patients are limited in the literature. In a study evaluating 46 AS patients, Luo et al. reported that the PCT value was higher than the control group.[29] In patients with axial spondyloarthropathy, a positive correlation was found between PCT levels and ASDAS but not with BASDAI.[30] In our study, PCT values were higher in the patient group. However, there was no difference between the groups according to the BASDAI.

In an examination of the relationship between clinical findings and laboratory parameters of AS patients, Sezgin et al. divided patients into two groups according to BASDAI and MPV and reported no difference between the groups in terms of morning stiffness or the number of swollen and tender joints.[22] Similar to this study, when the patients were divided into two groups according to BASDAI, we observed that there was no difference between them in terms of enthesitis index, quality of life, pain, VAS patient and physician global evaluations, BASMI and BASFI in our study.

The confirmation of increased systemic inflammation in AS patients are important in terms of demonstrating both serious disease activity and possible comorbid conditions. Therefore, it is important to practically determine the degree of inflammation in these patients.[20] The PLR and MPV values, which we found to have diagnostic value in demonstrating disease activity according to the results of ROC analysis, together with ESR and CRP, are useful markers in demonstrating the inflammatory response and disease activity in AS patients.

The superiority and dissimilarity of our study to other studies are that while just the relationship between lymphocyte and platelet parameters with BASDAI and BASFI was evaluated in other studies, the relationship between enthesitis index, quality of life, BASMI, patient and doctor global evaluation with these parameters

was also investigated. The most important limitations of our study were its retrospective design and the use of disease-modifying drugs, which may affect the complete blood count. In addition, we could not confirm whether the patients received any medical treatment that may affect platelet functions during the evaluation period. Prospective controlled and long-term studies will be useful to understand the relationship between AS patients and hematological parameters, and their effects on the disease. In addition, we think it would be beneficial to group patients in terms of the treatments they receive and, if necessary, using imaging techniques for enthesitis.

In conclusion, we determined that the NLR, PLR, and PCT parameters, which can be easily obtained from complete blood count, can be used in the initial evaluation of inflammation in AS patients. In addition, PLR and MPV were found to be effective in demonstrating disease activity. However, parameters other than PLR and MPV exhibited no significant relationship with clinical criteria. Platelets and neutrophils can be used as inexpensive and early diagnostic markers in AS patients to confirm inflammation.

Ethical Considerations: Approval was obtained from University Clinical Researches Ethics Committee (Date: 23/12/2020, Decision No: 370).

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