acta medica

ORIGINAL ARTICLE

Investigation of Mean Platelet Volume as a Prognostic Criterion in Non-Healing Wounds

Fatma Nilay Tutak[1]
ORCID: 0000-0001-6519-5716

Fatih Doğan[1]
ORCID: 0000-0001-8761-9321

Aşkı Vural[2]
ORCID: 0000-0002-4320-720X

[1]Adıyaman University, Medical Faculty, Department of Plastic Reconstructive and Aesthetic Surgery, Turkey.

[2]Adıyaman University, Medical Faculty, Department of Internal Diseases, Turkey.

Corresponding Author: Fatma Nilay Tutak
Adıyaman University, Medical Faculty, Department of Plastic Reconstructive and Aesthetic Surgery, Turkey.
E-mail: nilayprs@gmail.com

Received: 17 August 2021, Accepted: 22 October 2021, Published online: 19 March 2022

ABSTRACT

Objective: We aimed to evaluate if the Mean Platelet Volume (MPV) is an acute phase reactant in non-healing wounds, by analyzing its correlation with Erythrocyte Sedimentation Rate (ESR).

Method: Our study was carried out in a descriptive type with the participation of patients with non-healing wounds. The laboratory data and characteristics of the patients were accessed retrospectively, and the obtained data were recorded in the data recording form.

Results: The sample group consisted of 92 patients with non-healing wounds. 26.9% of the patients with non-healing wounds had pressure sores, 37.6% of them had diabetic foot wounds, 18.3% had non-healing wounds developed after trauma, and 17.2% had necrotizing fasciitis. The average age of the patients was 53.22±19.13, and the average length of stay in the hospital was 108.98±18.78 (min 3 months, max 6 months) days. The MPV value, which was found to be high in the early stages of non-healing wounds, decreased after the wound was completely healed. When the MPV value was compared to ESR, an acute phase reactant, a positive and strong statistically significant correlation was found between MPV and ESR based on the result of this correlation analysis ($r=0.256$, $p<0.01$).

Conclusion: MPV can be used as a marker, just like ESR, in the presence of non-healing wounds. MPV value can be measured with blood taken into the complete blood count. However, an extra blood sample and a different tube are required for ESR. Using MPV value instead of ESR will provide savings in terms of cost and labor.

Keywords: Mean platelet volume, non-healing wounds, prognostic criteria

INTRODUCTION

Wound healing includes complex biochemical and cellular processes, and it is affected by many variables such as intracellular components and extracellular matrix [1,2]. In non-healing wounds, the process of new vessel formation (angiogenesis) is often impaired. Due to insufficient blood supply, nutrients and oxygen cannot be transported to the wound [3-5]. Non-healing wounds cause low comfort levels, low quality of life and low morale and motivation, loss of work power, loss of function due to the wound, long morbidity period and/or risk of death. This reveals the importance of the issue [1,5]. In addition, depending on the location and size of the wound, periodic maintenance often causes the individual to be unable to perform self-care alone, and this is emotionally and socio-economically exhausting. If non-healing wounds deepen over time and progress towards the bone, they cause osteomyelitis. Osteomyelitis, which can be defined as bone inflammation, prepares the

ground for amputation. Despite the high awareness of the problems caused by non-healing wounds, its management cannot be provided at an optimal level.

Platelets are small and morphotic elements of blood. Platelets are effective at the stage of hemostasis and fibrosis in the optimally smooth and expected wound healing process. In the first stage of the wound healing process, platelets accumulate at the wound site. When antagonists (Thromboxane A2 receptor antagonists, etc.) are activated, cytoplasmic granular content and inflammatory cytokines (interleukin-1 and interleukin-6, and tumor necrosis factor-alpha) are released and aggregated. Thus, fibrosis and inflammatory processes are initiated [6,7]. Platelets play an important role in the pathogenesis of local and systemic inflammation. Interleukin (IL)-6, which increases in the inflammatory process, has a direct effect on megakaryocytes and stimulates thrombopoietin simultaneously [8].

Mean Platelet Volume (MPV) can provide important data on cardiovascular and respiratory diseases [9-12], rheumatoid arthritis [13], juvenile systemic lupus erythematosus [14], neoplasms [15,16], diabetes mellitus [17] and Crohn's disease [18,19]. The MPV value may change in such systemic inflammations. A typical mean value of platelet volume ranges from 9.7fL to 12.8 fL in intravascular fluid. In the literature reviews, it was reported that MPV value increases in the presence of ischemic heart disease, stroke, venous thromboembolism, hypertension, metabolic syndrome and neoplasm [20-26] There are also studies showing that MPV value decreases in the presence of trauma and sepsis [6,27]. Normally, the MPV value is in the range of 7.5 fL and 10 fL.

In case of bone damage caused by non-healing wounds, magnetic resonance imaging (MRI) and probe-to-bone (PTB) tests can be applied. Erythrocyte Sedimentation Rate (ESR) guides the applications of care and treatment in all non-healing wounds. Apart from the cost of MRI and PTB, they fall short of the reliability of ESR in terms of the certainty of their results [28]. ESR is defined as the sedimentation rate of erythrocytes. In the presence of inflammation in the body, some protein structures (fibrinogen, α2, β and γ globulin) combine with erythrocytes, causing erythrocytes to precipitate faster [29].

Debris accumulation in the wound paves the way for bacteria to multiply. Dead cells and cell debris in necrotic tissue reduce host defenses and promote infection. The presence of necrotic tissue creates a mechanical obstacle to wound healing, limiting the epithelization of the wound surface, prolonging the inflammatory process and causing inflammation [1-5]. This creates a non-healing wound.

Acute phase reactants (AFRs) are proteins whose serum concentrations increase (positive AFR) or decrease (negative AFR) by at least 25% in response to inflammation. Positive AFRs include Erythrocyte Sedimentation Rate (ESR), C-reactive protein (CRP), procalcitonin (PCT), serum amyloid A (SAA), ferritin, and so forth. Among these, CRP, PCT and ESR are the most used in the evaluation of infection and inflammation [30]. However, these are laboratory tests that are costly and require a new tube of blood from the patient. It is advantageous to work on MPV with other parameters on complete blood count. In this study, we aimed to investigate the MPV value as a prognostic criterion in non-healing wounds.

MATERIALS AND METHODS

The data of our study were analyzed retrospectively. The research design is descriptive. The sample group consisted of 92 patients with non-healing wounds who were followed up in the Plastic, Reconstructive and Aesthetic Surgery Clinic of Adıyaman University Medical Faculty Hospital between 2014 and 2019. Patients treated in the study were included in the sampling. The purposive sampling method was used in sampling.

Inclusion Criteria;

i. Patients with a non-healing wound
ii. Being treated in the specified clinic between 2014 and 2019
iii. Being 14 years old or older
iv. Patients without malignancy

Exclusion Criteria;

i. Non-problematic, acute wounds
ii. Patients followed up outside the period of 2014 and 2019
iii. Being under the age of 14
iv. Patients with malignancy

Patient data were analyzed retrospectively using past computer-based records, patient files and electronic health records, and these data were recorded in a data record form developed by the researcher. Parameters such as sociodemographic characteristics, wound etiology, length of hospital stay, blood values of the patients were recorded.

Statistics

Statistical analysis of the results obtained in the study was performed using IBM SPSS (Statistical Package for the Social Sciences) Statistics 25. Descriptive statistical methods (Frequency, Standard Deviation, Arithmetic Mean) were used in data evaluation. The Kruskal-Wallis test, Wilcoxon signed-rank test, One-way ANOVA and Post hoc test were performed to determine the statistical significance of the differences between the means of the groups. Correlation analysis was used. Kolmogorov-Smirnov and Shapiro-Wilk tests were performed to find normal distribution assumptions. The results were evaluated at 95% confidence interval with a significance level of $p<0.05$.

Ethics

Prior to the study, the requisite approvals were obtained from Adıyaman University Clinical Research Ethics Committee (Decision No:2015/02-05). After the Ethics Committee Report was issued, access to patient records was provided and patient confidentiality was taken into account, and only health records were accessed, identity information was not examined.

RESULTS

The sample group of this study consisted of 92 patients with non-healing wounds. Non-healing wounds were classified as follows; 26.9% (n=25) of the patients had pressure sores, 37.6% (n=35) of them had diabetic foot wounds, 18.3% (n=17) had non-healing wounds developed after trauma, and 17.2% (n=16) had necrotizing fasciitis. When the characteristics of the patients were examined, the average age of the patients was found as 53.22±19.13 (min 14, max 80) years. 60.2% (n=56) of the sample group was determined as male and 39.8% (n=37) as female. The average length of stay in the hospital was determined as 108.98±18.78 days (min 3 months, max 6 months). The patients were discharged after the recovery of the non-healing wounds. The average healing time of problematic wounds was determined as 114±24.46 days (min 3 months, max 6 months). Laboratory data of the patients are included in Table 1.

Average blood values were determined as follows; Phosphorus as 3.36±0.93 (min 1.9, max 7.4), Calcium as 9.03±0.53 (min7.5, max 10.1), Vitamin D as 12.57±11.86 (min 2.49 max, 103.16), Parathyroid hormone as 42.23±33.69 (min 12.6, max 218.3), Magnesium as 2.19±0.42 (min 1.23, 3.23), ESR at the time of admission as 44.15±23.3 (min 2, max 113), WBC at the time of admission as 10.04±4.08 (min 3.83, max 22.77), MPV at the time of admission as 10.52±3.72 (min 4.54, max 13.6), PLT at the time of admission as 287.05±89.01 (min 139.5, max 610.3), HGB at the time of admission as 12.11±1.74 (min 8.81, max 18.3), Albumin as 3.14±0.52 (min 1.6, max 4.24), total protein value as 6.69±0.72 (min 4.6, max 8.2) and ALP as 92.48±57.43 (min 18, max 405) (Table 2.).

According to the Wilcoxon analysis, there is a statistically significant relationship between admission and discharge values of the means of HGB, WBC, ESR and MPW. Accordingly, while the ESR value was 44.15±23.3 (min 2, max 113) at the time of admission, it was determined as 26.49±15.51 (min 6, max 83) at the time of discharge (p=0.001), and while the MPV value was 10.52±3.72 (min 4.54, max 13.60) at the time of admission, it was determined as 6.9±1.65 (min 4.4, max 14.83, median 6.62) at the time of discharge (p=0.024).

Table 1. Results of Patients' Laboratory Data.

Laboratory Data	(Mean±SD)	Min-Max
Phosphor	3.36±0.93	1.9-7.4
Calcium	9.03±0.53	7.5-10.1
Vitamin D	12.57±11.86	2.49-103.16
Parathormone	42.23±33.69	12.6-218.3
Magnesium	2.19±0.42	1.23-3.23
ESR (Admission)	44.15±23.3	2-113
WBC (Admission)	10.04±4.08	3.83-22.77
MPV (Admission)	10.52±3.72	4.54-13.6
PLT (Admission)	287.05±89.01	139.5-610.3
HGB (Admission)	12.11±1.74	8.81-18.3
Albumin	3.14±0.52	1.6-4.24
Total Protein	6.69±0.72	4.6-8.21
ALP	92.48±57.43	18-405

Table 2. Comparison of Laboratory Data and Values of Non-Healing Wounds at the time of Admission and Discharge.

Laboratory Data		Value at the time of Admission	Value at the time of Discharge	Items
HGB	Mean±SD	12.11±1.74	12.32±1.79	p=0.158
	Min-Max (Median)	8.81-18.3	8.74-17.87	z=-1.413
WBC	Mean±SD	10.04±4.08	7.49±1.81	**p=0.001****
	Min-Max (Median)	3.83-22.77	4.25-14.37	z=-6.483
PLT	Mean±SD	287.05±89.01	280.11±84.22	p=0.141
	Min-Max (Median)	139.5-610.3	83.86-576.6	z=-1.472
ESR	Mean±SD	44.15±23.3	26.49±15.51	**p=0.001****
	Min-Max (Median)	2-113	6-83	z=-7.274
MPV	Mean±SD	10.52±3.72	6.9±1.65	**p=0.024***
	Min-Max (Median)	4.54-13.60	4.4-14.83	z=-5.007

*p<0.05, **p<0.01, z; Wilcoxon signed-rank test

Table 3. Comparison of MPV Value with the Type of Non-Healing Wound.

	Type of Non-healing Wound	Admission Value (Mean±SD)	Discharge Value (Mean±SD)	p, z
MPV value	Pressure Sores (1)	10.35±1.40 (min 5.57, max 13.20)	6.32±0.63 (min 5.21, max 7.16	**p=0,001**** z=1654
	Traumatic (2)	10.29±1.3 (min 5.49, max 13.70)	6.46±0.76 (min 4.74- max 8.89)	p=0.56 z=11003
	Diabetic Foot (3)	10.28±1.4 (min 5.65, max 13.50)	6.44±0.71 (min 4.78- max 8.35)	p=0.06 z=2211
	Necrotizing Fasciitis (4)	10.34±1.9 (min 4.54, max 13.80)	6.21±1.48 (min 4.63, max 8.93)	**p=0.001**** z=756
	Post hoc			4>1>2, 3

*p<0.05, **p<0.01, z; Wilcoxon signed-rank test, F=Post hoc test

The comparison of MPV and type of non-healing wound was given in Table 3. The difference between the admission and discharge values of MPV value was found to be statistically significant in necrotizing fasciitis and pressure sores (p<0.01). In the post hoc analysis, the statistical difference between MPV values at the time of admission and discharge in non-healing wounds, from the highest to the lowest, was listed as follows; pressure sores > necrotizing fasciitis > traumatic wound > diabetic foot wound.

In the comparison of sociodemographic data with the types of non-healing wounds, there is a statistically significant difference in the types of wounds depending on gender (p=0.001, t=1214). Decubitus ulcers and traumatic wounds were found to be higher in males than females (p=0.001, KW=11503). The higher rate of the diabetic foot and necrotizing fasciitis in women compared to men was found to be statistically significant (p=0.001, KW=11597).

Table 4 includes the correlation of laboratory data. A positive and strong statistically significant correlation was found between MPV and ESR (r=0.256, p=0.016). There is a positive and moderately significant correlation between Calcium and Vitamin D (r= .457, p=0.000). There is a strong and negative correlation between calcium and ESR at the time of admission (r=-. 216, p=0.043). Similarly, there is a strong and negative correlation between Vitamin D and Parathyroid hormone (r=-. 249, p<0.029).

Table 5 presents the comparison of the laboratory data with the types of non-healing wounds. Accordingly, a statistically significant correlation was found between the types of non-healing wound and vitamin D, parathyroid hormone and magnesium values. 25-hydroxy vitamin D was found to be the highest in non-healing wounds developed after trauma, and the lowest in necrotizing fasciitis (p=0.009, KW=11600). The parathyroid hormone level was found to be the highest in necrotizing fasciitis and the lowest in pressure sores (p=0.037, KW=8466). Magnesium value was found to be the highest in non-healing wounds developed after trauma and the lowest in pressure sores (p=0.001,

Table 4. Correlation of Laboratory Data.

Laboratory Data	r, p	Magnesium	Phosphor	Calcium	25-hydroxy vitamin D	Parathormone	ESR	MPV
Magnesium	r	1.000						
	p	-						
Phosphor	r	-0.06	1					
	p	.580	-					
Calcium	r	0.02	0.206	1				
	p	.852	.051	-				
25-hydroxy vitamin D	r	-0.021	0.211	.457	1.000			
	p	.848	.051	**.000****	-			
Parathormone	r	0	-0.038	-0.071	-.249	1		
	p	0.367	.740	.534	**.029**	-		
ESR	r	0.133	0	-.216	-0.131	-0.131	1	
	p	.221	0.187	**.043***	.233	.251	-	
MPV	r	0.089	0.037	0	-.008	0.065	.256	1.000
	p	.409	.726	0.61	.939	.566	**.016***	-

*p<0.05, **p<0.01, r; Spearman Rank Correlation

KW=16928). In the Post hoc analysis, the HGB value, from the highest to the lowest, was determined as follows; pressure sores> necrotizing fasciitis> traumatic wound> diabetic foot. MPV values were higher in pressure sores and necrotizing fasciitis than the diabetic foot and traumatic wound.

DISCUSSION

The treatment of non-healing wounds aims to reduce morbidity and mortality, to increase the quality of life and comfort, and to provide socioeconomic well-being. In the treatment of non-healing wounds, clinicians usually deal with the wound area. However, the focus should not only be on the wound, but also on laboratory data. In this study, we obtained evidence for evaluating MPV as a prognostic criterion in the presence of problematic wounds. In this study, we obtained evidence for evaluating MPV as a prognostic criterion for non-healing wounds. In our study, the significant difference between MPV values at the time of admission and discharge suggests that MPV may be a prognostic criterion. At the same time, a positive and strong statistically significant relationship (r=0.256, p=0.016) was found between MPV and ESR. This has been a finding that supports our hypothesis. This evidence is promising as it means that MPV can be used instead of ESR.

The sample group of this study consisted of 92 patients with non-healing wounds. Non-healing wounds were classified as follows; 26.9% (n=25) of the patients had pressure sores, 37.6% (n=35) of them had diabetic foot wounds, 18.3% (n=17) had non-healing wounds developed after trauma, and 17.2% (n=16) had necrotizing fasciitis. The average length of stay in the hospital was determined as 108.98±18.78 days (min 3 months, max 6 months). The patients were discharged after the recovery of the non-healing wounds. They were then called to be followed up periodically. The mean treatment period for non-healing wounds was determined as 114±24.46 days (min 3 months, max 6 months).

In the literature, it has been reported that CRP, ESR, platelet and MPV are important biomarkers in determining clinical processes and MPV levels are associated with ESR and CRP levels [31-34]. In a previous study, 83 patients with ulcerative colitis were examined, and in this study, an increase in ESR, CRP, neutrophil levels and a decrease in MPV were found. In addition, the relationship between MPV level and inflammation has been reported in previous studies [35-37]. It is thought that the increasing number and activity of platelets during the inflammation process affects MPV levels [38,39].

Crohn's disease, Hepatitis B, Acute Appendicitis cases are reported to be associated with MPV levels, depending on the inflammation [40,41]. In a previous study, it was reported that the MPV value varied during the remission and relapse periods of inflammatory bowel diseases, increasing during remission and decreasing during relapse periods [42]. Therefore, it is possible that MPV levels may

Table 5. Comparison of the Laboratory Data with the Types of Non-Healing Wound.

Laboratory Data	Types of Non-healing Wound	n	Mean±SD	Min-Max	p, KW, t
Albumin	Pressure Sores	25	3.05±0.62	1.6-4.2	p=0.270 KW=3924
	Traumatic	17	3.36±0.48	2.6-4.2	
	Diabetic Foot	34	3.15±0.5	2.1-4.24	
	Necrotizing Fasciitis	16	3.03±0.41	2.23-3.56	
Total Protein	Pressure Sores	25	6.78±0.56	6.1-8.04	p=0.100 KW=6255
	Traumatic	17	6.46±0.93	4.6-7.6	
	Diabetic Foot	34	6.95±0.58	5.9-8.2	
	Necrotizing Fasciitis	16	6.26±0.76	5.2-6.99	
ALP	Pressure Sores	25	95.68±36.83	49-166	p=0.368 KW=3157
	Traumatic	17	106.18±114.83	36-405	
	Diabetic Foot	34	83.21±22.7	18-121	
	Necrotizing Fasciitis	16	92.63±47.05	57-199	
Phosphor	Pressure Sores	23	3.43±1.16	2-7.4	p=0.928 t=0.111
	Traumatic	17	3.33±0.72	2.1-4.3	
	Diabetic Foot	34	3.29±0.88	1.9-5	
	Necrotizing Fasciitis	16	3.45±0.93	1.9-5.2	
Calcium	Pressure Sores	25	9.08±0.45	7.8-9.8	p=0.962 KW=0.288
	Traumatic	17	8.98±0.71	7.5-9.7	
	Diabetic Foot	34	9.03±0.43	8.4-10.1	
	Necrotizing Fasciitis	16	9.02±0.68	7.9-9.9	
25-hydroxy vitamin D	Pressure Sores	21	14.03±21.26	2.49-103.16	**p=0.009**** KW=11600
	Traumatic	17	17.02±7.1	6-26	
	Diabetic Foot	32	10.51±6.44	2.95-28.06	
	Necrotizing Fasciitis	16	10.06±3.66	4-16	
Parathormone	Pressure Sores	18	29.11±9.42	12.6-46.4	**p=0.037**** KW=8466
	Traumatic	17	41.54±19.99	22-74	
	Diabetic Foot	28	46.01±50.74	18-218.3	
	Necrotizing Fasciitis	16	51.13±20.53	23-75	
Magnesium	Pressure Sores	22	2.01±0.31	1.23-2.6	**p=0.001**** KW=16928
	Traumatic	17	2.46±0.39	1.9-3.1	
	Diabetic Foot	33	2.09±0.42	1.39-3.23	
	Necrotizing Fasciitis	16	2.34±0.38	1.8-3.1	
HGB (Admission)	Pressure Sores (1)	25	12.73±2.16	9.94-18.3	p=0.104 F=2114 Post hoc; 1>2>3>4
	Traumatic (2)	17	12.26±1.61	8.81-15.6	
	Diabetic Foot (3)	35	11.92±1.41	9.35-15.44	
	Necrotizing Fasciitis (4)	16	11.43±1.64	9.26-14.3	
WBC (Admission)	Pressure Sores	25	10.68±4.44	4.46-22.75	p=0.415 KW=2.851
	Traumatic	17	9.45±4.46	4.26-18.6	
	Diabetic Foot	35	10.53±3.87	6.52-22.77	
	Necrotizing Fasciitis	16	8.57±3.37	3.83-13.57	
PLT (Admission)	Pressure Sores	25	310.34±126.91	139.5-610.3	p=0.293 KW=3724
	Traumatic	17	289.22±42.85	232-345.7	
	Diabetic Foot	35	279.43±75	154.2-515	
	Necrotizing Fasciitis	16	265.02±80.93	193-436.5	
ERS (Admission)	Pressure Sores	23	36.09±20.43	2-88	p=0.198 KW=4222
	Traumatic	17	50.24±30.23	13-113	
	Diabetic Foot	32	45.59±20.76	13-112	
	Necrotizing Fasciitis	16	46.38±22.81	23-89	
MPV (Admission)	Pressure Sores (1)	25	10.35±1.40	5.57-13.20	p=0.907 F=0.904 Post hoc; 1,4>2,3
	Traumatic (2)	17	10.29±1.3	5.49-13.70	
	Diabetic Foot (3)	35	10.28±1.4	5.65-13.5	
	Necrotizing Fasciitis (4)	16	10.34±1.9	4.54-13.8	

*p<0.05, **p<0.01, KW; Kruskal-Wallis Test t; One-Way ANOVA Test, F=Post hoc Test

increase or decrease in systemic inflammations. The increase in MPV in the inflammation is related to the stimulation of thrombopoietin formation by IL-6 and the direct effect of this cytokine on megakaryocytes [43]. MPV acts as an inflammatory marker in many chronic diseases. Thus, it can show the activity of the diseases and the effectiveness of the treatment [44]. In a study investigating the MPV value in diabetic foot wounds, it was found that amputation surgery was more common in patients with high MPV value compared to those with lower MPV value [45].

In our study, the MPV value at the time of admission was found to be high in all four different wound types, including the diabetic foot wound. In addition, when comparing the MPV with the types of non-healing wounds, the difference between the MPV value at the time of admission and discharge was found to be the highest in necrotizing fasciitis and the lowest in diabetic foot wound. The difference between values at the time of admission and discharge was statistically significant in necrotizing fasciitis and pressure sores. In addition, in our study, the ESR value was found 44.15±23.3 at the time of admission and 26.49± 5.51 at the time of discharge (p=0.001). Accordingly, the MPV value was 7.52±1.72 at the time of admission and 6.9±1.65 at the time of discharge (p=0.024). As a prognostic criterion in inflammatory diseases, ESR is an important biomarker, and it increases as a result of inflammatory conditions [46]. In this way, it may be possible to use the ESR value alone for diagnosis because some parameters such as age, gender and the presence of a concomitant secondary infection may also affect the level of ESR. ESR reacts slowly in an inflammatory situation [47]. However, in our study, there is a more remarkable decrease in MPV value compared to ESR. This result can be taken into account as a finding that increases the potency of MPV to be a prognostic criterion.

The data regarding MPV in the literature differ due to the fact that the studies have been conducted in different and independent groups, the reliability of the measurement devices is not known exactly, and the changing approaches of the scientists. In the literature review, no study was found to determine the correlation between non-healing wounds and MPV level. In this regard, our study results can be a basis for the use of MPV as an acute phase reactant in clinical applications in non-healing wounds, as well as guiding clinicians. This study was limited by the nature of its single-center design.

CONCLUSION

In our study, it was found that the MPV value was high in the non-healing wounds prior to the treatment and decreased after the non-healing wounds started to heal. In the literature, no study was found to determine the correlation between ESR and MPV in non-healing wounds. In this regard, this study can be seen as an important source of information. However, some important parameters that may affect MPV could not be evaluated due to the retrospective design of our study. These can be listed as environmental factors, nutrition, alcohol use, smoking and psychological factors.

According to our results, high MPV and ESR values at the same time and a decrease in both values after the healing show the correlation between MPV and ESR levels. Therefore, we recommend that this change in MPV level should be evaluated in larger sample groups. The return of these values to normal after the non-healing wounds are healed is the most important evidence that they increase due to inflammation. We believe that our study will guide clinicians and academics and form a basis for future studies. In addition, if the evidence we have obtained is strengthened, the use of MPV value instead of ESR will save in terms of cost and labor.

Author contribution

Study conception and design: FNT, FD, and AV; data collection: FNT, FD, and AV; analysis and interpretation of results: FNT and FD; draft manuscript preparation FNT, FD, and AV. All authors reviewed the results and approved the final version of the manuscript.

Ethical approval

The study was approved by the Adıyaman University (Protocol no. 02-5/2015).

Funding

The authors declare that the study received no funding.

Conflict of interest

The authors declare that there is no conflict of interest.

REFERENCES

[1] Sheng L, Zhang Z, Zhang Y, Wang E, Ma B, Xu Q, et al. A novel "hot spring"-mimetic hydrogel with excellent angiogenic properties for chronic wound healing. Biomaterials 2021;264:120414.

[2] Catanzano O, Quaglia F, Boateng JS. Wound dressings as growth factor delivery platforms for chronic wound healing. Expert Opinion on Drug Delivery 2021.

[3] Sun G, Zhang X, Shen YI, Dickinson LE, Fox-Talbot K, Reinblatt M, Steenbergen C, Harmon JW, Gerecht S. Dextran hydrogel scaffolds enhance angiogenic responses and promote complete skin regeneration during burn wound healing. Proc Natl Acad Sci USA 2011; 108(52):20976-81.

[4] Briquez PS, Clegg LE, Martino MM, Gabhann FM, Hubbell JA. Design principles for therapeutic angiogenic materials, Nat Rev Mater 2016;1(1):15006.

[5] Russell MJ, Daniel RM, Hall AJ. On the emergence of life via catalytic ironsulfide membranes. Terra Nova 1993; 5(4):343-34

[6] Linke B, Schreiber Y, Picard-Willems B, et al., Activated platelets induce an anti-inflammatory response of monocytes/macrophages through cross-regulation of PGE2 and cytokines. Mediators of Inflammation 2017;14.

[7] Korniluk A, Koper-Lenkiewicz OM, Kamińska J, Kemona H, Dymicka-Piekarska V. Mean platelet volume (MPV): new perspectives for an old marker in the course and prognosis of inflammatory conditions. Mediators of inflammation. 2019.

[8] Zimmet J, Ravid K. Polyploidy: occurrence in nature, mechanisms, and significance for the megakaryocyte platelet system. Experimental Hematology 2000;28(1):3-16.

[9] Slavka G, Perkmann T, Haslacher H, et al., Mean platelet volume may represent a predictive parameter for overall vascular mortality and ischemic heart disease. Arteriosclerosis, Thrombosis, and Vascular Biology 2011;31(5):1215-18.

[10] Shah B, Oberweis B, Tummala L, et al., Mean platelet volume and long-term mortality in patients undergoing percutaneous coronary intervention. American Journal of Cardiology 2013:111(2):185-89.

[11] Feng Y, Yin H, Mai G, et al., Elevated serum levels of CCL17 correlate with increased peripheral blood platelet count in patients with active tuberculosis in China. Clinical and Vaccine Immunology 2011;18(4):629-32.

[12] Koç S, Eyibilen A, Erdoğan AS. Mean platelet volume as an inflammatory marker in chronic sinusitis. European Journal of General Medicine 2011;8(4):314-17.

[13] Gasparyan AY, Sandoo A, Stavropoulos-Kalinoglou A, Kitas GD. Mean platelet volume in patients with rheumatoid arthritis: the effect of anti-TNF-α therapy. Rheumatology International 2010;30(8):1125-29.

[14] Yavuz S, Ece A. Mean platelet volume as an indicator of disease activity in juvenile SLE. Clinical Rheumatology 2014;33(5):637-641.

[15] Li N, Yu Z, Zhang X, et al. Elevated mean platelet volume predicts poor prognosis in colorectal cancer. Scientific Reports 2017;7(1):10261.

[16] Yin JB, Wang X, Zhang X, Liu L, Wang RT. Mean platelet volume predicts survival in pancreatic cancer patients with synchronous liver metastases. Scientific Reports 2018;8(1):6014.

[17] Rollini F, Franchi F, Muñiz-Lozano A, Angiolillo DJ. Platelet function profiles in patients with diabetes mellitus. Journal of Cardiovascular Translational Research 2013;6(3):329-45.

[18] Liu S, Ren J, Han G, et al. Mean platelet volume: a controversial marker of disease activity in Crohn's disease. European Journal of Medical Research, 2012;17(1):27.

[19] Zubcevic N, Mesihovic R, Zubcevic S. Usefulness of laboratory data in estimation of Crohn's disease activity. Medical Archives 2010;64(1):33-36.

[20] Lippi G, Mattiuzzi C, Comelli I, Cervellin G. Mean platelet volume in patients with ischemic heart disease: meta-analysis of diagnostic studies. Blood Coagul Fibrinolysis 2013; 24:216-219.

[21] Turfan M, Erdogan E, Ertas G, Duran M, Murat SN, Celik E, et al. Usefulness of mean platelet volume for predicting stroke risk in atrial fibrillation patients. Blood Coagul Fibrinolysis 2013; 24:55-58.

[22] Cay N, Ipek A, Gumus M, Birkan Z, Ozmen E. Platelet activity indices in patients with deep vein thrombosis. Clin Appl Thromb Hemost 2012;18:206-10.

[23] Cao X, Xie X, Zhou J, Yang P, Wang Y, Chen Z. Increased platelet volume in a general population with prehypertension: a cross-sectional study of 80 545 participants from China. Hypertens Res 2012;35:903-908.

[24] Lippi G, Salvagno GL, Targher G, Guidi GC. Relationship between mean platelet volume and biochemical components of the metabolic syndrome. Clin Drug Investig 2007; 27:731-32.

[25] Aksoy S, Kilickap S, Hayran M, Harputluoglu H, Koca E, Dede DS, et al. Platelet size has diagnostic predictive value for bone marrow metastasis in patients with solid tumors. Int J Lab Hematol 2008; 30:214-19.

[26] Thompson CB. Selective consumption of large platelets during massive bleeding. BMJ (Clin Res Ed) 1985; 291:95-96

[27] Robbins G, Barnard DL. Mean platelet volume changes in infection. J Clin Pathol 1983; 36:1320.

[28] Xu J, Cheng F, Li Y, Zhang J, Feng S, Wang P. Erythrocyte Sedimentation Rate Combined With the Probe-to-Bone Test for Fast and Early Diagnosis of Diabetic Foot Osteomyelitis. The International Journal of Lower Extremity Wounds 2020.

[29] Kutlucan A. Eritrosit Sedimentasyon Hızı ve Klinik Kullanımı [Erythrocytes Sedimentation Rate and Clinical Use]. Konuralp Tıp Dergisi 2012;4(3):73-76.

[30] Hacımustafaoğlu M. Akut Faz Reaktanları (Eritrosit Sedimentasyon Hızı, CRP) [Acute Phase Reactants (Erythrocyte Sedimentation Rate, CRP)]. Cocuk Enfeksiyon Dergisi 2017;11(1):53-55.

[31] Yuksel O, Helvaci K, Basar O, Koklu S, Caner S, Helvaci N, Abayli E, Altiparmak E. An overlooked indicator of disease activity in ulcerative colitis: mean platelet volume. Platelets 2009; 20: 277-81.

[32] Collins CE, Rampton DS. Platelet dysfunction: a new dimension in inflammatory bowel disease. Gut 1995; 36: 5-8.

[33] Danese S, Motte Cd Cde L, Fiocchi C. Platelets in inflammatory bowel disease: clinical, pathogenic, and therapeutic implications. Am J Gastroenterol 2004; 99: 938-45.

[34] Ozturk ZA, Dag MS, Kuyumcu ME, Cam H, Yesil Y, Yilmaz N, Aydinli M, Kadayifci A, Kepekci Y. Could plate- let indices be new biomarkers for inflammatory bowel diseases? Eur Rev Med Pharmacol Sci 2013; 17:334-41.

[35] Gasparyan AY, Ayvazyan L, Mikhailidis DP, Kitas GD. Mean platelet volume: a link between thrombosis and inflammation? Curr Pharm Des 2011; 17: 47-58.

[36] Gasparyan AY, Sandoo A, Stavropoulos-Kalinoglou A, Kitas GD. Mean platelet volume in patients with rheuma- toid arthritis: the effect of anti-TNF-alpha therapy. Rheu- matol Int 2010; 30: 1125-9.

[37] Liu S, Ren J, Han G, Wang G, Gu G, Xia Q, Li J. Mean platelet volume: a controversial marker of disease activity in Crohn's disease. Eur J Med Res 2012; 17:27.

[38] Threatte GA. Usefulness of the mean platelet volume. Clin Lab Med 1993; 13: 937-50.

[39] Bath PM, Butterworth RJ. Platelet size: measurement, physiology and vascular disease. Blood Coagul Fibrinolysis 1996; 7: 157-61.

[40] Ozturk ZA, Dag MS, Kuyumcu ME, Cam H, Yesil Y, Yil- maz N, Aydinli M, Kadayifci A, Kepekci Y. Could plate- let indices be new biomarkers for inflammatory bowel diseases? Eur Rev Med Pharmacol Sci 2013; 17:334-41.

[41] Zha A, Wang Y, Zha R. Meta analysis of the changes of blood coagulation in patients with active ulcerative colitis. Xi bao yu fen zi mian yi xue za zhi= Chinese journal of cellular and molecular immunology 2015;31(11):1528-32.

[42] Coşkun Y. Role of Mean Platelet Volume as a Marker of Dısease Actıvıty in Patients with Ulceratıve Colıtıs. Acta Medica 2019;35:3355.

[43] Senchenkova EY, Komoto S, Russell J, et al. Interleukin-6 mediates the platelet abnormalities and thrombogenesis associated with experimental colitis. American Journal of Pathology 2013;183(1):173-81.

[44] Mete E, Akelma AZ, Çizmeci MN, Bozkaya D, Kanburoğlu MK. Decreased mean platelet volume in children with acute rotavirus gastroenteritis. Journal Platelets 2014;25(1):51-54.

[45] Aslan M, Adanas C. Blood systemic inflammatory markers in adult brucella knee arthritis 2019.

[46] Kapukaya R, Kapukaya A, Keklikcioglu B, Özdemir AA. How important are mean platelet volume and neutrophil values in diabetic foot amputation decision?. European Journal of Plastic Surgery 2021; 1-4.

[47] Feng JF, Huang Y, Chen QX. The combination of platelet count and neutrophil lymphocyte ratio is a predictive factor in patients with esophageal squamous cell carcinoma. Transl Oncol 2014; 7:632-637.

