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Original Article

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Relationship of Arteriovenous Fistula Thrombosis and Complete Blood Counting Parameters in Hemodialysis Patients With Arteriovenous Fistula

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ABSTRACT

Objective: The most common reason for hospitalization in hemodialysis patients is related to complications due to vascular access dysfunction. Therefore, studies on maintaining arteriovenous fistula continuity for a longer period are still up-to-date. The aim of this study was to determine the relationship between late arteriovenous fistula thrombosis and complete blood count parameters (especially, mean platelet volume) that were evaluated before arteriovenous fistula creation in hemodialysis patients.

Methods: Forty-six end-stage kidney disease patients who presented to our clinic between July 1, 2020 and February 2, 2022, for arteriovenous fistula creation were included as the study population. Two groups were created: those who dialyzed without complications in the first year and those who developed thrombosis within 1 year. By evaluating the examinations of the patients, the whole blood parameters of the participants with and without thrombosis on Doppler ultrasound were compared before the arteriovenous fistula was created.

Results: Mean platelet volume values were lower in the patients with late arteriovenous fistula thrombosis than in the patients with normal arteriovenous fistula functions ($P = .000$). Lower hemoglobin (Hgb) values were detected in the thrombosis group ($P = .000$). There was a marked correlation between the risk of arteriovenous fistula thrombosis and low mean platelet volume values. While a weak positive correlation was determined between white blood cell and mean platelet volume values in thrombosed arteriovenous fistula cases ($0.30 < r < 0.50$, $P = .468$), it was found that platelet count and mean platelet volume values weakly correlated negatively ($-0.30 < r < -0.50$, $P = .013$).

Conclusion: These results suggest that preoperative low mean platelet volume values can associated with higher arteriovenous fistula thrombosis risk.

Keywords: Arteriovenous fistula stenosis, complete blood counting, MPV, hemodialysis

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INTRODUCTION

The most reliable and sustainable way for the continuity of dialysis in end-stage kidney disease is the creation of a native arteriovenous fistula (AVF).[1] Dysfunction of the vascular access pathway in dialysis patients is the major reason of morbidity,[2] and 20% to 25% of hospitalizations in regular dialysis patients are due to vascular access problems.[2,3] Medications, endothelial cell injury due to recurrent access, stasis, hypercoagulability, and red cell mass are reported factors that are related to vascular access malfunctions.[4,5] Moreover, diabetes, the AVF site, advanced age (>65), the duration of AVF after surgical procedure, smoking, increased lipid profile were listed as risks for stenosis of AVF.[3,5] Although it occurs frequently in the AVF region, the pathogenesis of stenosis is not fully explained due to its multi-mechanistic thrombotic or sclerotic processes.[3-5] The most common cause of this occlusive process has been indicated as venous stasis which occurs due to increased neointimal hyperplasia and disrupted peri-anastomotic outflow due to inadequate remodeling.[3,4]

Previous studies claimed that complete blood counting parameters are associated with venous flow.[6] Especially mean platelet volume (MPV) suggested as an important predictive marker for vascular thrombotic processes.[6,7] Moreover, it has been claimed that both high and low MPV levels may be directly related to inflammatory events. Additionally, MPV was reported as a platelet activation marker.[8] More granules are contained in larger platelets that have rapid aggregation properties with collagen, express excess glycoprotein Ib and IIb/IIIa receptors, and release more thromboxane A2.[8,9] Activation sites are also areas where platelet shape and volume changes can occur. Contact of platelets with agonists such as serotonin and adenosine diphosphate (ADP) leads to shape changes such as pseudopodia formation.[10,11] Recent reports suggesting that increased levels of MPV may be associated with vascular thrombosis have also suggested that it might be related with inflammation.[12]

The aim of present study was to determine the relationship between complete blood counting values (especially serum MPV levels) and the late AVF thrombosis development in HD patients.

METHODS

The ethical approval was obtained from the clinical research Ethics Committee of Fırat University (Approval no: 2022/04-16.) The study designation was conducted regarding the Helsinki Declaration Principles and in accordance with the scope of the local guidelines for good clinical practice. Signed informed consent was taken from all participants.

This prospective cross-sectional study was carried out between July 1, 2020, and February 2, 2022, in the Cardiovascular Surgery Department of Elazig Fethi Sekin City Hospital. The end-stage kidney disease patients just before the creation of the AVF were recorded. Patients with a known cancer history, bleeding diathesis, systemic circulatory disorder (including steal syndrome), developing thrombosis within the first month, or patients whose records could not be reached due to follow-up deficiencies were excluded from the study. Two groups were created for 46 patients who underwent active dialysis by AVF access as follows: as the first group who developed fistula thrombosis within the first year (group 1, n = 20), and the second group who continued active dialysis without any problems (group 2, n = 26). The complete blood parameters (hemoglobin: Hgb, g/dL; mean platelet volume, MPV, fL; white blood cell count: WBC, 10^{-3}/μL; platelet count: PLT, 10^{-3}/μL) of the patients just before the creation the AVF were recorded and the records of the patients who had thrombosis during the color Doppler (Philips Lumify linear transducer, Philips Healthcare, Cambridge, MA) examination in the outpatient clinic were evaluated and recorded.

Statistical Analysis

All statistical evaluations were made by using a software program SPSS version 15.0 (SPSS Inc., Chicago, IL). Five tests were used for determining the normal distribution analysis of continuous data (skewness-kurtosis, Shapiro–Wilk Test, histogram, mean/SD, Q-Q plots). Normally distributed continuous data were presented as mean ± SD (mean ± SD), and not normally distributed continuous data were shown as Median (minimum—maximum), and Mann–Whitney *U*-test was made for comparisons. Relationships between blood parameters were tested with Pearson analysis among normally distributed data and Spearman's rho correlation analysis among non-normally distributed data. Blood values were categorized over clinical reference values, and the relationship between the frequency of abnormal values and stenosis was examined using the chi-square test. In this study, $\alpha = 0.05$ and $P < \alpha$ was considered significant.

RESULTS

Thrombosis was observed in 20 of 46 patients. An insignificant difference was detected between the 2 groups in terms of age and gender ($P > .05$). The lower MPV (9.12 ± 0.82 vs. 7.89 ± 0.94 fL) and Hgb (11.39 ± 2.12 vs. 9.87 ± 1.42 g/dL) levels were found in the thrombosis group ($P < .05$). The main characteristics of the groups are compared in Table 1.

Frequency analysis of blood values was performed by comparing normal and abnormal values between the 2 groups (Table 2). According to analysis, there is a marked relation between the thrombosis frequency and abnormal MPV values ($P = .011$). There is no relationship between the frequency of abnormal HB, WBC, PLT values, and thrombosis.

Table 1. Baseline Characteristics of Study Population

	Control	Thrombosis	*P**
Age (years)	58.85 ± 13.36	61.34 ± 15.10	.562
Gender (male/%)	11/42%	8/40%	.612
Hemoglobin (g/dL)	11.39 ± 2.12	9.87 ± 1.42	.006
WBC (10^{-3}/μL)	8.89 ± 3.10	9.01 ± 3.41	.902
MPV (fL)	9.12 ± 0.82	7.89 ± 0.94	.000
PLT (10^{-3}/μL)	218 (106-491)	218.50 (94-504)	.965

*$P < .05$ is significant.
MPV, mean platelet volume; PLT, platelet count; WBC, white blood cell count.

MAIN POINTS

- Arteriovenous fistula dysfunction is the most common reason for hospitalization in hemodialysis patients.
- We aimed to determine the relationship between preoperative complete blood count parameters (especially mean platelet volume) and late arteriovenous fistula thrombosis.
- We observed that preoperative low mean platelet volume values can associated with higher arteriovenous fistula thrombosis risk.

Table 2. Correlation Analysis of Categorized Blood Data With Chi-Square Test

	Control (n)	Thrombosis (n)	Chi-Square Test (*P**)
Hemoglobin (reference 13.5-16.9 g/dL)			*P* = .075 (Fisher's exact test)
Normal	3	0	
Abnormal	17	26	
WBC (reference 3.91-10.90 10^{-3}/μL)			*P* = 0.99
Normal	5	6	
Abnormal	15	20	
MPV (fL)			Value: 6.460 *P* = .011 (Yates test)
Normal	10	3	
Abnormal	10	23	
PLT (10^{-3}/μL)			Value: 0.827 *P* = .363 (Yates test)
Normal	15	15	
Abnormal	5	11	

*$P < .05$ is significant.
MPV, mean platelet volume; PLT, platelet count; WBC, white blood cell count.

After the determination of frequency, the correlations between thrombosis and complete blood parameters were evaluated (Table 3). A weak positive correlation was detected between WBC and MPV values in AVF thrombosis group ($0.30 < r < 0.50$, $P < .05$). A weak negative correlation was detected between PLT values and MPV values ($-0.30 < r < -0.50$, $P < .05$).

Table 3. Correlation Analysis Between Blood Parameters of Stenosis Patients

			Hemoglobin	WBC	MPV
Pearson correlation	Hemoglobin				
		r	1.000	0.079	0.438
		P	–	.700	.025
	WBC				
		r	0.079	1.000	−0.149
		P	.700	–	.468
	MPV				
		r	0.438	−0.149	1.000
		P	.025	.468	–
Spearman's rho's correlation	PLT				
		r	0.074	0.271	−0.482
		P	.721	.180	.013

Weak positive correlation: $0.30 < r < 0.50$; weak negative correlation: $-0.30 < r < -0.50$.
MPV, mean platelet volume; PLT, platelet count; WBC, white blood cell count.

DISCUSSION

These findings revealed that MPV can be related to thrombotic AVF malfunction. Our results supported that low Hgb and MPV levels before AVF formation increased the risk of fistula thrombosis after the procedure.

Although kidney transplant is a certain treatment for end-stage kidney insufficiency, the life of these patients depends on dialysis for a long time due to donor insufficiency. The safest vascular access route for maintaining dialysis is arteriovenous fistulas.[1-4] Therefore, fistula continuity is important. While anastomosis quality, vascular structure, and long-term dialysis are the major factors that determine the continuity of the fistula, the experience of the dialysis team, patient-related systemic factors, and thrombotic susceptibility are effective in maintaining adequate flow in the fistula.[2-5] Despite the determination of possible thrombotic reasons for AVF fistula stenosis during hemodialysis, the initial risk factors before AVF creation are not sufficiently defined.[3-5]

In our study, we detected lower initial MPV levels before AVF creation in HD patients with AVF stenosis. The platelet functions can be assessed by determining the serum MPV values simply.[7,13,14] Heterogeneous platelet density, size, and/or reactivity are detected in routine serum evaluations. Increased reactivity is detected in larger platelets.[8-10]

Inflammatory disorders lead to lowering MPV values which is related to impaired platelet functions.[14] In cases with cancer-associated venous thrombosis, low MPV levels were related with higher mortality and progressive disease risk.[15] On the contrary, it has been stated that higher than normal MPV levels are also related to a higher risk of venous thromboembolism.[16] Lower MPV values were usually associated with older platelets which are exhausted and dysfunctional.[17] In the light of current studies and these previous data, reports have been reported of both low and high MPV levels associated with increased thrombosis.[16-18] We think that the association between lower MPV level and increased risk of AVF thrombosis in our findings might be due to higher thrombosis or inflammatory response of abnormal MPV levels. Based on our results, the positive correlation between WBC and MPV can support the inflammatory theory or oppositely, the negative correlation between platelet count and MPV can support the thrombotic theory.[19]

There are some limitations that limit the level of evidence of the study. First of all, tests evaluating the thrombocyte functions in a broad sense could not be performed. In further studies, laboratory parameters evaluating platelet functions and changes in MPV levels should be revealed. Another limitation is related to the sample size of the study. Larger cohorts should be evaluated for the determination of comprehensive results.

CONCLUSION

Our findings support that low MPV levels increase the risk of fistula thrombosis. We believe that the determination of MPV

levels before the procedure in patients who are planning to open AV fistula will be useful in revealing the possible risk of thrombosis and taking the necessary precautions.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Fırat University (Approval no: 2022/04-16, Date: 17.03.2022).

Informed Consent: Verbal informed consent was obtained from the patients who agreed to take part in the study.

Peer-review: Externally peer-reviewed.

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