

# Mean Platelet Volume, Association with Inflammatory and Nutritional Markers in Maintenance Hemodialysis Patients

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**Keywords.** hemodialysis, mean platelet volume, inflammatory marker, nutritional marker

**Introduction.** Mean Platelet Volume (MPV) has been revealed to be a risk factor for ischemic heart disease in the hemodialysis patients. The aim of present study is to investigate the association between MPV level with inflammatory and nutritional factors in patients requiring chronic hemodialysis.

**Methods.** 100 patients who were on maintenance hemodialysis were included. Based on the median MPV (8.7 fL) patients were divided into two groups of low and high MPV level to assess and compare in terms of inflammatory (erythrocyte sedimentation rate, C-reactive protein, and transferrin), and nutritional (albumin, ferritin, uric acid, blood urea nitrogen, creatinine, triglyceride, cholesterol, low density lipoprotein, and high density lipoprotein) parameters.

**Results.** The median MPV level in our patients was  $8.7 \pm 1.8$  fl. There was no statistical difference in the level of inflammatory and nutritional markers between the two groups, and none of them were related to MPV level ( $P > .05$ ). The prevalence of IHD was significantly higher in the high MPV group ( $P < .05$ ). After adjustment for the age, no association was observed between different parameters and MPV level except for transferrin in patient's  $\leq 60$  years old. Mean transferrin levels were significantly lower in the high MPV group ( $P < .05$ ).

**Conclusion.** Present study did not show any association between inflammatory and nutritional markers with MPV level in hemodialysis patients except for the transferrin level in younger cases.

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## INTRODUCTION

Cardiovascular problems are the main causes of mortality and morbidity among patients under dialysis and may be due to hypertension, uremic toxins, oxidative stress, dyslipidemia, and inflammation.<sup>1</sup> It has been shown that increased platelet activity is a risk factor for cardiovascular diseases.<sup>2,3</sup> Mean platelet volume (MPV) is a marker for platelet activity<sup>4,5</sup> which is affected by dyslipidemia, hypertension, diabetes, and smoking.<sup>6-9</sup>

MPV is higher among patients with chronic

kidney disease (CKD) and end-stage renal disease (ESRD) and is associated with higher mortality rate.<sup>10-14</sup> In several previous reports, direct and reverse correlation have been revealed between C-reactive protein (CRP) and MPV.<sup>15,16</sup> Enhanced platelet activity is an essential factor in pathogenesis of atherogenesis and thrombosis and may increase the risk of vascular occlusion.<sup>17-20</sup> MPV is considered as a marker for platelet activity and increased risk of cardiovascular diseases.<sup>20-22</sup> According to several studies, platelet has antimicrobial effects by releasing peptides from alpha granules.<sup>23</sup>

Furthermore, MPV is a pro-inflammatory factor which is involved in prognosis of ESRD patients.<sup>24-26</sup> Malnutrition and inflammation are more common in patients suffering from CKD than normal population which play important roles in cardiovascular disease.<sup>27</sup> Despite the huge number of patients undergoing hemodialysis and the impact of malnutrition and inflammation on cardiovascular disease as the leading cause of death, these factors and their relation are not thoroughly understood. Therefore, recognition of factors and the analysis of their function in patients requiring dialysis may help in reducing the morbidity and mortality of cardiac diseases.<sup>28-31</sup> The aim of this study was to evaluate the association between nutritional and inflammatory factors with MPV level as an indicator of cardiovascular disease.

**MATERIALS AND METHODS**

This observational study performed as a cross-sectional comparative-descriptive survey and conducted in accordance with the tenets of the Declaration of Helsinki. The ethical committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran; approved the project. The inclusion criteria included age above 19 years and hemodialysis treatment. The exclusion criteria were

acute infections, anticoagulant consumption in the past 6 months, decompensated heart failure, chemotherapy, and blood disorders. Informed consent form was obtained from each patient.

After considering inclusion and exclusion criteria, 100 consecutive patients with ESRD who were on maintenance hemodialysis were enrolled. Blood samples were obtained after 8 to 10 hours of fasting. Nutritional and inflammatory markers including creatinine, BUN, albumin, uric acid, total cholesterol, LDL, HDL, triglyceride (TG), FBS, HbA1C, ESR, CRP, ferritin, transferrin, cell blood count, and MPV were assessed in a single lab with a single standard method. Ischemic heart disease (IHD) was defined as a history of myocardial

**Table 1.** Underlying Diseases of the Study Participants

Variables	Number / Percent (n = 100)
Smoking	14
Diabetes	47
Hypertension	69
Ischemic Heart Disease	26
Congestive Heart Failure	5
DVT / Pulmonary Thromboembolism	1
Dyslipidemia	11
Cerebral Vascular Accident	2
Hypothyroidism	8

**Table 2.** Association Between MPV Level and Laboratory and Numerical Background Parameters

Parameters	MPV (fL)		P
	< 8.7	> 8.7	
	Mean ± SD	Mean ± SD	
Dialysis Duration, y	5.49 ± 4.67	4.41 ± 4.75	> .05
Systolic Blood Pressure, mmHg	124.58 ± 22.57	123.70 ± 20.89	> .05
Diastolic Blood Pressure, mmHg	77.40 ± 11.74	75.76 ± 15.30	> .05
BMI, kg/m <sup>2</sup>	24.91 ± 5.23	25.48 ± 4.71	> .05
BUN, mg/dL	58.60 ± 17.57	59.22 ± 15.63	> .05
Creatinine, mg/dL	8.95 ± 2.79	8.15 ± 2.79	> .05
Uric Acid, mg/dL	5.41 ± 1.47	5.72 ± 1.48	> .05
Albumin, g/L	3.96 ± 0.48	4.08 ± 0.54	> .05
Ferritin, ng/mL	526.54 ± 317.59	521.07 ± 448.99	> .05
Transferrin, ng/dL	313.32 ± 44.75	293.98 ± 57.27	> .05
Triglyceride, mg/dL	130.36 ± 79.12	132.90 ± 77.72	> .05
Total Cholesterol, mg/dL	132.84 ± 33.57	133.60 ± 46.02	> .05
LDL, mg/dL	72.50 ± 22.44	73.12 ± 34.93	> .05
HDL, mg/dL	30.92 ± 6.19	31.70 ± 9.47	> .05
FBS, mg/dL	104.76 ± 47.36	107.54 ± 44.91	> .05
HbA1C, g/dL	6.34 ± 1.68	6.25 ± 1.24	> .05
ESR, mm/h	34.36 ± 25.55	30.50 ± 24.87	> .05
CRP, mg/L	16.95 ± 25.49	17.06 ± 25.16	> .05

Abbreviations: BUN, blood urea nitrogen; LDL, low density lipoprotein; HDL, high density lipoprotein; ESR, erythrocyte sedimentation rate; CRP, C-reactive protein.

infarction, coronary artery bypass graft, or critical stenosis on coronary angiography.

Congestive heart failure (CHF) was described as an ejection fraction under 40% which was calculated with Doppler echocardiography.

The association between inflammatory and nutritional factors with MPV was determined with SPSS version 25 using Chi-Square, Fisher, and Independent-Sample-T tests. *P* value < .05 was considered statistically significant.

## RESULTS

After considering inclusion criteria 100 hemodialysis patients were enrolled in our study. Mean age of participants was  $61.3 \pm 13.6$  years and mean dialysis duration was  $4.9 \pm 4.7$  years. Mean systolic and diastolic blood pressures were  $124.1 \pm 21.6$  and  $76.6 \pm 13.6$  mmHg, respectively. Mean body mass index was  $25.2 \pm 4.9$  kg/m<sup>2</sup>. The majority of participants were male (62%). Forth eight percent (48%) and 87% of subjects were consuming statins and erythropoietin respectively. The most common systemic diseases among our patients were hypertension and diabetes. One of our patients had a history of deep vein thrombosis that her drug consumption had been discontinued more than 6 months prior to the study (Table 1).

The mean platelet count, leukocyte count, hemoglobin, and MPV was  $173650 \pm 44630$ ,  $7113 \pm 2560$ ,  $105 \pm 1.6$ , and  $8.9 \pm 1.8$  fl; respectively.

Patients were divided into two groups based on the MPV median value, and demographical, clinical and laboratory parameters were compared between two groups.

None of the inflammatory and nutritional factors were associated with MPV level (Table 2). However, after adjustment for age with the cut-off point of 60 years, transferrin was significantly lower in subjects with high MPV group (*P* < .05). The association between MPV levels with IHD was statistically significant (*P* < .05) even after adjustment for the age (*P* < .05) (Table 3).

## DISCUSSION

The correlation between platelet activity and adverse clinical outcomes has been investigated in the literature. MPV level is a hematologic parameter that has been proposed as a prognostic factor in tissue viability, and for guiding the appropriate management.<sup>32</sup> MPV is one of the important

**Table 3.** Association Between Mean Platelet Volume (MPV) Level and Background Parameters

Parameters	MPV (fL)		<i>P</i>
	< 8.7	> 8.7	
Sex			
Male	50.0%	50.0%	> .05
Female	50.0%	50.0%	
Smoking			
+	42.9%	57.1%	> .05
-	51.2%	48.8%	
Diabetes			
+	53.2%	46.8%	> .05
-	47.2%	52.8%	
Hypertension			
+	49.3%	50.7%	> .05
-	51.6%	48.4%	
Ischemic Heart Disease			
+	26.9%	73.1%	< .05
-	58.1%	41.9%	
Congestive Heart Failure			
+	40.0%	60.0%	> .05
-	50.5%	49.5%	
Dyslipidemia			
+	45.5%	54.5%	> .05
-	50.6%	49.4%	
Cerebral Vascular Accident			
+	50.0%	50.0%	> .05
-	50.0%	50.0%	
Hypothyroidism			
+	62.5%	37.5%	> .05
-	48.9%	51.1%	
Statin Consumption			
+	45.8%	54.2%	> .05
-	53.8%	46.2%	
Erythropoietin Consumption			
+	51.7%	48.3%	> .05
-	38.5%	61.5%	
Age			
< 60 years	49.0%	51.0%	> .05
≥ 60years	51.0%	49.0%	

independent risk factors of thromboembolism and cardiovascular diseases.<sup>10</sup> Besides, based on literature MPV level increases in chronic inflammatory status and malnutrition.<sup>33,34</sup> Previous studies have shown that MPV is higher in patients with CKD.<sup>10-14,29,30,32</sup> Inflammatory markers and various cytokines have key roles in the beginning and continuation of renal disease.<sup>35,36</sup>

The impact of nutritional and inflammatory factors on MPV has been less investigated. There is a significant association between MPV and atherosclerosis.<sup>37</sup> In present study, we evaluated whether larger MPV level is associated with higher

values of inflammatory and nutritional parameters. A prospective study by Verdoia *et al.* revealed the association between higher mortality rate and increased MPV level. Lokesh *et al.* reported that the platelet parameters in hemodialysis patients are less than in the controlled population, which made the clinical utility of these indices doubtful.<sup>2</sup> Moreover, higher MPV was related with increased risk of cardiovascular morbidities and mortality rate.<sup>19</sup> The association between systemic diseases and MPV was evaluated in our study. Since MPV is an inexpensive and feasible laboratory index, it has been assessed in many studies and the association of this parameter with other cardiovascular risk factors has been widely investigated. In our study, only IHD had an association with higher MPV level ( $P < .05$ ).

Although, many studies have assessed the MPV role in thromboembolism and its association with cardiovascular diseases, there are limited numbers of studies that have investigated the association of MPV with nutritional and inflammatory factors. Nasri *et al.* showed a reverse correlation between MPV and CRP level.<sup>16</sup> Bilen *et al.* reported higher ESR and CRP levels in hemodialysis patients that were not statistically significant.<sup>31</sup> In present study there was no significant association between ESR, CRP with MPV level.

In our study, we assessed various nutritional and inflammatory markers such as ESR, CRP, transferrin, albumin, ferritin, uric acid, BUN, Cr, TG, and cholesterol. Despite the hypothesis that inflammation has impacts on platelet size,<sup>38</sup> none of the nutritional markers showed association with the MPV level in our study. Among all the inflammatory markers that were assessed in current study, the only marker which was associated with MPV level after adjustment for the age was transferrin. Patients with higher MPV levels had significantly lower levels of transferrin. We could not find any association between FBS and HbA1C with MPV. CRP level is a predictor for mortality and morbidity in dialysis patients,<sup>15</sup> However in our study, we found no statistically significant association. This study has some limitations, mainly due to the small sample size and not considering the duration of hemodialysis as a probable confounding factor.

In conclusion, according to our result, there was no association between inflammatory and nutritional factors with MPV levels in hemodialysis

patients except for transferrin. Due to the association between ischemic heart disease and MPV, preventive approaches in hemodialysis patients would be beneficial to decrease the burden of the problem. However, further studies with a larger sample size are required to attain more definite results.

## REFERENCES

1. Moeinzadeh F, Shahidi S, Mortazavi M, et al. Effects of Omega-3 Fatty Acid Supplementation on Serum Biomarkers, Inflammatory Agents, and Quality of Life of Patients on Hemodialysis. *Iran J Kidney Dis.* 2016; 10(6):381-387.
2. Lokesh S, Siva RG, Kadavanu TM, Hemachandar R, Kumar A, Tiwari SR, Lakshmi A, Ezhumalai G.A.comparative study of platelet parameters in end stage renal disease patients undergoing. haemodialysis and healthy individuals; *Int J Adv Med.* 2016; 3(3):559-563.
3. Chris W McIntyre. Haemodialysis-Induced Myocardial Stunning in Chronic Kidney Disease – A New Aspect of Cardiovascular Disease.2010; 29(2):105-10.
4. S G Chu, R C Becker, P B Berger, D L Bhatt, J W Eikelboom, B Konkle, E R Mohler, M P Reilly, J S Berger. Mean platelet volume as a predictor of cardiovascular risk: a systematic review and meta-analysis, *J. Thromb. Haemost.* 2010; 8(1):148-56.
5. Han J.S, Park K.S, Lee M.J, et al. Mean platelet volume is a prognostic factor in patients with acute kidney injury requiring continuous renal replacement therapy. *J.Crit. Care.* 2014; 29(6):1016-21.
6. Theoret J.F, Yacoub D, Hachem A, Gillis M.A, Merhi Y. P-selectin ligation induces platelet activation and enhances microaggregate and thrombus formation. *Thromb Res.* 2011; 128(3):243-50.
7. Gasparyan A.Y, Ayvazyan L, Mikhailidis D.P, Kitis G.D. Mean platelet volume: a link between thrombosis and inflammation? *Curr Pharm Des.* 2011; 17(1):47-58.
8. Lance M.D, Sloep M, Henskens M, Marcus M.A. Mean platelet volume as a diagnostic marker for cardiovascular disease: drawbacks of preanalytical conditions and measuring techniques, *Clin Appl Thromb Hemost.* 2012; 18(6):561-8.
9. Machin S.J, Briggs C. Mean platelet volume: a quick, easy determinant of thrombotic risk? *J Thromb Haemost.* 2010; 8(1):146-7.
10. Kim S, Molnar MZ, Fonarow GC, et al. Mean platelet volume and mortality risk in a national incident hemodialysis cohort. *Int J Cardiol.* 2016; 220:862-870.
11. US Renal Data System, USRDS 2012 Annual Data Report: Atlas of Chronic Kidney Disease in the United States, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2012.
12. Ashman N, Macey MG, Fan SL, Azam U, Yaqoob MM. Increased platelet-monocyte aggregates and cardiovascular disease in end-stage renal failure patients. *Nephrol Dial Transplant.* 2003; 18(10):2088-2096.
13. Scialla JJ, Plantinga LC, Kao WH, Jaar B, Powe NR,

- Parekh RS. Soluble P-selectin levels are associated with cardiovascular mortality and sudden cardiac death in male dialysis patients. *Am J Nephrol*. 2011; 33(3):224-230.
14. Nilgul Akalin, et al. Mean Platelet Volume Measurements Affecting Evaluation of Parameters in Dialysis Patients, *Kidney Disord Clin Pract* .2015; 1:101.
  15. Altun E, Paydas S, Kaya B, Seydaogullari G. The relationship between inflammation, blood pressure, and mean platelet volume in chronic kidney disease. *Saudi J Kidney Dis Transpl*. 2016; 27:836-8.
  16. Hamid Nasri, et al. Association of platelet count and mean platelet volume with serum c-reactive protein in regular hemodialysis patients. *Asian journal of cell biology*.2006; 1(1):59-64.
  17. Barzegari, H., Maleki Verki, M., Seyedian, S., & Ghani Kakhaki, M. Platelet Count in Patients with Acute Coronary Syndrome. *Iranian Journal of Emergency Medicine*. 2018; 5:e1.
  18. Beyranvand M.R, Kolahi A.A. Characteristic and final diagnosis of patients with primary diagnosis of acute coronary syndrome. *Babaol J uni Med Sci*. 2011; 4:5-9.
  19. Verdoia M, Schaffer A, Suryapranata H, De Luca G. Effects of HDL-modifiers on cardiovascular outcomes: a meta-analysis of randomized trials. *Nutr Metab Cardiovasc Dis*. 2015; 25(1):9-23.
  20. De Luca G, Verdoia M, Cassetti E, et al. Mean platelet volume is not associated with platelet reactivity and the extent of coronary artery disease in diabetic patients. *Blood Coagul Fibrinolysis*. 2013; 24(6):619-624.
  21. Pizzulli L, Yang A, Martin JF, Luderitz B. Changes in platelet size and count in unstable angina compared to stable angina or noncardiac chest pain. *Eur Heart J* 1998; 19:80–84.
  22. Jagroop IA, Mikhailidis DP. Mean platelet volume is an independent risk factor for myocardial infarction but not for coronary artery disease. *Br J Haematol* 2003; 120:169–170.
  23. Mirzaei M, Daneshpajoo A, Farsinezhad A, et al. The Therapeutic Effect of Intravesical Instillation of Platelet Rich Plasma on Recurrent Bacterial Cystitis in Women: A Randomized Clinical Trial. *Urol J*. 2019; 16(6):609-613.
  24. Slavka G, Perkmann T, Haslachner H, et al. Mean platelet volume may represent a predictive parameter for overall vascular mortality and ischemic heart disease. *Arterioscler Thromb Vasc Biol*. 2011; 31(5):1215-1218.
  25. Burr ML, Holliday RM, Fehily AM, Whitehead PJ. Haematological prognostic indices after myocardial infarction: evidence from the diet and reinfarction trial (DART). *Eur Heart J*. 1992; 13:166–170.
  26. Han JS, Park KS, Lee MJ, et al. Mean platelet volume is a prognostic factor in patients with acute kidney injury requiring continuous renal replacement therapy. *J Crit Care*. 2014; 29(6):1016-1021.
  27. Peev V, Nayer A, Contreras G. Dyslipidemia, malnutrition, inflammation, cardiovascular disease and mortality in chronic kidney disease. *Curr Opin Lipidol*. 2014; 25(1):54-60.
  28. Chu SG, Becker RC, Berger PB, et al. Mean platelet volume as a predictor of cardiovascular risk: a systematic review and meta-analysis. *J Thromb Haemost*. 2010; 8(1):148-156.
  29. Ezgi Coskun Yenigun, et al. Is there a relation between mean platelet volume and chronic kidney disease stages in diabetic patients? *Int J Clin Exp Med* .2016; 9(1):330-335.
  30. Turgutalp K, et al. Mean platelet volume and related factors in patients at different stages of diabetic nephropathy: a preliminary study. *Clin Appl Thromb Hemost* 2014; 20:190-195.
  31. Bilen Y, et al. dose decreased mean platelet volume predict inflammation in chronic renal failure, dialysis, and transplanted patients? *Ren Fail*.2014; 36(3):488.
  32. Peretti M, Zampieri N, Bertozzi M, et al. Mean Platelet Volume and Testicular Torsion: New Findings. *Urol J*. 2019; 16(1):83-85.
  33. Agin M, Kayar Y, Dertli R. The relationship between mean platelet volume and platelet levels of children with *Helicobacter pylori* and gastritis. *Prz Gastroenterol*. 2019; 14(3):198-201.
  34. Ay S, Gokdemir B, kayhan kocak O.F, Sahutoglu S, Sahin S. Relationship between mean platelet volume and malnutrition. *Clinical Nutrition*. 37, S253.10. 1016/j. clnu.2018.06.1893.
  35. Shahbazi M, Smailnejad Ganji K, Mirzakhani M, Mohammadnia-Afrouzi M, Akbari R. The role of immune response in initiation and progression of chronic kidney disease. *Iran J Kidney Dis*. 2019; 13(5):283-299.
  36. Jin K, Vaziri ND. Elevated Plasma Cyclophilin A in Hemodialysis and Peritoneal Dialysis Patients: a Novel Link to Systemic Inflammation. *Iran J Kidney Dis*. 2017; 11(1):44-49.
  37. Yayar O, Eser B, Bicakci F, Ayli MD. Is mean platelet volume a predictor of atherosclerosis in hemodialysis patients? *J Turgut Ozal Med Cent*. 2017; 24(4):430-3.
  38. Gasparyan AY, Ayzvazyan L, Mikhailidis DP, Kitas GD. Mean platelet volume: a link between thrombosis and inflammation? *Curr. Pharm. Des*. 2011; 17(1):47–58.

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