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Evaluation of the relation between HBA1C and MPV, PDW levels of patients with Type 2 diabetes admitted in internal medicine polyclinics

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ABSTRACT

OBJECTIVE: Diabetes is a chronic, broad-spectrum metabolic disorder that requires continuous medical care, in which the organism cannot adequately benefit from carbohydrates, fats, and proteins due to insulin deficiency or defects in the effect of insulin. Vascular complications are considered to be the main cause of mortality in diabetic patients. Platelet activation plays a role in the development of vascular complications. The aim of this study was to evaluate the relationship between HbA1c, which is the parameters that we can evaluate in primary healthcare institutions, and increased Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) levels, which are thought to be a platelet activation markers in patients with Type 2 diabetes mellitus.

METHODS: In our study, the data for 600 patients who applied to Internal Medicine outpatient clinic of our hospital between January 01, 2022, and June 31, 2022, were obtained by examining their epicrisis through the hospital information management system. Six hundred patients, including 300 control group with HbA1c level below 6.5 and 100 patients each 7–8.5 8.5–10 and above 10, were included in the study. HbA1c, MPV, and PDW levels of the patients were recorded.

RESULTS: Among 600 patients who applied to internal medicine polyclinics of our hospital between January 01, 2022, and June 31, 2022, 412 participants were female, while 188 participants were male. It was determined that the participants were 46.91±12.68 years old on average, the youngest participant was 18 years old and the oldest participant was 66 years old. It was determined that the mean HbA1c value of the participants participating in the study was 7.6±2.4, the lowest HbA1c value was 4.3, and the highest HbA1c value was 19.3. It was determined that the mean MPV value of the participants was 10.1±1.1, the lowest MPV value was 7.7, and the highest MPV value was 13.3. It was determined that the mean PDW value of the participants was 16.0±0.4, the lowest PDW value was 14.8, and the highest PDW value was 17.2.

CONCLUSION: In this study, it was determined that MDV and PDW levels showed a statistically significant difference according to the HbA1c value ranges of the patient group. Accordingly, the MPV and PDW levels of the participants whose HbA1c value range is >10 are higher. It was observed that MPV and PDW levels increased as the HbA1c value range increased.

Keywords: Diabetes mellitus type 2; HbA1c; MPV; PDW.

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Diabetes mellitus Type 2 (DM2) is a chronic, wide-spectrum metabolic disorder with the lack or the defect in the effect of insulin thus leading to insufficient use of lipids and carbohydrates by the organism and leading to continuous medical care.

Chronic complications of DM2 can be classified as microvascular (retinopathy, nephropathy, and neuropathy) and macrovascular (hypertension, ischemic heart disease, peripheral vascular disease, and cerebrovascular disease) [1].

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The role of thrombocytes in etiopathogenesis of thromboembolic complications in DM2 patients is mostly clarified in various studies. In DM2 patients, adhesion and aggregation start as thrombocytes are activated thus leading to occlusions in microvascular system and leading to tissue hypoxy and ischemia earlier than non-diabetic patients [1].

Thrombocytes are defined as small, seedless, and discoid-shaped group of blood cells. Their count is around 150.000 and 450.000. They are effective for around 7–10 days. Thrombocytes are produced with the effect of thrombopoetin hormone's effect which is synthesized majorly in liver. 1/3 of them is in spleen and they are demolished there by macrophage cells [2].

Thrombocytes (PLTs) have an active role in hemostasis. In case of endothelial damage, PLTs interconnect with a lot of adhesive glycoproteins (Gp) like fibrinogen, von Willebrand factor, thrombocyte activating factor, fibronectin, and collagen. After this activation, PLTs start the adhesion and aggregation phases. Through Gp IIb-IIIa PLTs connect with fibrinogen and they cling to each other which is called aggregation [3].

Mean platelet volumu (MPV) is a parameter to calculate the mean volume of platelets in circulation. MPV is also one of the parameters to evaluate the function and activation of thrombocytes. Its value must be between 7 and 12 fL [4].

MPV is a risk factor for atherothrombosis. It is shown that relatively big platelets metabolically secrete much more dense granules in enzymatic cyclus [5]. Therefore, relatively bigger platelets with high MPV are more active. Hence, there is an obvious relation between high levels of MPV and augmented thrombocyte activation processes (Table 1) [6].

After those data, studies have shown that in case of microvascular complications in DM2 patients, MPV is found in high levels [7].

Studies on MPV generally are based on demonstrating the relation between thrombosis and vascular complications related to thrombosis. During the progression of atherosclerotic diseases, the platelets have an obvious role.

During acute myocardial infarction (MI), after percutan coronary angioplasty, thrombosis of vessels can occur thus leading us to study its relation with MPV levels. Meta-analysis shows high levels of MPV in MI patients versus healthy people.

Highlight key points

- Studies showed that in case of microvascular complications in Type 2 Diabetes Mellitus (DM2) patients, Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) are found in high levels.
- It has been determined that participants with a HbA1c value range >10 also have higher MPV and PDW levels.
- HbA1c and MPV, PDW can easily and cost effectively be investigated in primary care system and family medicine centers therefore the continuous follow up of those parameters can help the clinician to aid and prevent diabetic patients from its micro and macrovascular complications and forward the life expectation with more life comfort.

As an addition to these results, in MI patients with high levels of MPV mortality rates were relatively high. Furthermore, patients who undergo another tour of percutan coronary intervention due to reocclusion have relatively high levels of MPV values than other patients [8].

A study on DM2 patients showed that coronary artery diseases and cerebrovascular accidents occur in high MPV level ones than those with normal MPV level [9].

Platelet distribution width (PDW) is a method to help calculate the dimension differences of platelets. As the difference of structural dimension between thrombocytes increase, PDW levels are relatively high. Its normal impedance calculated values are between 9.0 and 14.0 fL.

In our study, we tried to make a first step to prove that by comparing HbA1c values with MPV and PDW levels (which can be measured easily and less costly in primary care system), we can diminish the mortality and morbidity rates of patients with diabetes mellitus Type 2, which are caused by micro and macrovascular complications of the disease.

This study is conducted in accordance with the Declaration of Helsinki

MATERIALS AND METHODS

Our study's ethic board approval number is 19-10-2022/195-2022.

In our study, the data for 600 patients who applied to internal medicine polyclinic of our hospital between January 01, 2022, and June 31, 2022, were obtained by examining their epicrisis through the hospital information management system. Six hundred patients, including 300 control group with Hba1c level below 6.5 and 100 patients each 7–8.5, 8.5–10 and above 10 were in-

Table 1. Conditions affecting MPV

Conditions augmenting MPV	Conditions diminishing MPV
Acute myocardial infarct/post-infraction	Hypersplenism
Ischemic cerebrovascular accident	Marrow hypoplasia/aplasia
Splenectomy/hyposplenism	Chemotherapy/Radiotherapy
Smoking	Wiskott-Aldrich
Diabetes mellitus type 2	Acute Leukemia
Bernard Soulier	Chronic renal failure
Idiopathic thrombocytopenic purpura	
Preeclampsia	
Sepsis	

MPV: Mean platelet volume.

cluded in the study. Hba1c, MPV, and PDW levels of the patients were recorded.

Data of individuals are collected in SPSS (Statistical Package for the Social Sciences. SPSS Statistics 22.0 (Armonk, New York: IBM Corp.). Results are shown, for quantitative variables in mean±standard deviation and qualitative variables as frequency and percentage variables. Comparison between groups is added in the program of data about participants. For qualitative variables independent groups' t test and one-way variance test, for detecting the relationship between variables, Pearson correlation test is used.

During the study for all results, p below 0.05 was accepted as statistically significant.

RESULTS

This part of the study consists of the derived findings and their evaluation which is derived. from SPSS (Statistical Package for the Social Sciences. SPSS Statistics 22.0 (Armonk, New York: IBM Corp.).

Four different groups were observed within the participants; a control group with 300 individuals, a group of 100 persons with a HbA1C value between 7 and 8.4, a group of 100 persons with a HbA1C value between 8.5 and 9.9 and a group consisting again of 100 persons with a HbA1C value higher than 10.

412 of participants are female and 188 are male.

Median age of participants is 46.91±12.68, the youngest one is 18 years old, and the oldest one is 66 years old (Table 2).

Table 2. Distribution of the demographic information of the participants

	n	%			
Groups					
Control group	300	50.0			
7–8.4	100	16.7			
8.5–9.9	100	16.7			
>10	100	16.7			
Gender					
Female	412	68.7			
Male	188	31.3			
	Average	SD	Min.	Max.	Median
Age	46.91	12.68	18	66	49

SD: Standard deviation; Min: Minimum; Max: Maximum.

Table 3. Median values of variables

	Average	SD	Minimum	Maximum	Median
HbA1c	7.6	2.4	4.3	19.3	6.5
MPV	10.1	1.1	7.7	13.3	10.0
PDW	16.0	0.4	14.8	17.2	16.0

SD: Standard deviation; MPV: Mean platelet volume; PDW: Platelet distribution width.

Average HbA1c value of the participants was 7.6±2.4. The lowest HbA1c value was observed as 4.3 while the highest HbA1c value was 19.3.

Average MPV value of the participants was 10.1±1.1. The lowest MPV value was observed as 7.7 while the highest MPV value was 13.3.

Average PDW value of the participants was 16.0±0.4. The lowest PDW value was observed as 14.8 while the highest PDW value was 17.2 (Table 3).

When HbA1c, MPV, and PDW levels of the participants were compared in t test as independent groups regarding their gender, HbA1c and PDW levels showed a statistically significant difference in regard of the genders ($p<0.05$). Male participants have higher HbA1c and PDW levels then female participants (Table 4).

Table 4. Comparison of the HbA1c, MPV versus PDW levels of the participants regarding their gender

	Gender (Female=412 Male=188)	Average	SD	t	p
HbA1c	Female	7.237	2.2419	-4.751	0.000
	Male	8.283	2.6111		
MPV	Female	10.085	1.0925	-0.746	0.456
	Male	10.155	1.0267		
PDW	Female	15.947	0.3751	-3.164	0.002
	Male	16.051	0.3722		

SD: Standard deviation; MPV: Mean platelet volume; PDW: Platelet distribution width.

Table 5. Comparison of MPV and PDW levels between control and patient groups

	Groups	Average	SD	T	p
MPV	Control group (n=300)	10.069	1.0954	-0.876	0.382
	Patient group (n=300)	10.145	1.0484		
PDW	Control group (n=300)	15.926	0.3553	-3.531	0.000
	Patient group (n=300)	16.033	0.3907		

SD: Standard deviation; MPV: Mean platelet volume; PDW: Platelet distribution width.

Table 6. Comparison of the MPV and PDW levels in the patient group regarding HbA1c value intervals

	N	Average	SD	F	p
MPV					
7–8.4	100	9.947	0.9646	3.521	0.031
8.5–9.9	100	10.152	1.0766		
>10	100	10.337	1.0740		
Total	300	10.145	1.0484		
PDW					
7–8.4	100	15.965	0.3697	3.315	0.038
8.5–9.9	100	16.029	0.4154		
>10	100	16.106	0.3765		
Total	300	16.033	0.3907		

SD: Standard deviation; MPV: Mean platelet volume; PDW: Platelet distribution width.

When MPV and PDW levels of the control and patient groups were compared in t test as independent groups, PDW levels showed a statistically significant difference between these two groups ($p<0.05$). Participants in the patient group have higher PDW levels than participants in the control group (Table 5).

When MPV and PDW levels of the patient group were compared regarding their HbA1c value intervals in one directional variance test, MPV and PDW levels showed a statistically significant difference regarding their HbA1c value intervals in the patient group

Table 7. Correlation between HbA1c levels and MPV and PDW levels in patients with type 2 diabetes mellitus

	HbA1c	MPV	PDW
HbA1c			
r	1	0.089*	0.185**
p		**0.029**	**0.000**
MPV			
r		1	0.351**
p			**0.000**
PDW			
r			1

*: Correlation 0.05 level (2-way); **: Correlation 0.01 level (2-way); MPV: Mean platelet volume; PDW: Platelet distribution width.

($p<0.05$). It has been determined that participants with an HbA1c value range >10 also have higher MPV and PDW levels.

It has been observed that with a higher HbA1c value range, the levels of MPV and PDW also rise (Table 6).

We performed a Pearson correlation test regarding to the correlation between HbA1c levels and MPV and PDW levels in patients with Type 2 diabetes Mellitus. The correlation between HbA1c levels and MPV and PDW levels was found to be with a lower statistically significance (Table 7).

Whereas the correlation between MPV and PDW was statistically in medium significance. According to this finding, these variables influence each other in positive direction.

Therefore, when the level of one variable rises, the levels of the other variables rise also. When the level of one variable decreases, the levels of the other variables decrease too.

DISCUSSION

Diabetes is a chronic ailment demanding vigilant medical monitoring. As per data from the World Health Organization, the incidence of diabetes in Turkey outpaces that of Europe, with its prevalence attaining epidemic proportions, thus giving rise to a significant global concern. This underscores the mounting significance of studies dedicated to elucidating the diagnosis and management of the ailment [10].

A plethora of investigations have explored the elevation of MPV resulting from activated platelets and their contributory factors. MPV is widely recognized as an independent marker of functional status. The assessment of MPV within the ambit of routine comprehensive blood analysis offers a facile and cost-effective modality for tracking vascular complications in diabetes as Hekimsoy et al. [4] pointed (2004).

Our study results showed a statistically significant difference between the levels of HbA1c, PDW levels, and gender. HbA1c and PDW levels of male participants were higher than female ones.

Dincoglu ve Karatas, [11] in 2020, regarding to their study results, have concluded that HbA1c levels show statistically significant difference between genders. They have concluded that HbA1c levels of male participants were higher than those of female ones.

Within the context of our study, a positive correlation has been discerned between levels of HbA1c and the indices for MPV and PDW. Individuals exhibiting HbA1c levels surpassing 10 displayed elevated MPV and PDW values.

Similar to our study, Dincoglu and Karatas, [11] in their foretold study on diabetic patients, have showed statistically significant differences of MPV and PDW and HbA1c value range. They have showed that MPV and PDW levels of patients with HbA1c levels >7 were significantly higher than patients with HbA1c levels <7. They also concluded that as HbA1c value ranges get higher, MPV and PDW levels get higher accordingly to these values.

Seferović et al., [12] during their research in 2018, showed also that MPV and PDW levels of patients change in statistically significant degrees regarding to their HbA1c values.

MPV and PDW levels of patients with high degrees of HbA1c were significantly higher than those with relatively low levels of HbA1c levels.

In our study, we have concluded, by regarding to our results, that there was a statistically low level of a significant relation between HbA1c and MPV and PDW values, but a statistically mediocre level of a significant relation between MPV and PDW levels leading to positive feedback between those parameters.

In a similar way, earlier researchers like Keskin and Balci (2011) [13] established a positive correlation between HbA1c – an indicator of long-term glycemic con-

trol and markers of platelet activation, namely, MPV and PDW, in cases of Type 2 diabetes mellitus and cardiovascular disease [13].

They argued that escalated MPV and PDW values stemming from glycemic imbalances could amplify the risk of vascular complications, and early identification of such complications through platelet indices could mitigate both patient morbidity and health-care expenditure.

Furthermore, Kadic et al. (2016) [14] pointed a positive correlation between MPV levels and both long-term (HbA1c) and short-term glycemic control indicators in individuals with Type II diabetes [14].

Ulutas et al. (2014) [15], in their prospective study, found that there was a statistically significant correlation between HbA1c and MPV values.

Conclusion

Our investigation illuminates that MPV and PDW can serve as economical and straightforward tools at the primary health-care level for screening micro/macrovascular complications associated with diabetes mellitus. Timely recognition and intervention for these complications hold the potential to arrest progression. Nevertheless, further comprehensive multicentric studies are imperative to assess the predictive utility of MPV and PDW in the realm of vascular complications.

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REFERENCES

1. Türkiye Endokrinoloji ve Metabolizma Derneği (TEMD). Diabetes Mellitus ve Komplikasyonlarının Tanı, Tedavi ve İzlem Kılavuzu. 15. ed. Ankara:BAYT; 2022.
2. Konkle BA. Disorders of platelets and vessel wall. In: Fauci AS, Braunwald E, Kasper DL, Hauser SL, eds. Harrison's Principles of Internal Medicine. 17th ed. New York, NY: McGraw-Hill; 2008.
3. Mathur A, Robinson MS, Cotton J, Martin JF, Erusalimsky JD. Platelet reactivity in acute coronary syndromes: evidence for differences in platelet behaviour between unstable angina and myocardial infarction. Thromb Haemost 2001;85:989–94.
4. Hekimsoy Z, Payzin B, Ornek T, Kandoğan G. Mean platelet volume in type 2 diabetic patients. J Diabetes Complications 2004;18:173–6.
5. Han JY, Choi DH, Choi SW, Kim BB, Ki YJ, Chung JW, et al. Stroke or coronary artery disease prediction from mean platelet volume in patients with type 2 diabetes mellitus. Platelets 2013;24:401–6.
6. Endler G, Klimesch A, Sunder-Plassmann H, Schillinger M, Exner M, Mannhalter C, et al. Mean platelet volume is an independent risk factor for myocardial infarction but not for coronary artery disease. Br J Haematol 2002;117:399–404.
7. Demirtas L, Degirmenci H, Akbas EM, Ozcicek A, Timuroglu A, Gurel A, et al. Association of hematological indices with diabetes, impaired glucose regulation and microvascular complications of diabetes. Int J Clin Exp Med 2015;8:11420–7.
8. Chu SG, Becker RC, Berger PB, Bhatt DL, Eikelboom JW, Konkle B, et al. Mean platelet volume as a predictor of cardiovascular risk: a systematic review and meta-analysis. J Thromb Haemost 2009;8:148–56.
9. Khan PN, Nair RJ, Olivares J, Tingle LE, Li Z. Postsplenectomy reactive thrombocytosis. Baylor Univ Med Cent Proc 2009;22:9–12.
10. American Diabetes Association. Classification and diagnosis of diabetes: standards of medical care in diabetes. Diabetes Care 2021;44:15–33.
11. Dinçoğlu H, Karataş Eray İ. Evaluation of the relationship between HbA1c with MPV and PDW levels in patients with type2 diabetes mellitus. [Article in Turkish]. Ankara Med J 2020:825–34.
12. Seferović PM, Petrie MC, Filippatos GS, Anker SD, Rosano G, Bauersachs J, et al. Type 2 diabetes mellitus and heart failure: a position statement from the Heart Failure Association of the European Society of Cardiology. Eur J Heart Fail 2018;20:853–72.
13. Keskin Ö, Balcı B. Diabetes mellitus and cardiovascular complications. [Article in Turkish]. Kafkas J Med Sci 2011;1:81–5.
14. Kadić D, Hasić S, Spahić E. Mean platelet volume predicts the glycemic control deterioration in diabetes mellitus type 2 patients. Med Glas (Zenica) 2016;13:1–7.
15. Ulutas KT, Dokuyucu R, Sefil F, Yengil E, Sumbul AT, Rizaoglu H, et al. Evaluation of mean platelet volume in patients with type 2 diabetes mellitus and blood glucose regulation: a marker for atherosclerosis? Int J Clin Exp Med 2014;7:955–61.