National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

Use of mean platelet volume as a tool to assess the progression of type 2 diabetes mellitus

Shilalipi Pradhan[1], Aurobinda Chinara[1], Bimal Kumar Sahoo[2]

[1]Department of Physiology, MKCG Medical College and Hospital, Berhampur, Odisha, India, [2]Department of Community Medicine, MKCG Medical College and Hospital, Berhampur, Odisha, India

Corresponding to: Aurobinda Chinara, E-mail: aurobinda.silu@gmail.com

Received: January 02, 2019; **Accepted:** January 17, 2019

ABSTRACT

Background: Diabetes mellitus (DM) is characterized by chronic hyperglycemia resulting in micro- and macro-vascular complications and is correlated with glycemic control and its duration. The undergoing pathologic thrombosis associated with atherosclerotic plaque rupture is a major cause of morbidity and mortality. Mean platelet volume (MPV) is a simple economical test in the monitoring of DM. **Aims and Objectives:** This study aims to determine the activation of platelets in diabetes by measuring the MPV in non-diabetic and diabetic subjects, respectively and to find out the correlation of MPV with blood glucose level. **Materials and Methods:** It was a cross-sectional study conducted on 70 previously diagnosed diabetic and 130 non-diabetic patients using convenient sampling in SCB Medical College, Odisha. Blood parameters such as body mass index (BMI), fasting blood sugar (FBS), postprandial blood sugar (PPBS), glycated hemoglobin (HbA1c), and MPV were recorded from complete blood count and compared using independent sample *t*-test and Pearson correlation test. **Results:** Mean age of the diabetic population was 53.7 ± 10.63 years. Positive correlation was found between MPV and BMI, FBS, PPBS, and HbA1c. The mean MPV in Group A was significantly lower than that of Group B. **Conclusion:** MPV in Type 2 DM was significantly elevated and positively correlated to blood glucose level. Thus, strict glycemic control measures should be advised to patients with DM for halting the progression of complications in them.

KEY WORDS: Mean Platelet Volume; Diabetes Mellitus; Platelet Activation

INTRODUCTION

Diabetes Mellitus (DM) is a major global health problem due to its high prevalence and morbidity. The Type 2 DM is a part of metabolic syndrome which comprises dyslipidemia, hypertension, impaired fibrinolysis, and increased procoagulation factors resulting in deadly complications and dire consequences affecting eyes, kidneys, peripheral nerves, and micro- and macro-vascular structures.[1] The prevalence of diabetic microvascular complications is higher in people with poor glycemic control, associated hypertension, and obesity.[2]

Vascular disorders such as coronary arterial disease have enhanced the morbidity and mortality in Type 2 DM. It induces atherosclerosis, circulation dysfunction, and dysregulation of coagulation. Reports prove the risk from cardiovascular mortality correlating with blood glucose concentration.[3]

DM is a prothrombotic state with platelets being the central element of the atherothrombotic process due to their prothrombotic and pro-inflammatory function.[4-6] With

Access this article online	
Website: www.njppp.com	Quick Response code
DOI: 10.5455/njppp.2019.9.0100117012019	

increased activity in Type 2 DM leads to its progression and eventually to deadly complications. Their altered morphology and function prove the above notion.[7-10] Larger platelets are younger, more reactive, and aggregable producing a procoagulant effect evident by elevated mean platelet volume (MPV) developing macrovascular complications such as myocardial infarction, ischemic stroke, and venous thromboembolism.[10]

Thus, the assessment of the functions of the platelets is essential. However, measurement of the most parameters of platelet activity is time consuming and expensive and requires high sample volume and specialty training.[11] Platelet volume, a marker of platelet function and activation, is assessed using MPV by automated hematology analyzers.[3] This is simple, economical, quick, and easy to measure parameter of platelet size and, consequently, its enzymatic activity with prothrombotic potential.[12]

Glycated hemoglobin (HbA1c) values as a marker of long-term glucoregulation have been already established and this should be kept <7% to reduce the risk of micro- and macro-vascular complications in Type 2 DM patients.[13] Thus, it can be suggested that improving glycemic control decreases MPV and proper glycemic control should be done to prevent or delay vascular complications in these patients.

Hence, the study was carried out with the primary objective to determine whether platelets were activated in diabetes by measuring the MPV in the diabetics compared to the healthy and prediabetic individuals. Secondly to find out the correlation of MPV with blood glucose level in Type 2 DM patients.

MATERIALS AND METHODS

It was a cross-sectional study carried out on 200 subjects after taking appropriate consent. The study was conducted in the Department of Physiology, Medicine, and Endocrinology, S.C.B. Medical College, Cuttack, between September 2014 and October 2016 using convenient sampling. Two groups of the study population were selected. The first group was the diagnosed cases of diabetics attending Endocrinology OPD and the others were non-diabetic patients attending medicine OPD. Blood samples from them were taken in physiology department and investigated for fasting blood sugar (FBS), postprandial blood sugar (PPBS), HbA1c, and MPV (from complete blood count [CBC]).

CBC was done by automated hematology analyzer. FBS and PPBS were done by glucose oxidase method and HbA1c by liquid chromatography. The study population was categorized into two groups, i.e. diabetic and non-diabetic using their blood parameters.[14] Subjects with normal and prediabetic findings were included as non-diabetic group. Weight and height were recorded using standard weighing machine and stadiometer with proper calibrations to calculate the body mass index (BMI). They were grouped into underweight, normal, and overweight/obesity as per the WHO along with their risk of comorbidities.[15]

Those individuals not giving consent or taking medications for any malignancy were excluded. Permission for the study was approved from the institutional ethics committee.

Statistical analysis was done with the help of Microsoft Excel and SPSS version 20.0. For analysis of continuous data, mean and standard deviation (SD) was calculated. Frequency and proportion were used for qualitative data. Tests of significance such as independent *t*-test and Pearson correlation test were used. Independent *t*-test compared the mean between any two parametric variables. Pearson correlation test was utilized for finding the correlation (r) between any two variables. The diabetic group was divided based on the HbA1c levels into Group A with HbA1c <6.5% (controlled DM) and Group B with HbA1c ≥6.5% (uncontrolled DM) to further analysis. $P < 0.05$ was considered to be statistically significant.

RESULTS

The study included two groups; one was diabetic and other non-diabetic. The former group included 70 and the later 130 individuals for the study [Table 1].

A total of 200 study participants were included after meeting the inclusion and exclusion criteria. Of them, 35% were diabetic and rest, i.e. were non-diabetic. The mean age of the diabetic population was 53.7 ± 10.63 years, whereas that of non-diabetic was 44.37 ± 12.27 years. In the non-diabetics group, 40% were male and 25% were female. Similarly, 16% and 19% of the diabetics were male and female study subjects, respectively.

The mean BMI in the diabetics was 24.05 ± 7.56 kg/m^2, whereas it was 21.57 ± 3.28 kg/m^2 in non-diabetics

Table 1: Comparison of various parameters between the diabetic and non-diabetic group

Characteristic	Diabetic	Non-diabetic	*P* value
Number (%)	70 (35)	130 (65)	
Age (years)	53.7±10.63	44.37±12.27	
Male (%)	32 (16)	80 (40)	
Female (%)	38 (19)	50 (25)	
BMI (kg/m^2)	24.05±7.36	21.57±3.28	0.008
FBS (mg/dl)	139.49±52.61	89.71±9.93	<0.001
PPBS (mg/dl)	234.600±84.2793	154.143±27.2446	<0.001
HbA1c (%)	8.955±2.5520	5.600±0.5753	<0.001
MPV (fl)	9.896±1.2765	8.821±1.1495	< 0.001

MPV: Mean platelet volume, FBS: Fasting blood sugar, PPBS: Postprandial blood sugar, BMI: Body mass index, HbA1c: Glycated hemoglobin

with statistical significance between their mean BMI (P = 0.008). The mean FBS, PPBS, and HbA1c levels in the diabetic population were 139.49 ± 52.61 mg/dL, 234.6 ± 84.27 mg/dL, and 8.95 ± 1.27%. Similarly, 89.71 ± 9.93 mg/dl, 154.14 ± 27.24 mg/dL, and 5.6 ± 0.57% were respective FBS, PPBS, and HbA1c parameters in the non-diabetic group. Statistical significance was also found between the mean of the above three parameters of the two groups. In the diabetic subjects, MPV was significantly higher (9.89 ± 1.27 fl) as compared to the control group (8.82 ± 1.14 fl) (P < 0.001).

Table 2 shows the mean (S.D) MPV in both male and female study subjects. Independent t-test was used to compare the means and no statistical significance was found between them (P = 0.227).

The correlation of MPV with all parameters, i.e. BMI, FBS, PPBS, and HbA1C using Pearson correlation test is demonstrated in Table 3. Positive correlation was found between MPV and other parameters. However, baring BMI, rest all had statistical significance with MPV [Table 3 and Figures 1-3].

Table 4 reveals the distribution of all the parameters and the diabetic population (with respect to HbA1c levels). Of 70 diabetic patients, there were 26 in Group A with mean HbA1c = 6.17 ± 0.6% and 44 in Group B with mean HbA1c = 9.65 ± 0.273%. The mean BMI in Group A was 24.71 ± 3.1kg/m^2 and Group B was 23.89 ± 0.89 kg/m^2 (P = 0.025). The mean FBS level in Group A was 104.76 ± 21.37 mg/dL while that of Group B was 148.17 ± 54.55 mg/dL (P = 0.001). In Group A, the mean PPBS level was 156.92 ± 54.55 mg/dL while that of Group B was 254.01 ± 80.99 mg/dL (P = 0.001). The mean MPV in Group A (9.254 ± 1.09 fl) was significantly lower than that of Group B (9.963 ± 1.27 fl) with P = 0.001.

Table 2: Comparison of MPV between males and females

Sex	Mean MPV (fl)	*P* value
Male	9.57±1.3	0.227
Female	9.34±1.32	

MPV: Mean platelet volume

Table 3: Correlation of MPV with various parameters

Parameters	Characteristic	*r* value	*P* value
MPV	BMI	0.045	0.522
MPV	FBS	0.173	0.014
MPV	PPBS	0.186	0.008
MPV	HbA1c	0.307	0.001

MPV: Mean platelet volume, FBS: Fasting blood sugar, PPBS: Postprandial blood sugar, BMI: Body mass index, HbA1c: Glycated hemoglobin

DISCUSSION

The present study was a cross-sectional study conducted to know if platelets are activated in Type 2 DM which was done by measuring the MPV in two groups (diabetic and non-diabetic) along with the evaluation of any correlation of MPV with different blood parameters.

The mean age in the diabetic group was 53.7 ± 10.63 years and 44.37 ± 12.27 years in the non-diabetic group. However, Akinsegun *et al*. in his study had higher mean age in diabetics (62.35 ± 9.84 years) but lower age in controls (32.38 ± 66.44 years) than the present study.[16] Kodiatte *et al*. had mean age as 55 ± 11.32 years in diabetics and 51.5 ± 10.1 years in non-diabetics.[17]

Similarly, male:female distribution was 40%:25% in the non diabetic group and 16%:19% in the diabetic group. In the study by Akinsegun *et al*., distribution of males and females in diabetics was 73%:27% and 63%:37% in controls.[16] Males were 65% and 57.8%, with females as 35% and 42.2% in both respective the groups in the study by Kodiatte *et al*.[17]

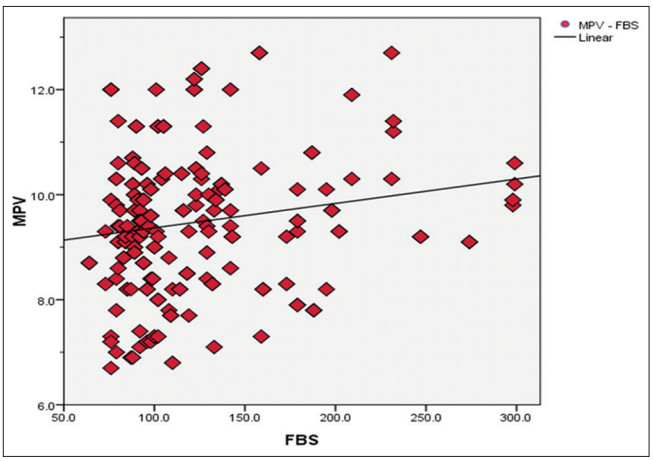

Figure 1: Correlation graph between mean platelet volume and fasting blood sugar (r = 0.173, P = 0.014)

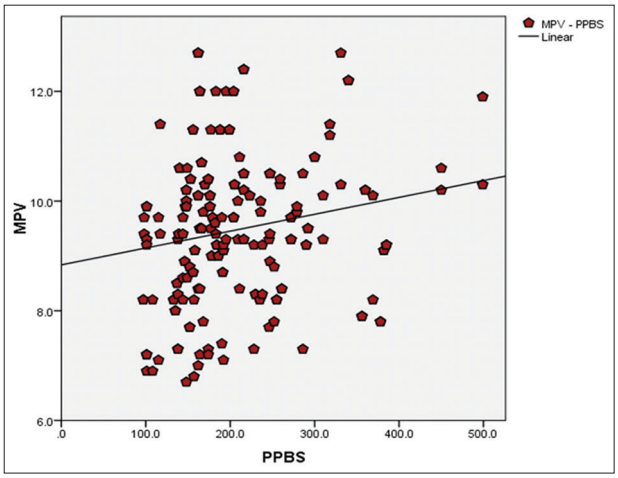

Figure 2: Correlation graph between mean platelet volume and postprandial blood sugar (r = 0.186, P = 0.008)

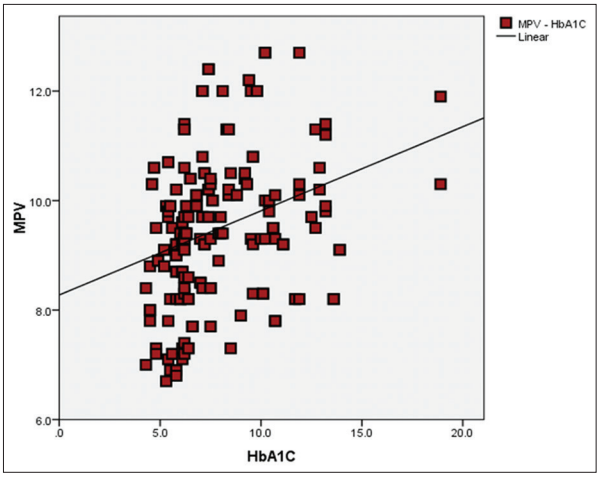

Figure 3: Correlation graph between mean platelet volume and glycated hemoglobin (*r* value = 0.307, *P* = 0.001)

Table 4: Comparison of diabetic study population (Group A and Group B) with other parameters

Parameters	Diabetic population		*P* value
	Group A HbA1c <6.5%	Group B Hba1c ≥6.5%	
Number of patients	26	44	
MPV	9.254±1.09	9.963±1.27	0.001
BMI	24.71±3.1	23.89±8.09	0.025
HbA1c	6.17±0.6	9.65±0.237	0.001
FBS	104.76±21.37	148.17±54.55	0.001
PPBS	156.92±42.18	254.01±80.99	0.001

MPV: Mean platelet volume, HbA1c: Glycated hemoglobin, FBS: Fasting blood sugar, PPBS: Postprandial blood sugar, BMI: Body mass index

The BMI in diabetic group is more than non-diabetic group which was statistically significant (*P* = 0.008) but not in the study of Kodiatte *et al*.[17]

A significant difference was also found in both groups on parameters such as FBS, PPBS, and HbA1c which is similar to the results of Kodiatte *et al*. and Ulutas *et al*.[17,18]

MPV was significantly elevated in study participants who were diabetic (9.896 ± 1.2765) as compared to non-diabetic (8.821 ± 1.1495) which was also near to the findings of Kodiatte *et al*., Zuberi *et al*., Radha and Selvam, Sharpe and Trinick, Hekimsoy *et al*., Demirtunc *et al*., and Jindal *et al*. but contradicts the results of Ünübol *et al*.[2,5,17,19-23]

No statistical difference was found between MPV of men and women among both groups which is in accordance with Park *et al*., Bain, and Bancroft *et al*.[24-26]

MPV had positive correlation with all the parameters (BMI, FBS, PPBS, and HbA1c) [Figures 1-3]. However, statistical significance was found only with FBS, PPBS, and HbA1c. Similar observations were also seen in the study by Kodiatte *et al*.[17]

Our study showed that HbA1c is not proportional to MPV in each and every patient, and it was in accordance with studies conducted by Kodiatte *et al*. and Papanas *et al*.[17,27] However, overall, it was seen that average level of MPV values of uncontrolled DM is well above the values of MPV of controlled DM patients as marked against their respective ages and it clearly illustrated from the table that MPV values of uncontrolled DM patients proportionally increase with HbA1c.

A significant difference between MPV and HbA1c was observed in controlled DM and uncontrolled DM patients which is also found with the results of Demirtunc *et al*., Jindal *et al*., Kodiatte *et al*., and Papanas *et al*.[2,5,17,27]

Strength and Limitations

The study strength lies in the use of MPV as a tool apart from conventional parameters such as FBS, PPBS, and HbA1c in predicting a progression which in alignment with those parameters would help us in managing of Type 2 DM in comprehensive manner. Although the study highlights the essentiality of MPV in inferring about the course patients, still some limitations exist. The sample size needs to increase to generalize the results. Some conditions like menstrual cycle where MPV increases physiologically have been ignored.

CONCLUSION

We can conclude from the present study that MPV in Type 2 DM was significantly elevated in comparison to non-diabetes (healthy non-diabetics and prediabetics). Furthermore, there was a strong correlation of MPV with FBS, PPBS, and HbA1c. MPV remains increased and high in Type 2 DM patients with HbA1c >6.5% when compared with HbA1c <6.5%. The increased platelet size may be one factor in the increased risk of atherosclerosis associated with DM and associated vascular complications.

Diabetes is an epidemic in India, and by investigating MPV in uncontrolled DM patients, we can caution them to reduce their high glycemic level to a state of Type 2 DM category (HbA1c <6.5%), thereby minimizing complications. Indicators for monitoring microvascular and macrovascular complications and their progression in Type 2 DM can be done by MPV and HbA1c together. Hence, we propose that MPV can be used as a simple and cost-effective tool to monitor the progression and control of DM and its cardiovascular complications.

REFERENCES

1. Beckman JA, Creager MA, Libby P. Diabetes and atherosclerosis: Epidemiology, pathophysiology, and

management. JAMA 2002;287:2570-81.
2. Demirtunc R, Duman D, Basar M, Bilgi M, Teomete M, Garip T, *et al.* The relationship between glycemic control and platelet activity in Type 2 diabetes mellitus. J Diabetes Complications 2009;23:89-94.
3. Shah B, Sha D, Xie D, Mohler ER 3rd, Berger JS. The relationship between diabetes, metabolic syndrome, and platelet activity as measured by mean platelet volume: The national health and nutrition examination survey, 1999-2004. Diabetes Care 2012;35:1074-8.
4. Kaplan ZS, Jackson SP. The role of platelets in atherothrombosis. Hematology Am Soc Hematol Educ Program 2011;2011:51-61.
5. Jindal S, Gupta S, Gupta R, Kakkar A, Singh HV, Gupta K, *et al.* Platelet indices in diabetes mellitus: Indicators of diabetic microvascular complications. Hematology 2011;16:86-9.
6. Kubisz P, Stančiaková L, Staško J, Galajda P, Mokáň M. Endothelial and platelet markers in diabetes mellitus Type 2. World J Diabetes 2015;6:423-31.
7. Ferreiro JL, Gómez-Hospital JA, Angiolillo DJ. Platelet abnormalities in diabetes mellitus. Diab Vasc Dis Res 2010;7:251-9.
8. Schneider DJ. Factors contributing to increased platelet reactivity in people with diabetes. Diabetes Care 2009;32:525-7.
9. Kakouros N, Rade JJ, Kourliouros A, Resar JR. Platelet function in patients with diabetes mellitus: From a theoretical to a practical perspective. Int J Endocrinol 2011;2011:742719.
10. Vinik AI, Erbas T, Park TS, Nolan R, Pittenger GL. Platelet dysfunction in Type 2 diabetes. Diabetes Care 2001;24:1476-85.
11. Michelson AD. Methods for the measurement of platelet function. Am J Cardiol 2009;103:20A-26A.
12. 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 2010;8:148-56.
13. Skyler JS, Bergenstal R, Bonow RO, Buse J, Deedwania P, Gale EA, *et al.* Intensive glycemic control and the prevention of cardiovascular events: Implications of the ACCORD, ADVANCE, and VA diabetes trials: A position statement of the American diabetes association and a scientific statement of the American college of cardiology foundation and the American heart association. Circulation 2009;119:351-7.
14. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care 2011;34 Suppl 1:S62-9.
15. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults, National Institutes of Health, National Heart, Lung, and Blood Institute. Bethesda: U.S. Department of Health and Human Services, Public Health Service; 1998.
16. Akinsegun A, Akinola Olusola D, Sarah JO, Olajumoke O, Adewumi A, Majeed O, *et al.* Mean platelet volume and platelet counts in Type 2 diabetes: Mellitus on treatment and non-diabetic mellitus controls in Lagos, Nigeria. Pan Afr Med J 2014;18:42.
17. Kodiatte TA, Manikyam UK, Rao SB, Jagadish TM, Reddy M, Lingaiah HK, *et al.* Mean platelet volume in Type 2 diabetes mellitus. J Lab Physicians 2012;4:5-9.
18. 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.
19. Zuberi BF, Akhtar N, Afsar S. Comparison of mean platelet volume in patients with diabetes mellitus, impaired fasting glucose and non-diabetic subjects. Singapore Med J 2008;49:114-6.
20. Radha RK, Selvam D. MPV in uncontrolled and amp; controlled diabetics- its role as an indicator of vascular complication. J Clin Diagn Res 2016;10:EC22-6.
21. Sharpe PC, Trinick T. Mean platelet volume in diabetes mellitus. J Med 1993;86:739-42.
22. Hekimsoy Z, Payzin B, Ornek T, Kandoğan G. Mean platelet volume in Type 2 diabetic patients. J Diabetes Complications 2004;18:173-6.
23. Ünübol M, Ayhan M, Güney E. The relationship between mean platelet volume with microalbuminuria and glycemic control in patients with Type II diabetes mellitus. Platelets 2012;23:475-80.
24. Park Y, Schoene N, Harris W. Mean platelet volume as an indicator of platelet activation: Methodological issues. Platelets 2002;13:301-6.
25. Bain BJ. Platelet count and platelet size in males and females. Scand J Haematol 1985;35:77-9.
26. Bancroft AJ, Abel EW, Mclaren M, Belch JJ. Mean platelet volume is a useful parameter: A reproducible routine method using a modified coulter thrombocytometer. Platelets 2000;11:379-87.
27. Papanas N, Symeonidis G, Maltezos E, Mavridis G, Karavageli E, Vosnakidis T, *et al.* Mean platelet volume in patients with Type 2 diabetes mellitus. Platelets 2004;15:475-8.

How to cite this article: Pradhan S, Chinara A, Sahoo BK. Use of mean platelet volume as a tool to assess the progression of type 2 diabetes mellitus. Natl J Physiol Pharm Pharmacol 2019;9(3):243-247.

Source of Support: Nil, **Conflict of Interest:** None declared.