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Research Article

Mean Platelet Volume as a Marker of Glycemic Control in Type 2 Diabetes Mellitus: A Cross-Sectional Study

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ABSTRACT
Background: Platelet activation contributes significantly to the development of vascular complications in type 2 diabetes mellitus (T2DM). Mean platelet volume (MPV), a routinely available hematological parameter, reflects platelet size and activity and has been proposed as a simple marker of platelet activation. This study aimed to evaluate the association between MPV and glycemic control in patients with T2DM.
Methods: A hospital-based cross-sectional study was conducted in the Department of General Medicine at Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar, India, from January 2022 to June 2023. One hundred patients with confirmed T2DM were enrolled. Clinical details, fasting blood glucose (FBS), postprandial blood glucose (PPBS), glycated hemoglobin (HbA1c), and complete blood counts including MPV were recorded. Correlations between MPV and glycemic parameters were analyzed using Pearson's correlation coefficient. Comparisons between glycemic control groups were performed using Student's *t*-test and one-way ANOVA. A p value <0.05 was considered statistically significant.
Results: The study population had a mean age of 51.7 ± 9.7 years, with females constituting 57% of participants. The mean HbA1c and MPV were 8.6 ± 1.8% and 8.27 ± 1.05 fL, respectively. MPV showed significant positive correlations with HbA1c (r=0.591, p<0.001), PPBS (r=0.349, p<0.001), FBS (r=0.239, p=0.017), and duration of diabetes (r=0.493, p<0.001). Mean MPV increased progressively with worsening glycemic control, from 7.29 ± 0.80 fL in patients with HbA1c <7% to 8.75 ± 0.99 fL in those with HbA1c >8% (p<0.001). No significant associations were observed between MPV and age, sex, or body mass index.
Conclusion: Mean platelet volume is significantly associated with poor glycemic control and longer duration of diabetes in patients with T2DM. As an inexpensive and routinely available laboratory parameter, MPV may serve as a useful adjunctive marker for identifying patients at increased risk of platelet activation and vascular complications. Larger prospective multicenter studies are warranted to validate its prognostic utility.

Keywords: Type 2 Diabetes Mellitus, Mean Platelet Volume, MPV, Glycated Haemoglobin, Hba1c, Glycemic Control, and Platelet Activation.

INTRODUCTION

Diabetes mellitus (DM) is one of the most common endocrine disorders worldwide, with an increasing prevalence in both developed and developing countries[1]. Chronic hyperglycemia is associated with accelerated atherosclerosis and remains a major cause of cardiovascular, cerebrovascular, and peripheral vascular morbidity and mortality[2,3]. Despite advances in diabetes care, vascular complications continue to contribute substantially to the disease burden[2].

Platelet dysfunction plays an important role in the pathogenesis of diabetic vascular

complications[4]. Patients with type 2 diabetes mellitus (T2DM) exhibit increased platelet activation, enhanced aggregation, and a prothrombotic state[5]. Mean platelet volume (MPV), a routinely available parameter obtained from automated complete blood counts, reflects platelet size and activity[6]. Larger platelets are metabolically and enzymatically more active and possess greater thrombotic potential[7]. Elevated MPV has been identified as an independent risk marker for adverse cardiovascular events, including myocardial infarction, transient ischemic attack, and ischemic stroke[8].

Several studies have demonstrated significantly higher MPV values in patients with T2DM, particularly among those with microvascular and macrovascular complications[9,13]. Poor glycemic control has been implicated as a key determinant of increased platelet activation[10,13]. Glycated hemoglobin (HbA1c), the standard marker of long-term glycemic control, is recommended to be maintained below 7% in most patients to reduce the risk of diabetes-related complications[14]. Improvement in glycemic control has been associated with a reduction in MPV, suggesting that platelet activity may be modifiable and that MPV could serve as a useful indicator of vascular risk[15].

Given that MPV is an inexpensive, readily available, and easily measurable laboratory paramete6,9r, it may have potential as a surrogate marker for assessing platelet activation and identifying patients at increased risk of vascular complications. The present study was undertaken to evaluate the relationship between mean platelet volume and glycemic control in patients with type 2 diabetes mellitus by comparing MPV values between patients with good and poor glycemic control.

MATERIALS AND METHODS

Study Design and Participants

This hospital-based cross-sectional study was conducted in the Department of General Medicine at Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar, India, between January 2022 and June 2023. A total of 100 consecutive patients with confirmed type 2 diabetes mellitus (T2DM) receiving treatment and attending the outpatient department or admitted to the medical wards were enrolled.

Clinical and Laboratory Assessment

Demographic and clinical data were recorded, and all participants underwent a detailed clinical examination, including measurement of body mass index (BMI).

Fasting blood glucose (FBS) and postprandial blood glucose (PPBS) levels were measured using the glucose oxidase method on an automated biochemical analyzer. Glycated hemoglobin (HbA1c) was estimated by high-performance liquid chromatography (HPLC). Complete blood counts, including mean platelet volume (MPV), were analyzed using an automated hematologyanalyzer.

Inclusion and Exclusion Criteria

Patients with confirmed T2DM receiving treatment were included in the study. Patients with type 1 diabetes mellitus, abnormal platelet counts (thrombocytopenia or thrombocytosis), current use of antiplatelet medications (e.g., aspirin or clopidogrel), known hematological disorders, or hemoglobin levels <8 g/dL were excluded.

Glycemic Control

Participants were categorized into two groups based on HbA1c values: good glycemic control (HbA1c <7%) and poor glycemic control (HbA1c ≥7%), in accordance with the American Diabetes Association recommendations.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of ChalmedaanandraoInstitute of Medical Sciences. Written informed consent was obtained from all participants prior to enrollment.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS software (version XX). Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Comparisons between groups were performed using the independent Student's *t*-test for continuous variables and the Chi-square test for categorical variables. A p value <0.05 was considered statistically significant.

RESULTS

A total of 100 patients with type 2 diabetes mellitus were included in this cross-sectional study. The mean age of the study population was 51.1 ± 9.7 years**,** with females

constituting 57% of participants. The mean duration of diabetes was 4.4 ± 3.3 years, while the mean HbA1c and MPV were 8.6 ± 1.8% and 8.27 ± 1.05 fL**,** respectively. Baseline demographic and laboratory characteristics are presented in Table 1a, 1b, 1c.

Table 1: Age Distribution

		Count	Percentage
AGE	<40 years	15	15.00%
	41-50 years	35	35.00%
	51-60 years	27	27.00%
	>60 years	23	23.00%
	Total	100	100.00%

In the study the majority of subjects were in the age group of 41 to 50 years, (35%)

Table 2: Gender Distribution

		Count	Percentage
Gender	Female	57	57%
	Male	43	43%
	Total	100	100%

In the study 57% were females and 43% were males.

Table 3: Descriptive Statistics

	Count	Mean	SD	Minimum	Median	Maximum
Age	100	51.7	9.7	35	50.5	72
Height	100	1.6	0.1	1.4	1.6	1.7
Weight	100	62.7	8	43	62.5	82
Bmi	100	24.9	3.2	18.3	25	32
Duration Of Diabetes	100	4.4	3.3	1	4	21
SBP	100	121	15.1	90	120	170
DBP	100	79.2	9.1	60	80	100
HB Gm%	100	12.3	1.6	9	12	16
TLC	100	6857	1815.6	4,000	6,400	12900
Platelet	100	3.4	1	1.5	3.3	5.6
MPV	100	8.3	1	5.3	8.1	10.9
FBS	100	190	68.7	108	170	410
PPBS	100	241.3	89.7	142	212	562
HBA1C	100	8.6	1.8	5.7	8.2	13
Urea	100	21.7	8.8	8	20	41
Creatinine	100	0.8	0.2	0.1	0.8	1.2

Most patients (71%) had diabetes for less than 5 years, and 91% were receiving oral hypoglycemic agents alone. Poor glycemic control was common, with 72% of patients having fasting blood glucose (FBS) ≥140 mg/dL**,** 53% having postprandial blood glucose (PPBS) ≥200 mg/dL, and 52% having HbA1c >8%.

Correlation between MPV and Glycemic Parameters

MPV demonstrated a significant positive correlation with all glycemic indices. The correlation was strongest with HbA1c ($r = 0.591$, $p < 0.001$), followed by PPBS ($r = 0.349$, $p < 0.001$) and FBS ($r = 0.239$, $p = 0.017$). In addition, MPV showed a significant

positive correlation with duration of diabetes **(**r = 0.493, p <0.001) (Table 2a, 2b, 2c, 2d respectively).

Table 2a: MPV Distribution

		Count	Percentage
MPV	7-7.9 fl	46	46%
	8-8.9fl	29	29%
	9-9.9 fl	17	17%
	>10 fl	8	8.00%
	TOTAL	100	100.00%

In the study 46% had MPV 7-7.9 fl, 29% had MPV 8-8.9 fl, 17% had MPV 9-9.9 fl, 8% had MPV >10 fl.

Table 2b: PPBS Distribution

		Count	Percentage
PPBS	<200 mg/dl	47	47.00%
	≥200 mg/dl	53	53.00%
	TOTAL	100	100.00%

In the study, 40% had PPBS less than 200 mg/dl and 53% had PPBS more than 200.

Table 2c: FBS Distribution

		Count	Percentage
Fbs	<140* Mg/Dl(Good Control)	28	28.00%
	≥140 Mg/Dl(Poor Control)	72	72.00%
	<Total	100	100.00%

In the study 28% had good control and 72% had poor control. At our center we are following an FBS value less than 140 as optimal control, which may not require further changes in ongoing treatment.

Table 2d: HbA1c Distribution

		Count	Percentage
HbA1c	<7 (Good Control)	16	16.00%
	7 To 8 (Fair Control)	32	32.00%
	>8 (Poor Control)	52	52.00%
	Total	100	100.00%

In the study 16% had good control, 32% had fair control, and 52% had poor control. Association between MPV and glycemic control The mean MPV was higher in patients with poor fasting glycemic control (8.38 ± 1.09 fL) than in those with good control (7.99 ± 0.87 fL); however, this difference was not statistically significant **(**p = 0.09**).**

Patients with PPBS ≥200 mg/dL also had a higher mean MPV (8.47 ± 1.12 fL) than those with PPBS <200 mg/dL (8.04 ± 0.91 fL). This difference reached statistical significance (p = 0.04).

When categorized according to HbA1c, mean MPV increased progressively with worsening glycemic control, measuring 7.29 ± 0.80 fL in patients with HbA1c <7%, 7.98 ± 0.77 fL in those with HbA1c 7–8%, and 8.75 ± 0.99 fL in patients with HbA1c >8% **(**ANOVA, p <0.001**).** Post-hoc Bonferroni analysis demonstrated significant differences between all three HbA1c groups.

Table 3: Correlation between MPV and Glycemic Parameters

Correlation					
		MPV	FBS	PPBS	HbA1c
MPV	PEARSON CORRELATION	1	0.239*	0.349**	0.591**
	P VALUE		0.017	<0.001*	<0.001*
	N	100	100	100	100
* correlation is significant at 0.05 level (2-tailed)					
**correlation is significant at 0.01 level(2-tailed)					

In the study there was significant positive correlation between FBS, PPBS, HbA1c with MPV i.ewith increase in FBS, PPBS, HbA1c there was increase in MPV and vice versa.

Association between MPV and Duration of Diabetes

Mean MPV increased significantly with longer duration of diabetes, from 7.71 ± 1.04 fL in patients with disease duration of 1 year to 9.28 ± 0.71 fL in those with 6–10 years of diabetes (ANOVA, $p<0.001$). Patients with diabetes duration exceeding 10 years also had significantly higher MPV values than those with shorter disease duration. (Table 4)

Table 4: Correlation between MPV and Duration of Diabetes

		MPV	Duration Of Diabetes
MPV	Pearson Correlation	1	0.493**
	P VALUE		<0.001*
	N	100	100

In the study there was significant positive correlation between duration of diabetes and MPV, i.e., with increase in duration of diabetes there was an increase in MPV and vice versa.

Association between MPV and Demographic Variables

No statistically significant association was observed between MPV and age **(**p = 0.006 reported in thesis but described as non-significant; this should be rechecked**),** gender **(**p = 0.256**),** or BMI **(**p = 0.548**).**

DISCUSSION

The present cross-sectional study evaluated the association between mean platelet volume (MPV) and glycemic control among 100 patients with type 2 diabetes mellitus (T2DM). The principal findings were: (i) MPV demonstrated a significant positive correlation with fasting blood glucose (FBS), postprandial blood glucose (PPBS), HbA1c, and duration of diabetes; (ii) HbA1c showed the strongest correlation with MPV; and (iii) patients with poor glycemic control had significantly higher MPV values than those with good glycemic control.

Diabetes mellitus is associated with chronic hyperglycemia, oxidative stress, endothelial dysfunction, and persistent low-grade inflammation, all of which contribute to platelet activation. Larger platelets are metabolically and enzymatically more active, contain higher concentrations of prothrombotic mediators such as thromboxane A_2 and β-thromboglobulin, and exhibit greater aggregability[7]. Consequently, MPV has emerged as a simple and inexpensive surrogate marker of platelet activation and thrombotic risk in patients with diabetes.

In the present study, MPV showed a significant positive correlation with HbA1c ($r = 0.591$, $p <0.001$), indicating that worsening long-term glycemic control is associated with increased platelet activity. Mean MPV increased progressively across HbA1c categories, with the highest values observed among patients with HbA1c >8%. These findings support the hypothesis that chronic hyperglycemia promotes platelet activation, thereby increasing the risk of microvascular and macrovascular complications.

Our findings are consistent with several previous studies. Saluja et al [9], demonstrated a significant positive association between MPV and HbA1c, suggesting increased platelet activation in poorly controlled diabetes. Similarly, Kodiatteet al[10] reported a strong positive correlation between MPV and fasting blood glucose, postprandial blood glucose, and HbA1c. Comparable observations were reported by Buchet al.[11], Shah et al.[12], Patidar et al.[13], Papanas et al.[16], RKN. Radha et al.[17], and Sadikujjaman et al [18], all of whom found significantly higher MPV values in patients with poor glycemic control. Collectively, these studies reinforce the potential role of MPV as an indirect marker of glycemic status and vascular risk in T2DM.

Although MPV demonstrated significant positive correlations with both FBS and PPBS, categorization of patients based on fasting or postprandial glucose did not show clinically meaningful differences in MPV. In contrast, HbA1c showed a strong and statistically significant association with MPV. This observation is biologically plausible because HbA1c reflects average glycemic exposure over the preceding 2–3 months[14], whereas FBS and PPBS are subject to short-term

fluctuations influenced by diet, stress, medications, and acute illness.

A significant positive correlation was also observed between MPV and duration of diabetes. Patients with longer disease duration had higher MPV values, suggesting cumulative platelet activation with prolonged exposure to hyperglycemia. Similar findings have been reported by Saluja et al; however, Kodiatte et al. did not observe a significant association between diabetes duration and MPV. Differences in study populations, sample size, and duration of disease may explain these discrepancies.

No significant association was observed between MPV and age, gender, or body mass index in the present study. These findings are broadly consistent with previous reports, indicating that glycemic control rather than demographic characteristics is the major determinant of platelet activation in patients with T2DM.

The clinical implication of this study is that MPV, which is routinely available as part of a complete blood count without additional cost, may serve as a practical adjunctive marker for identifying diabetic patients at increased thrombotic risk, particularly those with poor long-term glycemic control. Although MPV should not replace established markers such as HbA1c, it may complement routine clinical assessment and help identify patients who require more intensive risk factor modification.

The present study has certain limitations. First, it was a single-center cross-sectional study with a relatively small sample size, limiting the generalizability of the findings. Second, the cross-sectional design precludes establishing a causal relationship between poor glycemiccontrol and increased MPV. Finally, diabetic microvascular and macrovascular complications were not evaluated in relation to MPV. Larger prospective multicenter studies are required to determine whether elevated MPV independently predicts vascular complications and long-term clinical outcomes in patients with T2DM.

CONCLUSION

In this study there was an increase in Mean Platelet Volume with poor glycemic control in type 2 DM. Hence, MPV can be used as a simple and cost-effective tool for assessment of glycemic control in DM.

Conflict of Interest: The authors declared no conflict of interest.

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