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Original Article

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Assessment of mean platelet volume in diabetes mellitus and its correlation with hba1c in normoglycemic, diabetic and prediabetic status

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Abstract

***Background & Aims*:** Diabetes mellitus (DM) is a major global health issue in the modern era. Type 2 DM is the most common form and accounts for 90%. DM is identified to have a prothrombotic tendency, and the causative agent involved in this process might be the hyperactivity of the platelets. This study is intended to assess mean platelet volume in diabetes mellitus patients as well as the correlation between HbA1c and Mean Platelet Volume (MPV) in prediabetic, diabetic, and normoglycemic status.

***Materials & Methods*:** This was a prospective study conducted in the department of pathology, Hassan Institute of Medical Science, Hassan, India for a period of 3 months, from May 2022 to July 2022. The total sample size of this study was 600, which included 200 cases of diabetes, 200 patients with prediabetic status, and 200 subjects with normoglycemic levels. Diabetic, prediabetic, and normoglycemic status was confirmed by reviewing the medical records. Cases with abnormal hematocrit, abnormal platelet values, and chemotherapy patients were excluded from the study. Data was compiled and statistically analyzed using Microsoft Excel 2021.

***Results*:** The most common age group to have DM was 41 to 50 years, followed by 61 to 70 years. There is gender predilection in DM. The majority of people with diabetes have MPV between 8.01 to 10.00 fL. However, the majority of non-diabetics have MPV below eight fL.

***Conclusion*:** MPV is found to be higher in the people with diabetes when compared to prediabetics and non-diabetics. Also, HbA1c and MPV are positively correlated. Hence MPV and HbA1c can be used as markers of poor glycemic control and associated complications of diabetes.

***Keywords*:** Diabetes Mellitus Type 2, Glycemic Control, Glycated Hemoglobin A, Mean Platelet Volume, Prediabetic State

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Introduction

Diabetes mellitus (DM) is a significant public health issue with a steady increase in prevalence in the last few decades. The global prevalence has reached 8.5% at present in the adult population. The majority of people are affected by Type 2 DM (1). DM is a group of

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metabolic disorders presenting hyperglycemia due to defective insulin secretion, insulin action, or both. American Diabetes Association (ADA) and World Health Organisation (WHO) give the diagnostic criteria for DM based on plasma glucose and glycated haemoglobin (HbA1c). The fasting and two-hour postprandial plasma glucose cut-off are 126mg/dL and 200mg/dL, respectively. 6.5% was taken as the cut-off for HbA1c. DM was diagnosed if abnormal HbA1c and abnormal fasting and postprandial plasma glucose values were obtained on two separate days. A single reading of random plasma glucose of more than or equal to 200mg/dL also advocates a diagnosis of DM (2).

Prediabetes is when plasma glucose is more than the average value but is not high enough to call it diabetes. HbA1c values between 5.7% to 6.5% and fasting plasma glucose between 100mg/dL to 126mg/dL were considered prediabetic status (2). DM is associated with significant long-term complications involving the microvasculature and macro vasculature. DM-related deaths mainly occur due to atherosclerosis, causing secondary disturbances at cellular and metabolic levels (1,3). DM has now been found to create a prothrombotic tendency that leads to vascular complications. Platelets involved in homeostasis play a significant role in the pathogenesis of the same. Increased activation of platelets may be implicated as a causative factor that leads to vascular thrombotic events (4,5).

Activation of platelets leads to the release of mediators involved in inflammation, coagulation, thrombosis, and atherosclerosis. Hence evaluation of platelet hyperactivity is essential (6). Mean platelet volume (MPV) is a marker of platelets' biological activity and function. Accordingly, MPV might be elevated in the patients with DM prone to vascular thrombotic complications. It can be measured easily with automated blood cell counters widely used in most laboratories (7).

This study is intended to assess the mean platelet volume (MPV) in diabetic patients. Also, the correlation between MPV and HbA1c in normoglycemic, diabetic, and prediabetic status will be evaluated in the study. The current research can provide information on the early identification of vascular thrombotic complications in the patients with DM.

Materials & Methods

This was a prospective study conducted in the department of pathology, Hassan institute of medical science, Hassan, India for a period of 3 months, from May 2022 to July 2022. The study was initiated after the ethical clearance.

Glycated haemoglobin (HbA1c), fasting blood sugar, postprandial blood sugar, and random blood sugar values of the patients were obtained from the laboratory information system. Based on the available information, cases were categorized under non-diabetic, prediabetic, and diabetic groups. Further, the diabetic, prediabetic, and normoglycemic status was confirmed by reviewing the medical records. Cases with abnormal hematocrit or platelet values, and chemotherapy patients were excluded from the study.

The total sample size of this study was 600, which included 200 cases of diabetes, 200 patients with prediabetic status, and 200 subjects with normoglycemic levels. HbA1c value and mean platelet volume of these cases were collected. Data was compiled and statistically analyzed using Microsoft Excel 2021. Mean, standard deviation, p-value, and correlation analysis (Pearson r correlation) were calculated. P-value was calculated with an unpaired t-test. A p-value that is less than 0.05 was considered statistically significant.

Results

Present study includes 600 cases. Among the 600 cases, 200 subjects are diabetic, 200 are prediabetic, and 200 have a normoglycemic status. The most common age group among the non-diabetic cases was 31- 40 years (75/200= 37.5%), followed by 41 -50 years (50/200= 25%). Among the prediabetic cases, the most common age group was 41-50 years (77/200 = 38.5%), followed by 31- 40 years (40/200 = 20%). Diabetes was most common among 41 -50 years (58/200= 29%), followed by 61- 70 years (49/200 = 24.5%). Table 1 shows the age-wise distribution of cases.

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Table 1. Age Distribution

Age Group	Non-Diabetics	Pre-Diabetes	Diabetes
21-30	12	10	8
31-40	75	40	24
41-50	50	77	58
51-60	30	32	40
61-70	20	20	49
71-80	10	15	17
>80	3	6	4
Total	200	200	200

Among the diabetic cases 50.5% (101/200) were males and 49.5% (99/200) were females. In non-diabetic and prediabetic cases, a male predominance of 58.5% (117/200) and 54.5% (91/200) were noted. Table 2 shows the gender distribution of cases.

Table 2. Gender Distribution

Gender	Non-Diabetics	Pre-Diabetes	Diabetes
Male	117 (58.5%)	109 (54.5%)	101 (50.5%)
Female	83 (41.5%)	91 (45.5%)	99 (49.5%)
Total	200	200	200

The mean platelet volume of all the cases was analyzed. MPV was categorized into the following subgroups: </= 8.00 fL, 8.01-10.00 fL, and 10.01-12.00 fL. Most non-diabetic (170/200= 85%) and prediabetic (149/200 = 74.5%) cases were noted to have MPV less than or equal to 8.00 fL. Among the diabetics, the majority had MPV between 8.01 fL to 10.00 fL (120/200 = 60%). Very few non-diabetics and prediabetics were found to have MPV of more than ten fL. However, 17.5% of the people with diabetes had an MPV of more than 10 fL. The distribution of MPV is depicted in Table 3.

Table 3. Distribution of mean platelet volume (MPV)

MPV (fL)	Non-Diabetics	Pre-Diabetes	Diabetes
</=8	170 (85%)	149 (74.5%)	45 (22.5%)
8.01-10	28 (14%)	45 (22.5%)	120 (60%)
10.01-12	2 (1%)	6 (3%)	35 (17.5%)
Total	200	200	200

The mean and standard deviation of MPV in non-diabetic, prediabetic, and diabetic groups were calculated. The mean value of MPV in non-diabetics and prediabetics was 6.86 and 7.44, respectively. People with diabetes were found to have a higher mean value of 8.97. The mean value and standard deviation of each group are shown in Table 4.

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Table 4. Standard Deviation & Mean values of MPV

	Non-Diabetics	Pre-Diabetes	Diabetes
Mean	6.86	7.44	8.97
Standard Deviation (SD)	1.13	1.21	1.31

An unpaired t-test was used to analyze the statistical significance of the mean value among the study groups. P value was calculated and found to be <0.0001 in all the cases, and hence statistically significant. Table 5 shows the associations and p values.

Table 5. Mean platelet volume

Unpaired t-test – p-value		
Non-diabetic & Pre-diabetes	<0.0001	statistically significant
Non-diabetic & Diabetes	<0.0001	statistically significant
Pre-diabetic & Diabetes	<0.0001	statistically significant

Pearson correlation test was used to analyze the correlation between HbA1c and MPV. R-value was found to be 0.4846. It suggests a positive correlation. R square value, the coefficient of determination, was 0.2348. It means a partial prediction of the outcome.

Moreover, the p-value was found to be < 0.00001, and hence statistically significant. The correlation between HbA1c and MPV is shown in Table 6.

Table 6. Correlation between HbA1c & MPV

Pearson Correlation Coefficient: HbA1c & MPV		
R-value	0.4846	positive correlation
R square	0.2348	partial prediction of the outcome
p-value	<0.00001	statistically significant

Discussion

Platelets are flat, disc-shaped, non-nucleated structures derived from megakaryocytic cytoplasm. They are involved in maintaining the homeostasis of the body. The mean platelet volume (MPV) ranges between 7.5fL to 10.5fL. MPV is an indicator of the biological activity and function of platelets. More giant platelets with high MPV are more reactive and aggregable. They have denser granules and thus are more involved in prothrombotic events (8).

Hyperglycemia can induce non-enzymatic glycation of platelet surface proteins. This leads to a decrease in membrane fluidity, which further leads to the activation of platelets. (9). Platelets adhere to the endothelium and release mediators involved in thrombus formation and inflammation. It finally leads to atherosclerosis with micro and macrovascular complications. Microvascular complications include nephropathy, neuropathy, and retinopathy. Macrovascular complications include coronary arterial disease, stroke, and peripheral vascular diseases (10).

Studies by Swaminathan A et al. and Cadirci K et al. identified that MPV is higher in diabetes mellitus and is associated with vascular complications. (11, 12). In the present study also, MPV is found to be higher when compared to non-diabetics.

Mallem B et al. found a linear relationship between increased fasting, postprandial blood sugar, HbA1c, and MPV values. They also found that platelet count increases by 1.06 times in uncontrolled diabetes (13). Agarwal k et al. suggest using MPV with HbA1c as a diagnostic test and a prognostic marker of diabetes-

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related vascular complications (14). Kodikatte TA et al. found a positive statistical correlation between HbA1c and MPV (15). Similar observation was also found in the present study.

Rafael EH et al. found that MPV is higher in the patients with diabetes with vascular complications compared to the patients with controlled DM and without vascular complications. They also found that there is a significant association between MPV and hypertension. (16). According to Manavar MJ et al., MPV can be lower with reasonable glycemic control, and hence can decrease the incidence or delay microvascular complications. (17).

According to Li Z et al., females with MPV values more than 9.8 fL have a 92% increased risk of developing DM. Also, they concluded that there is no association between MPV and age, BMI, WBC count, hypertension, and hyperlipidemia (18).

Jaman S et al. found an increase in MPV, Platelet distribution width (PDW), and a decrease in the platelet count in people with diabetes with HbA1c more than 7. Hence, they concluded that MPV and PDW could be used as biomarkers of microvascular complications (19).

Ulutas KT et al. and El-Kafrawy N et al. found that the increased incidence of atherosclerosis in DM is possibly due to the hyperactivity of platelets. Hence, they suggest MPV as a prognostic marker of cardiovascular complications (20, 21).

Conclusion

Mean platelet volume is found to be higher in people with diabetes compared to non-diabetics. Also, there is a positive correlation between the HbA1c value and MPV. Hyperactive and large platelets have a higher MPV and may be involved in the pathogenesis of microvascular complications associated with diabetes. Hence MPV can be used as a marker of poor glycemic control and related complications.

Acknowledgments

No Declared

Conflict of interest

The authors have no conflict of interest in this study.

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