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Mean platelet volume in type 2 diabetes: A tertiary care study in India

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Abstract:
Increased platelet activity may contribute to vascular complications in patients with Type 2 diabetes mellitus, with mean platelet volume (MPV) reflecting platelet activation. This case-control study enrolled 200 participants, including 100 diabetic patients and 100 non-diabetic controls. MPV was higher among diabetic patients, particularly those with poor glycemic control (HbA1c ≥6.5%) and increased with longer diabetes duration. The findings indicate an association between elevated MPV, poor glycemic control and longer duration of diabetes. MPV may serve as a simple and inexpensive marker for assessing platelet activation and identifying diabetic patients at increased risk of vascular complications.

Keywords: Glycated hemoglobin (HbA1c), mean platelet volume (MPV), platelets, pre-diabetes, type 2 diabetes

Background:
Diabetes Mellitus (DM) is a chronic metabolic disorder that is rapidly increasing worldwide, imposing a substantial social, health and economic burden **[1].** It is characterized by persistent hyperglycemia resulting from a combination of genetic predisposition and environmental influences **[2]**. DM is strongly associated with both microvascular and macrovascular complications, which remain the leading causes of morbidity and mortality among affected individuals. Patients with diabetes have an increased risk of premature cardiovascular, cerebrovascular and peripheral vascular diseases, particularly when additional risk factors such as hypertension, obesity, smoking and dyslipidaemia are present **[3]**. A central pathological feature of DM is a prothrombotic state driven by chronic hyperglycaemia and insulin resistance, which enhances platelet activation and accelerates atherosclerosis **[4].** Oxidative stress and inflammation further contribute to endothelial dysfunction by reducing nitric oxide bioavailability and promoting platelet adhesion and aggregation, thereby aggravating vascular complications **[5].** Platelets play a crucial role in thrombosis, inflammation and atherogenesis through the release of bioactive mediators following vascular injury **[6].** Mean Platelet Volume (MPV), an indicator of platelet size and activity, is easily measured using routine haematological tests **[7].** Evidence suggests that MPV is elevated in patients with Type 2 Diabetes Mellitus (T2DM), reflecting increased platelet reactivity and the production of larger, more active platelets **[8].** Poor glycaemic control has also been associated with higher MPV levels, further contributing to the risk of vascular complications **[9].** Therefore, it is of interest to compare the MPV levels between patients with T2DM and non-diabetic individuals and to evaluate the association of MPV with glycemic control and diabetic complications.

Materials and Methods:
This study was designed as a comparative case–control investigation aimed at evaluating and comparing specific hematological parameters between individuals with type 2 diabetes mellitus and non-diabetic controls. Data were collected from patients who met the predefined inclusion and exclusion criteria. Before enrolment, each participant was carefully informed about the purpose of the study, the need for relevant laboratory investigations and how the findings could contribute to their further clinical management. Only those patients who provided informed consent and were willing to participate were included in the study. The participants were recruited from both the outpatient and inpatient departments of our hospital, ensuring a diverse representation of cases. The duration of the study extended over a period of one year, from June 2024 to June 2025. Prior to commencement, the study protocol was thoroughly reviewed and approved by the Institutional Ethics Committee to ensure adherence to ethical standards and patient safety. The ethical clearance was granted under approval number 125/PATHOLOGY/GMC/IECBMHR/2025 dated 27.05.2025. All procedures carried out during the study were in accordance with institutional guidelines and ethical principles for biomedical research involving human subjects. A total of 200 participants were included in the study, comprising 100 patients who were either newly diagnosed or previously known cases of type 2 diabetes mellitus and 100 non-diabetic individuals who served as controls. Detailed clinical and laboratory evaluations were performed for all participants. These investigations included a complete blood count with special emphasis on platelet indices such as platelet count (PC), Mean Platelet Volume (MPV), Platelet Distribution Width (PDW) and Plateletcrit (PCT). In addition, glycated hemoglobin (HbA1c) levels were measured to assess long-term glycaemic control in the study population. For the purpose of analysis, an MPV value greater than 7.5 femtoliters (fL) was considered elevated. The inclusion criteria for the study were clearly defined. Individuals aged more than 18 years diagnosed with type 2 diabetes mellitus, both with and without microvascular complications, were eligible to participate. Furthermore, only those participants who were willing to provide informed consent and comply with study procedures were included. The exclusion criteria were established to eliminate confounding factors that could influence the study outcomes. Patients who had received a blood transfusion within the last 14 days were excluded, as this could alter hematological parameters. Individuals with known bleeding disorders, recent blood loss, anemia or myeloproliferative disorders were also excluded. Additionally, patients on antiplatelet therapy, those with a known history of malignancy undergoing chemotherapy or radiotherapy and individuals with clinical evidence of heart failure or secondary hypertension were not considered for inclusion. Patients with a history of using drugs such as non-steroidal anti-inflammatory drugs (NSAIDs), other than oral hypoglycemic agents, or medications causing bone marrow suppression were excluded as

well. Pregnant women and individuals with any active infections at the time of evaluation were also excluded to maintain the accuracy and reliability of the study findings.

Statistical analysis:

The data entered in Microsoft Office Excel 2007 and IBM SPSS version 21 was used for analysis. The data presented in the form of tables. The data represented as frequencies, percentages, mean and standard deviation. Chi-square test and t-test were used to assess the relationship between the variables and p-value less than 0.05 was considered as significant.

Results:

Total 200 study population (100 cases & 100 controls) were taken. Cases and controls divided into males and females. Maximum no. of individuals (25 (25%) males and 11 (11%) females) came under 61-70 years of age group. After that 14 (14%) males & 10 (10%) females in 71-80 years, 11 (11%) and 05 (05%) in 51-60 years & Minimum no. of individual came under > 80 years (06 (06%) males, 04 (04%) females) **(Table 1).** HbA1c levels were ≥ 6.5% in 173 (86.5%) individuals. 17 (8.5%) individuals had HbA1c values between 5.7-6.4%, While 10 (5%) had HbA1c values <5.7% **(Table 2).** About 100 (50%) individual had MPV between 7.6-11.5fl and 26% (52) have it >11.6fl **(Table 4).** 107 (53.5%) individual had PDW >17fl **(Table 5)**, Plateletcrit >0.37% in 68% (136 in no) **(Table 6).** Platelet count was within normal range in majority of individuals 180 (90%) **(Table 3).** A total of 200 individuals were included in the study, comprising 100 cases and 100 controls. The study population was further stratified based on age, gender, glycemic status and platelet indices. The age and gender distribution of the study population is presented in **Table 1**. The majority of participants were concentrated in the 61–70 years age group, which accounted for 36% (n=72) of the total study population. Within this group, males constituted a larger proportion (25%) compared to females (11%). The next most represented age group was 71–80 years (24%, n=48), followed by 51–60 years (16%, n=32) and 41–50 years (14%, n=28). The >80 years age group had the lowest representation (10%, n=20). A clear male predominance was observed across all age groups, with males contributing 64% (n=128) of the study population, while females accounted for 36% (n=72). This trend was consistently seen in both cases and controls. Additionally, the distribution of cases and controls was uniform across all age groups, indicating a well-matched study design **(Table 1).** The distribution of HbA1c levels among the study population is shown in **Table 2.** A significant majority of participants (86.5%, n=173) had HbA1c levels >6.5%, indicating poor glycemic control and a high burden of diabetes within the study group. Only 8.5% (n=17) of individuals were within the prediabetic range (5.7–6.4%), while a small fraction (5%, n=10) had HbA1c levels <5.7%, which is considered normal. These findings highlight that most of the study population consisted of individuals with uncontrolled or poorly controlled diabetes **(Table 2).** The platelet count distribution is summarized in **Table 3**. The majority of participants (90%, n=180) had platelet counts within the normal reference range (1.5–4.5 lakhs/cumm). A small proportion of individuals had thrombocytopenia (<1.5 lakhs/cumm), accounting for 3.5% (n=7), while 6.5% (n=13) exhibited elevated platelet counts (>4.5 lakhs/cumm). Overall, platelet count remained within normal limits in most individuals, suggesting that quantitative platelet abnormalities were less common in this cohort **(Table 3).** The distribution of MPV values is depicted in **Table 4**. Half of the study population (50%, n=100) had MPV values within the normal range (7.6–11.5 fl). However, a considerable proportion of individuals (26%, n=52) demonstrated elevated MPV (>11.6 fl), indicating increased platelet size and activity. Additionally, 24% (n=48) had MPV values below the normal range. Importantly, it was observed that MPV was significantly higher among diabetic individuals (HbA1c ≥6.5%), suggesting enhanced platelet activation in this group. Furthermore, an increasing trend of MPV was noted with the longer duration of diabetes, indicating a possible relationship between chronic hyperglycemia and platelet reactivity **(Table 4).** The distribution of PDW values is shown in Table 5. A majority of participants (53.5%, n=107) had PDW values >17 fl, indicating increased heterogeneity in platelet size. Normal PDW values (10–17 fl) were observed in 30% (n=60) of individuals, while 16.5% (n=33) had values below 9 fl. The predominance of elevated PDW suggests increased platelet activation and variability, particularly among individuals with higher glycemic levels **(Table 5).** The distribution of Plateletcrit values is presented in **Table 6**. A substantial proportion of the study population (68%, n=136) exhibited Plateletcrit values >0.37%, indicating increased platelet mass. Lower Plateletcrit values (<0.20%) were observed in 18% (n=36), while 14% (n=28) had values within the intermediate range (0.20–0.36%). These findings suggest that platelet biomass is elevated in a significant proportion of individuals, which may be associated with increased thrombotic risk in diabetic patients **(Table 6).**

Table 1: Demographic distribution of study population

Age Group (Years)	No. of Males		No. of Females		Total No.
	Cases	Controls	Cases	Controls	
41–50	8 (8%)	8 (8%)	6 (6%)	6 (6%)	28 (14%)
51–60	11 (11%)	11 (11%)	5 (5%)	5 (5%)	32 (16%)
61-70	25(25%)	25(25%)	11(11%)	11(11%)	72(36%)
71–80	14 (14%)	14 (14%)	10 (10%)	10 (10%)	48 (24%)
>80	6 (6%)	6 (6%)	4 (4%)	4 (4%)	20 (10%)
Total	**64 (64%)**	**64 (64%)**	**36 (36%)**	**36 (36%)**	**200 (100%)**

Table 2: Distribution of HbA1c in study group

HbA1c levels	Total No. Cases+ Controls)
< 5.7%	10 (5%)
5.7-6.4%	17 (8.5%)
>6.5%	173 (86.5%)
	n = 200 (100%)

Table 3: Distribution of platelet count

Platelet Count	Total No. (Cases+ Controls)
<1.5 lakhs/cumm	07 (3.5%)
1.5-4.5 lakhs/cumm	180 (90%)
>4.5 lakhs/cumm	13 (6.5%)
	n = 200 (100%)

Table 4: Distribution of Pt based on MPV

MPV	Total No. (Cases+ Controls)
< 7.5 fl	48 (24%)
7.6-11.5 fl	100 (50%)
>11.6 fl	52 (26%)
	n = 200 (100%)

Table 5: Distribution of pt based on PDW

PDW	Total No. (Cases+ Controls)
<9 fl	33 (16.5%)
10-17 fl	60 (30%)
>17 fl	107 (53.5%)
	n=200(100%)

Table 6: Distribution of pt based on Plateletcrit (PCT)

Plateletcrit (PCT)	Total No. (Cases+ Controls)
<0.20%	36 (18%)
0.20-0.36%	28 (14%)
>0.37%	136 (68%)
	n = 200 (100%)

Discussion:

In the present study, the age of participants ranged from 41 to above 80 years. Most patients with Type 2 Diabetes Mellitus (T2DM) belonged to the 61–70 years age group, which is in agreement with findings reported in previous studies. Males constituted a greater proportion of the study population (64%) than females (36%). Glycated hemoglobin (HbA1c) levels exceeded 6.4% in the majority of cases (86.5%), indicating poor glycemic control. The platelet count remained within the normal physiological range in approximately 90% of cases. The mean platelet volume (MPV) in the present study was 9.575 fL, which lies within the normal range and is consistent with earlier research. MPV serves as an indicator of platelet size and functional activity. Larger platelets are metabolically more active, younger in circulation and possess a greater tendency for aggregation. They contain an increased number of dense granules and release higher concentrations of prothrombotic mediators such as serotonin, β-thromboglobulin and thromboxane A2, all of which enhance coagulation **[10].** This heightened platelet activity may contribute to thrombotic complications in diabetic patients, indicating that MPV reflects platelet functional status and thrombotic potential **[11].** Minor vascular injuries, such as rupture of atherosclerotic plaques, can further amplify platelet activation and recruitment, along with stimulation of platelet production in the bone marrow. Consequently, elevated MPV is increasingly recognized as a potential risk marker for vascular complications, particularly atherothrombosis **[12].** Diabetes mellitus is widely regarded as a prothrombotic condition due to enhanced platelet reactivity **[2],** although the precise relationship between platelet dysfunction and clinical complications has not been fully clarified **[7].** Dev *et al*. **[4]** proposed that platelet dysfunction may develop early in the course of diabetes, even before overt clinical manifestations and that improved glycemic control may reduce MPV values, thereby lowering thrombotic risk. In the present study, the mean platelet distribution width (PDW) was 16.03 fL, suggesting increased heterogeneity in platelet size and enhanced platelet activation. Similar observations have been reported by Khanna *et al*. **[8].** The mechanisms underlying elevated MPV are not completely understood; however, insulin resistance and chronic hyperglycemia are believed to play key roles **[13].** Activated platelets release multiple bioactive substances that contribute to endothelial dysfunction, oxidative stress and vascular injury **[14].** Therefore, MPV may act as a useful biomarker for platelet activation, arterial stiffness and future cardiovascular risk stratification **[15].** The mean plateletcrit (PCT) observed in the present study was approximately 0.397% and a substantial proportion of participants showed elevated platelet indices despite having platelet counts within the normal range. These findings support the concept that qualitative platelet abnormalities may occur in diabetic individuals even when quantitative platelet parameters remain unaffected. The observed elevation of MPV, PDW and PCT among participants with poor glycemic control further suggests enhanced platelet activation and a potentially increased risk of vascular complications.

Conclusion:

MPV was higher in patients with T2DM, particularly among those with poor glycemic control, suggesting increased platelet activation. Despite predominantly normal platelet counts, altered MPV and related platelet indicate potential platelet dysfunction in T2DM. MPV may serve as a simple and cost-effective marker for vascular risk assessment, although larger prospective studies are needed to establish clinically relevant cut-off values.

Limitations of the study:

Although the present study provides useful insight into the association between glycemic status and platelet indices, several limitations should be considered. The study was conducted on a relatively small sample size of 200 participants from a single center, which may limit the generalizability of the findings. Additionally, the cross-sectional case–control design allows only the identification of associations rather than causality. Potential confounding factors such as hypertension, smoking status, obesity, dyslipidemia and medication use were not completely controlled. Furthermore, platelet indices were assessed at a single time point and detailed subgroup analyses based on the duration of diabetes and diabetic complications were not performed. Therefore, larger multicentric prospective studies are required to validate these findings.

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