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Platelet Metrics In Type 2 Diabetes: A Practical Tool For Assessing Vascular Complications

Soumya V[1*], Sukesh[2], Rubina M P[3], Mohammed Safeer T K[4], Riyas Basheer K B[5], Nayana K Babu[6]

[*1]Research Scholar, Srinivas University, Mukka, Mangalore, Karnataka, India- 574146 & HOD cum Professor, Department of MLT, KMCT College of Allied Health Sciences, Mukkam, Kozhikode, Kerala, India- 673602.

[2]Professor, Department of Pathology, Srinivas Institute of Medical Sciences & Research centre, Mukka, Mangaluru, Karnataka, India- 574146

[3,4]Research Scholar, Srinivas University, Mukka, Mangalore, Karnataka, India- 574146

[5]Vice Principal, Tejasvini Physiotherapy College, Kudupu, Mangalore, Karnataka, India- 575028

[6]Associate Professor, KMCT College of Allied Health Sciences, Mukkam, Kozhikode, Kerala, India- 673602.

***Corresponding author:**

Soumya V

Research Scholar, Srinivas University, Mukka, Mangalore, Karnataka, India-574146 & HOD cum Professor, Department of MLT, KMCT College of Allied Health Sciences, Mukkam, Kozhikode, Kerala, India-673602.

Email ID: soumyavadakath@gmail.com

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ABSTRACT

Background: Chronic metabolic disorder Type 2 Diabetes Mellitus (T2DM) is characterized by hyperglycemia, which is associated with a range of complications, particularly vascular complications that significantly contribute to morbidity and mortality among patients. The ability to predict these complications early is crucial for preventive strategies and patient management. This study provides an overview of the practicality of platelet parameters for predicting vascular complications in type 2 diabetes patients, highlighting their importance in diabetes management and the potential benefits of incorporating them into clinical practice as accessible and cost-effective biomarkers for early risk assessment and improved patient management in the context of a global health challenge.

Method: The study included 250 T2DM patients and 125 non-diabetic individuals. Participants were selected using convenience sampling from outpatient and inpatient departments. The diabetic group was further categorized based on the presence or absence of vascular complications. Laboratory analyses were conducted to determine HbA1C levels and platelet parameters. Data were analyzed using SPSS version 21.0, applying non-parametric methods to evaluate platelet indices, HbA1c levels, and demographic variables.

Result: Elevated HbA1c, platelet count, MPV (Mean Platelet Volume), and PDW (Platelet Distribution Width) values were observed in T2DM patients with vascular complications, distinguishing them from T2DM patients without such complications and healthy subjects. The patient with Diabetes Mellitus and vascular complications exhibited an MPV of 14.44 fL, PDW of 19.21%, and a platelet count of 488.8 x 10^3/µL. These values surpass the normal ranges, suggesting heightened platelet activity, size variability, and a prothrombotic state.

Conclusion: The integration of MPV and PDW platelet indices could be an economical approach to T2DM vascular risk management, potentially bettering healthcare in rural settings.

Keywords: *Type 2 Diabetes, Vascular Complications, Platelet indices, HbA1c, Blood Parameters.*

1. INTRODUCTION

Diabetes mellitus (DM) stands as a major global health issue. The International Diabetes Federation (IDF) Diabetes Atlas (2021) reports that around 10.5% of adults aged 20 to 79 years are impacted by this disease. Alarmingly, nearly half of these individuals are unaware of their condition. Projections indicate that by 2045, approximately 783 million people, or one in every eight adults, will be affected by diabetes, marking a significant 46% increase (1).

A persistent elevation in blood glucose characterizes diabetes as an enduring metabolic ailment due to either insufficient pancreatic insulin production or inefficient systemic insulin utilization. Uncontrolled diabetes can cause significant damage to various body systems over time, primarily affecting the nerves and blood vessels. More than 95% of individuals with diabetes have type 2 diabetes, which poses a significant risk for serious complications (2).

Individuals with diabetes are more susceptible to atherothrombotic events and vascular diseases, which are major contributors to morbidity and mortality. The detrimental impacts of hyperglycemia are broadly separated into macrovascular complications (peripheral arterial disease, coronary artery disease, and stroke) and microvascular complications (diabetic neuropathy, retinopathy, and nephropathy) (3,4). A prevalent complication of diabetes includes peripheral neuropathy. Post-diagnosis of type 2 diabetes mellitus, about 70% of sufferers eventually develop this nerve-related issue (5).

Numerous studies have demonstrated the involvement of enhanced platelet activation in the pathogenesis of vascular complications. Platelets obtained from individuals with diabetes exhibit evidence of platelet hyperactivity, characterized by increased adhesiveness and aggregation in response to various factors, including insulin effects, hyperglycemia, hyperlipidemia, endothelial dysfunction, oxidative stress, and inflammatory states (6,7,10).

Active platelet involvement in thrombotic events may alter platelet characteristics in the circulation. Platelet indices, which are blood-based parameters associated with platelet shape and proliferation kinetics, can provide valuable insights into endothelial dysfunction and platelet functional status in the context of diabetic vascular complications (8,9).

Automated complete blood counts yield platelet indices, such as plateletcrit, mean platelet volume (MPV), and platelet distribution width (PDW). Recent findings propose that these indices could be clinically relevant for diagnosing and predicting outcomes in specific diseases (10,11).

Platelet indices are affordable and readily available parameters during routine blood tests. The most extensively investigated platelet metric is mean platelet volume (MPV), which represents the average size of platelets in the blood. The platelet distribution width (PDW) measures the range of platelet sizes as produced by megakaryocytes, which tends to increase with the activation of platelets. The platelet larger cell ratio (P-LCR) is another marker, signifying the share of platelets in circulation with a volume greater than 12 femtoliters (11,12).

Routine medical examinations and blood testing are the most proven methods for identifying diabetes and its associated complications. Early detection and prevention of thrombosis are essential to averting serious consequences, as thrombosis is a major contributor to vascular complications in type 2 diabetes. However, the current diagnostic criteria do not recommend the detection of thrombotic evidence in individuals with diabetes mellitus (13).

In this study, we investigate the feasibility of utilizing platelet indices as early indicators of the disease burden associated with developing vascular complications in diabetes mellitus. Efforts were made to compare the variations in these indices between individuals with diabetes mellitus with and without vascular complications.

2. MATERIALS AND METHOD

Study Design and Participants: This cross-sectional study included 375 participants: 250 individuals with Type 2 Diabetes Mellitus (T2DM), including both newly diagnosed and pre-existing cases, and 125 healthy, non-diabetic individuals aged over 18 years. Diabetes was diagnosed based on the American Diabetes Association guidelines. Participants with Type 1 diabetes, those under 18 years of age, and individuals with conditions such as venous thrombosis, cancer, hyperthyroidism, recent surgeries, coagulopathies, acute infections, or those unwilling to consent were excluded from the study.

The participants were categorized into three groups: Group A (T2DM with vascular complications), Group B (T2DM without vascular complications), and Group C (healthy controls without diabetes or vascular diseases). Participants were recruited from both outpatient settings, where they attended routine check-ups, and inpatient settings, where they were admitted for complications. Vascular complications were diagnosed through a combination of clinical history, physical examinations, laboratory tests, and imaging studies. Nephropathy was diagnosed using estimated glomerular filtration rate (eGFR) and urine albumin levels, retinopathy was assessed through fundoscopy performed by an ophthalmologist, and peripheral vascular disease was confirmed using Doppler ultrasound.

Vascular complications in this study were categorized into macrovascular (coronary artery disease, peripheral arterial disease, and stroke) and microvascular (retinopathy, nephropathy, and neuropathy). Microvascular complications were specifically chosen for this study due to their early onset in T2DM, their strong association with prolonged hyperglycemia, and their relevance in reflecting microvascular endothelial dysfunction, which is linked to alterations in platelet parameters. These factors make microvascular complications highly relevant for evaluating the practicality of platelet indices in T2DM patients.

Data Collection and Laboratory Analysis: Blood samples were collected from the participants within one week of diagnosing vascular complications to minimize temporal variability and subjected to routine biochemical and hematological tests in the central laboratory. The samples were collected in appropriate tubes and analyzed using specialized equipment.

For patients with chronic complications, samples were taken during routine follow-ups to reflect their ongoing condition. Prior to blood sample collection, participants were screened for febrile illnesses through clinical history, physical examination, and temperature measurements. Any individual with a body temperature exceeding 37.5°C was either excluded from the study or their sample collection was rescheduled once they were afebrile. This step ensured that febrile conditions, which could potentially affect the laboratory results, were controlled for during the study.

The complete blood cell count (CBC) analysis was performed using the ABX PentraXL hematological analyzer, while the biochemical parameters of the blood were assessed using the 'Randox Imola' biochemistry auto-analyzer.

The collected study data underwent analysis, considering different aspects such as age, sex, diabetes duration, locality, HbA1C levels, hematological parameters, and other demographic information.

The entire dataset was processed and analyzed using the statistical analysis capabilities of SPSS version 21.0. The study detailed qualitative data using frequency, percentage, median, and IQR, whereas quantitative data were expressed through mean and standard deviation (SD). The distribution's normality was assessed with the Kolmogorov-Smirnov test, revealing that the data did not exhibit a normal distribution.

Consequently, the comparison of outcomes across the groups was conducted using the non-parametric Kruskal-Wallis test. The significance level for the study was set at a 95% confidence interval ($p < 0.05$).

3. RESULTS

Descriptive data of the analysis subset shows, in Group A (T2DM with vascular complications) majority belongs to the age category 55-64 years (39%), whereas 45-54 years of age (41%) in Group B (T2DM without vascular complications) and while Group C (Healthy individuals) represent age of 30-44 years (59%). This study also reveals males are dominant in all groups (Table 1).

Variables		Group A	Group B	Group C
Age (Years)		54.74 ± 10.07	51.48 ± 9.45	46.62 ± 8.30
Gender	Male	80 (64%)	83 (66.4%)	72 (57.6%)
	Female	45 (36%)	42 (33.6%)	53 (42.4%)
Locality	Rural	72 (57.6%)	57 (45.6%)	44 (35.2%)
	Urban	53 (42.4%)	68 (54.4%)	81 (64.8%)
T2DM Duration	No Diabetes	0 (0%)	0 (0%)	125 (100%)
	< 3 Years	10 (8%)	19 (15.2%)	0 (0%)
	3-6 Years	48 (38.4%)	73 (58.4%)	0 (0%)
	6-9 Years	34 (27.2%)	23 (18.4%)	0 (0%)
	9-12 Years	24 (19.2%)	10 (8%)	0 (0%)
	12-15 Years	9 (7.2%)	0 (0%)	0 (0%)

Table 1. Demographic data of the study sample

Individuals with T2DM and vascular complications shows higher HbA1c level, Platelet count, MPV and PDW than the individuals with T2DM without vascular complications and healthy individuals (Table 2).

Blood Parameters	Group A	Group B	Group C
HbA1c	11.35 ± 2.62	8.98 ± 1.69	5.04 ± 0.69
Platelet	488.88 ± 185.33	247.71 ± 64.55	286.27 ± 126.98
MPV	14.44 ± 1.47	8.09 ± 0.57	9.49 ± 1.81
PDW	19.21 ± 2.42	15.99 ± 0.92	16.53 ± 0.94

Table 2. Baseline Blood Parameters among the Group

HbA1c, Platelets, MPV & PDW value comparison across the group shows notable disparity among the cohort and a statistically significant elevated measure observed in Group A followed by Group B & C (Table 3).

Blood Indices	Group	Mean ± SD	Std. Error	Median (IQR)	Kruskal Wallis test	p Value
HBA1c	Group A	11.35 ± 2.62	0.234	11.80 (9.0-13.5)	272.168	<0.001*
	Group B	8.98 ± 1.69	0.151	8.60 (7.5-10.25)		
	Group C	5.04 ± 0.69	0.061	5.20 (4.3-5.4)		
Platelet	Group A	488.88 ± 185.33	16.576	483 (362.5-644.5)	118.345	<0.001*
	Group B	247.71 ± 64.55	5.773	241 (194-298.5)		
	Group C	286.27 ± 126.98	11.357	255 (210-317)		
MPV	Group A	14.44 ± 1.47	0.132	14.6 (13.2-15.75)	262.437	<0.001*
	Group B	8.09 ± 0.57	0.051	7.9 (7.7-8.6)		
	Group C	9.49 ± 1.81	0.162	9.5 (7.95-11)		
PDW	Group A	19.21 ± 2.42	0.216	18.5 (17.6-19.95)	207.17	<0.001*
	Group B	15.99 ± 0.92	0.083	15.9 (15.35-16.7)		
	Group C	16.53 ± 0.94	0.084	17.3 (15.7-17.3)		
***Statistically significant**						

Table 3: Comparison of Blood Parameters between the Groups

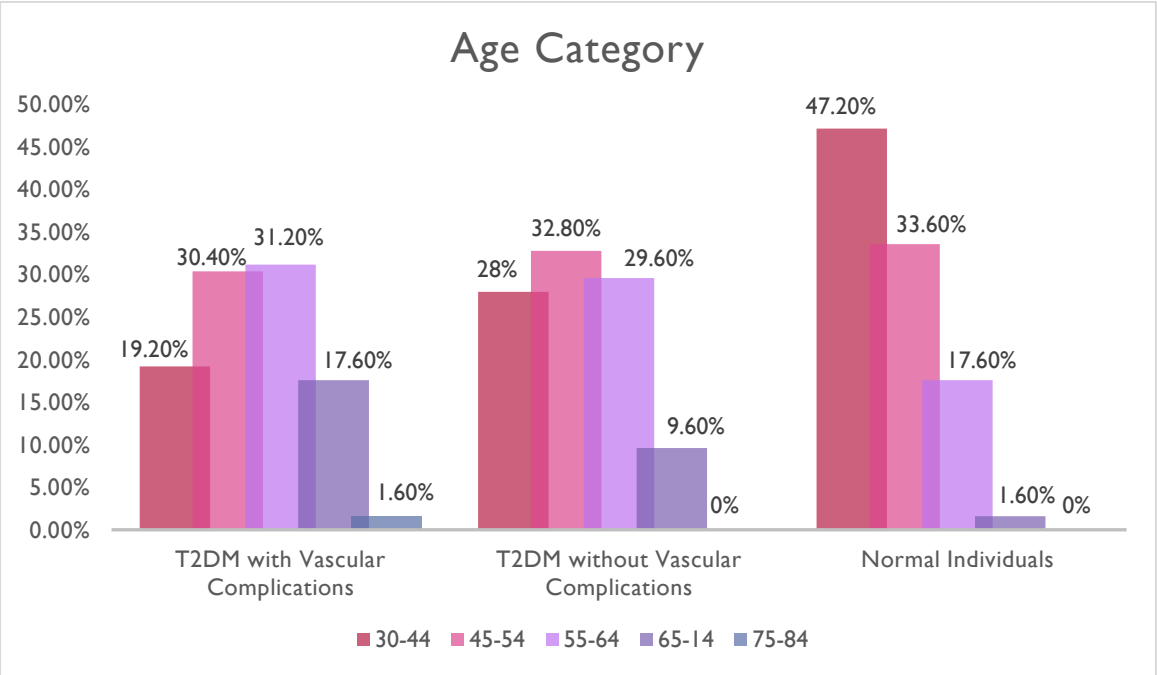

Figure 1: Frequency distribution of age

4. DISCUSSION

The findings of this investigation further support the existing evidence suggesting a link between variations in specific blood parameters and the presence and progression of vascular complications in patients with type 2 diabetes. The age distribution observed in Group A shows a greater proportion of individuals aged 55-64 years in group A (T2DM with vascular

complications), which aligns with previous research suggesting that advancing age is a key factor influencing the development of vascular complications in T2DM patients (Huang et al., 2020; Yazdanyar & Newman, 2009) (14).

Furthermore, the predominance of males across all groups is consistent with the well-established gender disparity in the prevalence and severity of T2DM and its associated complications, with men being disproportionately affected (Kautzky-Willer et al., 2016; Ling et al., 2022) (15).

The elevated levels of HbA1c, platelet count, mean platelet volume (MPV), and platelet distribution width (PDW) observed in Group A (T2DM with vascular complications) are particularly noteworthy. These findings corroborate the growing evidence supporting the role of these blood parameters as potential biomarkers for the prediction and monitoring of vascular complications in T2DM patients.

Specifically, the higher HbA1c levels in Group A are consistent with numerous studies that have established HbA1c as a reliable indicator of prolonged blood sugar regulation and a strong predictor of vascular complications in individuals with diabetes (Sherwani et al., 2016; Yusuf et al., 2020) (16).

The increased platelet count and altered platelet indices (MPV and PDW) observed in Group A align with recent research linking these parameters to the pathogenesis of vascular complications in T2DM. Elevated platelet count and MPV have been associated with increased platelet activation, aggregation, and inflammation, contributing to the evolution of atherosclerosis and thrombotic events (Akyol et al., 2022; Yaman et al., 2020) (17). Similarly, elevated PDW has been linked to poor glycemic control and an increased risk of diabetic peripheral neuropathy (Zhang et al., 2019) (18).

Our findings lend support to the suggestion made by Kim et al. that increased mean platelet volume (MPV) is a marker of heightened platelet reactivity in diabetes. We observed substantially elevated MPV, platelet distribution width and platelet count among type 2 diabetes mellitus (T2DM) patients with vascular complications (19).

The significant differences in these blood parameters across the groups, with Group A exhibiting the highest values, further reinforce their potential utility as biomarkers for risk stratification and monitoring of vascular complications in T2DM patients. Regular assessment and monitoring of these parameters may facilitate early detection, targeted interventions, and personalized management strategies to mitigate the risk of vascular complications and improve patient outcomes.

Nonetheless, recognizing the constraints of this research is crucial, particularly its cross-sectional nature and the possibility of confounding variables. To corroborate these results and investigate the relationships among blood markers, genetic predispositions, lifestyle influences, and treatment strategies concerning Type 2 Diabetes Mellitus and its related circulatory issues, forthcoming longitudinal studies involving more extensive and varied cohorts are essential.

5. CONCLUSION

In conclusion, the incorporation of platelet indices, particularly MPV and PDW, in conjunction with established risk factors, holds promise as an economical and readily available strategy for risk assessment and management of vascular complications in individuals with T2DM. These cost-effective biomarkers may enhance early identification, continuous monitoring, and timely treatment, potentially elevating patient care and life quality, particularly in rural areas with limited resources.

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