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ASSOCIATION OF GLYCAEMIC CONTROL AND PLATELET INDICES – A CROSS SECTIONAL STUDY

General Medicine

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ABSTRACT

Background: Cardiovascular complications account for most deaths in diabetic patients, emphasizing the effect of diabetes on cardiovascular health. Platelet indices like mean platelet volume (MPV) and platelet distribution width (PDW) are being recognised as important markers of imminent cardiovascular risk. Furthermore, diabetic patients often demonstrate platelet hyperreactivity which may add to the prothrombotic risk in diabetic population. **Methods:** A retrospective cross-sectional study was undertaken to evaluate association of MPV and PDW with adequacy of glycaemic control. Linear association with rising HbA1c and platelet indices was also analysed. Effect of increasing age, renal dysfunction and glycaemic control on PDW and MPV was evaluated using multivariate analysis. **Results:** A statistically significant relationship was observed between rising HbA1c levels and platelet indices, MPV (r=0.94) and PDW (r=0.86). On comparing means, patients with HbA1c > 6.5% demonstrated consistently elevated MPV (DF=6.5, p<0.001) and PDW (DF=6.1, p<0.001) as compared to those with HbA1c <= 6.4%. On multivariate analysis, increasing age and serum creatinine were found to have further additive effect on worsening platelet indices in diabetic patients. **Conclusion:** This study highlights an association between poor glycaemic control, increasing age, renal dysfunction and elevated platelet indices, which may contribute to enhanced pro-thrombotic risk. Regular assessment of platelet indices may serve as a valuable tool in cardiovascular risk prediction and prevention in this population.

KEYWORDS

Diabetes, mean platelet volume, platelet distribution width, platelet indices, cardiovascular risk, diabetes complications.

INTRODUCTION

Diabetes mellitus is a prevalent global health issue with significant implications for cardiovascular health. Cardiovascular complications like coronary artery disease, stroke, and heart failure, account for most deaths in diabetic patients, further emphasizing the effect of diabetes on cardiovascular health. Globally, over 463 million adults were living with diabetes in 2019, which is projected to rise to 700 million by 2045 due to factors such as aging populations and lifestyle changes. [1] India, one of the largest diabetic population, has seen a sharp increase in the prevalence of diabetes, and this surge is anticipated to nearly double by 2030. [2] Cardiovascular complications are a significant concern in India as well, where diabetes is responsible for a substantial number of hospitalizations.

In recent years, platelet indices such as mean platelet volume (MPV) and platelet distribution width (PDW) have emerged as important biomarkers in assessing cardiovascular risks. These indices, reflecting platelet activation and aggregation potential, are closely linked to the pathophysiology of atherothrombosis and vascular inflammation, both of which are pivotal in cardiovascular diseases (CVDs). Elevated MPV, for example, has been associated with an increased risk of coronary artery disease and acute myocardial infarction. Similarly, higher PDW values have been linked to unstable angina and the severity of coronary lesions. [3] Understanding platelet indices can help stratify patients at risk for cardiovascular complications and may guide early interventions to improve outcomes.

Platelet indices are significant in case of diabetes mellitus since both are associated with vascular complications. Diabetic patients often exhibit platelet hyperreactivity, contributing to the prothrombotic state characteristic of the disease. Studies have shown that MPV and PDW are significantly elevated in diabetic patients compared to non-diabetic individuals, correlating with poor glycaemic control and heightened cardiovascular risk. [4] Moreover, these indices have been linked to the progression of diabetic microvascular complications such as retinopathy and nephropathy. Such findings underscore the importance of evaluating platelet indices in diabetic populations to better understand their contribution to disease progression and complications.Despite the growing recognition of platelet indices in diabetes and cardiovascular diseases, there is paucity of studies evaluating the relationship between glycaemic control and platelet indices, particularly in Indian population. This gap in the literature highlights the need for studies like the present one, which aims to investigate the association between glycaemic control and platelet indices. Understanding this relationship could provide further insights into monitoring diabetes and its complications, potentially leading to better patient outcomes.

MATERIALS AND METHODS

Study Design And Participants

A retrospective cross-sectional study was conducted among data of diabetic patients at a tertiary-care centre located in Central India. The study was carried out on patient records from January to July 2024 and simple random sampling was performed to select records. All the included patients were diagnosed cases of diabetes mellitus and of more than 18 years of age. All the participants were on treatment including oral hypoglycaemic agents and/or insulin therapy. Cases were defined as per standard diagnostic criteria of HbA1c => 6.5%, fasting plasma glucose => 126 mg/dL, post-prandial => 200 mg/dL, at the time of diagnosis. [5] Platelet indices and renal function tests were recorded to evaluate their association with glycaemic control. Exclusion criteria comprised of factors that can directly affect cardiovascular outcomes or platelet indices. It included co-existing hypertension, coronary artery disease, coagulation disorders irrespective of treatment status, autoimmune disorders, patient taking anti-platelet drugs, co-existing anaemia or other malnutrition states and pregnancy. Records with incomplete medical history of co-morbidities, incomplete measurement of platelet indices were also excluded from the study. STROBE checklist for cross-sectional study was followed while designing the study. In total, 930 records were extracted; out of those, 424 were finally included in the study and 506 records were excluded based on above mentioned criteria. Patients were then classified based on adequate (HbA1c =< 6.4%) or inadequate (HbA1c => 6.5%) glycaemic control [6] and comparative analysis was performed based on platelet count, MPV and PDW. The reference range of MPV was taken to be 8 to 12 fL and that for PDW was 10.0-17.9 %. [7]

Study Tools

Data collection was done based on a pre-set proforma which included

baseline characteristics like age and gender, history of co-morbidities and medication, HbA1c, blood urea, serum creatinine, platelet count, MPV and PDW.

Statistical Analysis

Data was analysed using SPSS version 20 (IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp) and Microsoft Excel version 2019. Analyses included mean, standard deviation (SD), comparison of means, chi-square test, Spearman's correlation, linear regression analysis and multivariate analysis, wherever applicable. Spearman's correlation was used to assess linear dependence between variables. Correlation was judged very strong from 1 to 0.9, strong from 0.9 to 0.7, moderate from 0.7 to 0.5, low from 0.5 to 0.3 and poor from 0.3 to 0. The alpha risk was set to 0.05. A multivariate linear regression was performed to assess the relation between independent and explanatory variables. Data were checked for multicollinearity with the Belsley-Kuh-Welsch technique. Heteroskedasticity and normality of residuals were assessed respectively by the White test and the Shapiro-Wilk test. Statistical significance was set at $p < 0.05$. The Newey West correction for heteroskedasticity was applied. Advanced statistical analysis was performed with EasyMedStat (version 3.35.1; www.easymedstat.com).

RESULTS

The study included 424 participants, of which, 217 were males and 207 females. Mean age was 46 years (+/- 16.3) and mean HbA1c was 6.7 % (+/- 2.2). Patients with well- controlled HbA1c had a lower mean age compared to those with inadequate control (39 vs 64 years, p <0.001, 95% CI [22.98 to 27.02]).

A statistically significant relationship was observed between rising HbA1c levels and platelet indices, MPV and PDW (Table 1) (Figure1). Pearson correlation coefficient between HbA1c and MPV was calculated to be 0.94 (p <0.001) and 0.86 (p <0.001) forHbA1c and PDW. Additionally, a weak positive correlation was identified between HbA1c and serum creatinine (r = 0.34, p <0.001) and blood urea (r = 0.35, p <0.001).

Table 1: Correlation of HbA1c with various parameters

Parameter	Correlation Coefficient	Significance
MPV	0.94	p <0.001, 95% CI 0.9278 to 0.9502
PDW	0.86	p <0.001, 95% CI 0.8330 to 0.8829
S. Creatinine	0.34	p <0.001, 95% CI 0.2530 to 0.4216
B. Urea	0.35	p <0.001 95% CI 0.2635 to 0.4309
CI Confidence interval, MPV Mean platelet volume, PDW Platelet distribution width		

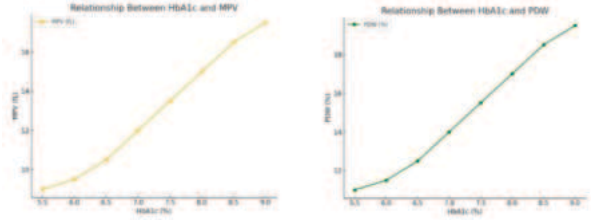

Figure 1: Relationship between HbA1c and Mean platelet volume (MPV) and platelet distribution width (PDW)

Patients with HbA1c > 6.5% demonstrated consistently elevated MPV. Moreover, all patients with HbA1c < 6.4% exhibited normal PDW, whereas more than half of those with HbA1c > 6.5% showed raised PDW. Comparison of means and Chi-square tests confirmed significant differences in platelet indices and renal markers between groups (Table 2) (Figures 2 & 3).

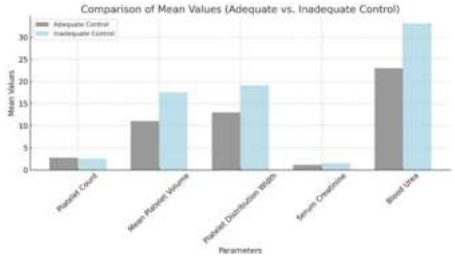

Figure 2: Means values of various parameters for adequate and inadequate glycaemic control groups.

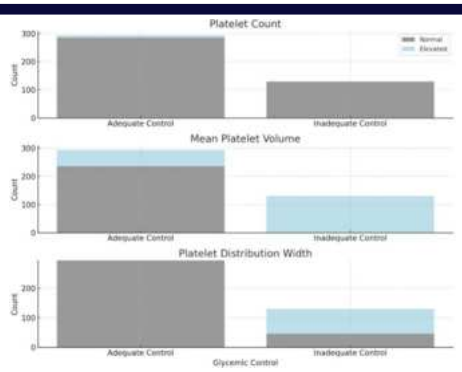

Figure 3: Platelet indices and glycaemic control

Table 2: Comparison Of Parameters Between Adequate-inadequate Glycaemic Control

Adequate Control			Inadequate Control		
		Chi Square results			Comparison of Means
Platelet Count (x10^6/microL)				Difference	-0.24
Mean	2.75 (±0.79)		Mean	2.51 (±0.68)	SE	0.08
Normal	285		Normal	129	95% CI	-0.3969 to -0.0831
Elevated	9	P = 0.1532	Elevated	1		P = 0.0028
Mean Platelet Volume (fL)					Difference	6.5
Mean	11 (± 1.14)		Mean	17.5 (±2.10)	SE	0.158
					95% CI	6.1894 to 6.8106
Normal	236		Normal	0		P < 0.0001
Elevated	58	P < 0.0001	Elevated	130		
Platelet Distribution Width (%)					Difference	6.1
Mean	13 (±2.54)		Mean	19.09 (±1.51)	SE	0.24
					95% CI	5.6290 to 6.5710
Normal	294		Normal	46		P < 0.0001
Elevated	0	P < 0.0001	Elevated	84		
S. Creatinine (mg/dL)					Difference	0.39
Mean	1.1 (±0.48)		Mean	1.49 (±1.21)	SE	0.082
					95% CI	0.2286 to 0.5514
Normal	262		Normal	99		P < 0.0001
Elevated	32	P = 0.0005	Elevated	31		
B. Urea (mg/dL)					Difference	10
Mean	23 (±10.68)		Mean	33.1 (±28.05)	SE	1.883
					95% CI	6.2982 to 13.7018

Normal	258		Normal	100		P < 0.0001
Elevated	36	P = 0.0046	Elevated	30		
CI: Confidence interval, SE: Standard error						

Multivariate analysis demonstrated that age and HbA1c independently contributed to increased PDW and MPV. For PDW, age ($\beta = 0.06$, 95% CI [0.05–0.08], $p < 0.0001$) and HbA1c ($\beta = 1.06$, 95% CI [0.91–1.21], $p < 0.0001$) were significant predictors. Similarly, age ($\beta = 0.03$, 95% CI [0.02–0.04], $p < 0.0001$) and HbA1c ($\beta = 1.33$, 95% CI [1.22–1.43], $p < 0.0001$) significantly predicted MPV. Strong positive correlations were observed between age and PDW ($\rho = 0.78$, $R^2 = 0.604$, $p < 0.001$) and age and MPV ($\rho = 0.76$, $R^2 = 0.589$, $p < 0.001$).Linear regression analysis showed that HbA1c significantly predicted MPV ($R^2 = 0.89$, $F(1,422) = 3412.11$, $p < 0.001$) with a regression coefficient (β) of 1.48. Similarly, HbA1c predicted PDW ($R^2 = 0.74$, $F(1,422) = 1225.65$, $p < 0.001$) with a regression coefficient (β) of 1.43. The correlation coefficients indicated that HbA1c accounted for 89% of the variance in MPV ($R^2 = 0.8899$) and 74% of the variance in PDW ($R^2 = 0.74$).

In multiple regression models, combining HbA1c and serum creatinine were noted to have considerable predictive power for both MPV ($R^2 = 0.89$, $F(2,421) = 1738.61$, $p < 0.001$) and PDW ($R^2 = 0.75$, $F(2,421) = 619.24$, $p < 0.001$). Both HbA1c and serum creatinine were significant predictors, though the impact of serum creatinine was less pronounced.

DISCUSSION

This study examined the association of diabetes mellitus with platelet indices, specifically mean platelet volume (MPV) and platelet distribution width (PDW), in a cohort of 424 patients. The findings revealed significant correlations between poor glycaemic control (HbA1c $\geq$ 6.5%) and elevated platelet indices, in agreement with existing literature suggesting that diabetes alters platelet morphology and function due to chronic hyperglycaemia-induced oxidative stress and inflammation. [8,9]

The positive correlation between HbA1c levels and MPV and PDW underscores the impact of sustained hyperglycaemia on platelet activation. Elevated MPV and PDW reflect increased platelet turnover and heterogeneity, markers of heightened platelet reactivity and therefore, atherothrombotic risk. These results are consistent with previous studies that identified raised MPV as a hallmark of diabetes-associated pro-thrombotic states, [8] and reported elevated PDW in diabetic populations with poor glycaemic control. [9]

Age also emerged as a significant predictor of platelet indices, with linear regression demonstrating strong correlations between advancing age and elevated MPV and PDW. These findings align with the broader understanding that aging exacerbates platelet activation due to endothelial dysfunction and increased systemic inflammation, compounding the pro-thrombotic risks in older diabetic patients. [10]The weak but significant correlation between HbA1c and renal function markers (serum creatinine and blood urea) highlights the interconnected nature of glycaemic control, platelet indices, and microvascular complications. Multivariate models incorporating HbA1c and serum creatinine enhanced predictive accuracy for MPV and PDW, suggesting that renal impairment may amplify the effects of hyperglycaemia on platelet activation.

Several mechanisms can explain these findings. Chronic hyperglycaemia promotes glycation of platelet proteins and alters their function, while hyperglycaemia-induced oxidative stress and inflammation contribute to increased platelet activation and aggregation. Additionally, the pro-inflammatory milieu in diabetes upregulates megakaryocyte activity, leading to the production of larger, more reactive platelets. [11] These pathophysiological changes collectively elevate the risk of atherothrombosis, a leading cause of morbidity and mortality in diabetes. [12]

Clinical implications of these findings are significant. Monitoring platelet indices in diabetic patients, especially those with poor glycaemic control or advancing age, can aid in identifying individuals at higher cardiovascular risk. Early interventions targeting improved glycaemic control and platelet function modulation, such as antiplatelet therapy, may mitigate these risks. This becomes further important in diabetic patients with renal dysfunction as both disorders can independently contribute to adverse cardiovascular outcomes.

Limitations: Retrospective design and the lack of longitudinal data restrict causality inference. Exclusion of patients on antiplatelet drugs limits the generalizability of these results to the broader diabetic population. Future studies should explore the impact of glycaemic variability on platelet indices and evaluate interventional strategies in prospective cohorts. Prospective studies with inclusion of patients with co-morbidities could provide better understanding of impact of glycaemic control on platelet indices in general population.

CONCLUSION

This study highlights an association between poor glycaemic control and elevated platelet indices, reinforcing the role of diabetes in enhancing pro-thrombotic risk. Age and renaldysfunction further amplify these alterations, underscoring the need for focussed risk stratification and management in diabetic patients. Regular assessment of platelet indices may serve as a valuable tool in cardiovascular risk prediction and prevention in this population.

REFERENCES

1. International Diabetes Federation (IDF). (2019). IDF diabetes atlas (9th ed.). Retrieved from https://diabetesatlas.org/
2. Anjana, R. M., Deepa, M., Pradeepa, R., et al. (2021). Prevalence of diabetes and prediabetes in 15 states of India: Results from the ICMR-INDIAB population-based cross-sectional study. The Lancet Diabetes & Endocrinology, 9(11), 585–596. https://doi.org/10.1016/S2213-8587(21)00072-9
3. Zubair, S., Zafar, M., & Qureshi, S. (2023). Role of platelet indices in predicting cardiovascular risk: A systematic review. Cardiology Research and Practice, 2023, Article ID 564839. https://doi.org/10.1155/2023/564839
4. Singh, V. P., Kaur, K., & Singh, T. (2020). Platelet indices and their significance in diabetes mellitus: An Indian perspective. Journal of Clinical and Diagnostic Research, 14(7),OC01–OC05. https://doi.org/10.7860/JCDR/2020/45213.13826
5. Pippitt, K., Li, M., & Gurgle, H. E. (2016). Diabetes mellitus: Screening and diagnosis. American Family Physician, 93(2), 103–109.
6. Sherwani, S. I., Khan, H. A., Ekhzaimy, A., Masood, A., & Sakharkar, M. K. (2016). Significance of HbA1c test in diagnosis and prognosis of diabetic patients. Biomarker Insights, 11, 95–104. https://doi.org/10.4137/BMI.S38440
7. Pogorzelska, K., Krętowska, A., Krawczuk-Rybak, M., & Sawicka-Żukowska, M. (2020). Characteristics of platelet indices and their prognostic significance in selected medical conditions: A systematic review. Advances in Medical Sciences, 65(2), 310–315. https://doi.org/10.1016/j.advms.2020.05.002
8. Demirtas, L., Degirmenci, H., Akbas, E. M., Ozcicek, A., Timuroglu, A., & Gurel, A. (2015). Association of mean platelet volume and platelet distribution width withdiabetic complications. Diabetology & Metabolic Syndrome, 7, 20. https://doi.org/10.1186/s13098-015-0019-8
9. Zuberi, B. F., Akhtar, N., & Afsar, S. (2008). Comparison of mean platelet volume in patients with diabetes mellitus, impaired fasting glucose and non-diabetic subjects. Singapore Medical Journal, 49(2), 114–116.
10. Khoury, M., Nasrallah, A., & Nakhoul, N. (2020). Role of platelet indices in cardiovascular risk assessment in diabetes. Clinical Diabetes, 38(4), 287–292. https://doi.org/10.2337/cd20-0010
11. Przygodzki, T., Luzak, B., et al. (2020). Diabetes and hyperglycemia affect platelet GPIIIa expression: Effects on adhesion potential of blood platelets from diabetic patients under in vitro flow conditions. International Journal of Molecular Sciences, 21(9), 3222. https://doi.org/10.3390/ijms21093222
12. American Diabetes Association. (2023). Standards of medical care in diabetes— 2023. Diabetes Care.