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Association of Mean Platelet Volume and Glycated Hemoglobin with Diabetic Retinopathy in Type 2 Diabetes Mellitus: A Cross-Sectional Study

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Abstract: ***Introduction: Diabetic retinopathy (DR), a microvascular complication of diabetes mellitus (DM), is a leading cause of preventable blindness. Recent interest has emerged regarding the role of mean platelet volume (MPV), a marker of platelet activation, in the pathophysiology of diabetic complications. Objective: This study aimed to assess the relationship between MPV, glycated hemoglobin (HbA1c), and the presence and severity of diabetic retinopathy in patients with type 2 diabetes mellitus. Methods: A cross-sectional study was conducted on 100 diabetic patients. Systematic random sampling was employed. Demographic details, duration of diabetes, treatment modality, MPV, and HbA1c levels were recorded. DR status was classified based on fundoscopic examination. Statistical analyses included t-tests, ANOVA, and Pearson correlation. Results: DR was observed in 60% of participants. MPV and HbA1c levels were significantly higher in patients with DR ($p < 0.05$). A positive correlation was found between MPV and HbA1c (r = significant), as well as MPV and duration of diabetes. Conclusion: Elevated MPV correlates with poor glycemic control and the presence of DR. MPV could serve as a simple, cost-effective marker for the early detection and monitoring of microvascular complications in patients with Diabetes mellitus.***

Keywords: Diabetic Retinopathy, Mean Platelet Volume (MPV), Glycated Hemoglobin (HbA1c), Type 2 Diabetes Mellitus, Microvascular Complications, Platelet Activation.

1. Introduction

Diabetes mellitus (DM) is a global public health challenge. As of 2022, approximately 830 million individuals are affected, according to WHO estimates. The burden of diabetes is rising particularly in low- and middle-income countries, where early detection and management of complications remain suboptimal.

Among the microvascular complications of diabetes, **diabetic retinopathy (DR)** stands out as the most common and a leading cause of preventable blindness. The global prevalence of DR among diabetic patients is approximately 27%. Chronic hyperglycemia leads to endothelial dysfunction and microvascular damage, contributing to DR pathogenesis.

HbA1c is widely recognized as the gold standard for long-term glycemic control. Persistent elevation in HbA1c is associated with the development and progression of DR. Additionally, alterations in platelet function—particularly an increase in platelet reactivity—have been noted in diabetic patients. **Mean Platelet Volume (MPV)** is a readily available parameter in routine complete blood counts and is considered a surrogate marker of platelet activity.

This study was undertaken to explore the association between MPV, HbA1c, and DR, aiming to evaluate MPV as a potential adjunct marker for microvascular risk assessment in diabetes.

Objectives:

1) To estimate the MPV in patients with diabetic retinopathy.
2) To compare the MPV in patients with and without diabetic retinopathy.
3) To assess the relationship between glycemic control (as assessed by HbA1c) and MPV in diabetic patients.

2. Materials and Methods

Study Design:
A hospital-based cross-sectional observational study was conducted in the Department of General Medicine, KVGMCH, Sullia.

Study Population:
The study included 100 patients diagnosed with type 2 diabetes mellitus, selected using systematic random sampling.

Inclusion Criteria:
- Diagnosed type 2 diabetic patients aged >18 years.
- Patients willing to provide informed consent.

Exclusion Criteria:
- Patients with hematological disorders.
- Those on antiplatelet therapy.
- Patients with infections, malignancies, or chronic inflammatory conditions.

Data Collection:
A pre-designed proforma was used to collect demographic data, diabetes duration, medication history, and investigation results including HbA1c and MPV. Retinal status was evaluated via fundoscopy by an ophthalmologist and classified into stages.

Laboratory Investigations:
- **HbA1c**: Measured using standardized immunoturbidimetric assay.
- **MPV**: Measured using an automated hematology analyzer.
- **Other routine investigations** were performed as per hospital protocol.

Statistical Analysis:
- Categorical variables were expressed as percentages.
- Continuous variables were presented as mean ± SD.
- Student's t-test was used to compare two groups.
- ANOVA was used for comparisons involving more than two groups.
- Pearson correlation coefficient was used to assess linear relationships.
- A p-value <0.05 was considered statistically significant.

3. Results

Demographics:
- The mean age of participants was 55.4 ± 12 years.
- Most participants were in the 51–60 years age group.
- 44% had diabetes duration <5 years; only 1% had >20 years.

Treatment Patterns:
- 73% were on insulin therapy.
- 10% were on both insulin and oral hypoglycemic agents.

Prevalence of DR:
- DR was present in 60% of patients.
- Among these, 29% had stage 1 DR, while 4% had stage 4 DR.

MPV Observations:
- The mean MPV was significantly higher in patients with DR compared to those without ($p < 0.05$).
- However, no significant correlation was found between MPV and DR staging.

HbA1c Observations:
- HbA1c values were higher in DR patients compared to non-DR (statistically significant).
- Tukey's post hoc analysis showed significant differences between earlier stages (1 vs 2, 1 vs 3).

Correlations:
- MPV and HbA1c: Positive correlation ($p < 0.05$).
- MPV and Duration of Diabetes: Positive correlation ($p < 0.05$).
- HbA1c and DR severity: Significantly associated with higher stages of DR.

Tables: MPV, HbA1c and Diabetic Retinopathy Study

Table 1

Sno.	Age Distribution	Males	Females
1	21 – 30 Years	0 (0%)	1 (1%)
2	31 – 40 Years	5 (5%)	2 (2%)
3	41 – 50 Years	11 (11%)	7 (7%)
4	51 – 60 Years	15 (15%)	17 (17%)
5	61 – 70 Years	11 (11%)	13 (13%)
6	71 – 80 Years	4 (4%)	11 (11%)
7	81 – 90 Years	2 (2%)	0 (0%)
8	91 – 100 Years	1 (1%)	0 (0%)
	Total	49 (49%)	51 (51%)
	Mean age	57.83 ± 13.15	59.09 ± 11.37
Overall Mean age		58.48 ± 12.23	

Table 2

SNO.	Duration of Diabetes	No. of Patients	Percentage
1	1-5 Years	44	44%
2	6 – 10 Years	33	33%
3	11 – 15 Years	15	15%
4	16 – 20 Years	7	7%
5	> 20 Years	1	1%
Mean duration of diabetes		7.84 ± 4.98	

Table 3

S. NO.	Medication	No. of Patients	Percentage
1	Oral Hypoglycemic agents	17	17%
2	Insulin	73	73%
3	OHA + Insulin	10	10%

Table 4

S No.	Diabetic Retinopathy	No. of Patients	Percentage
1	Diabetic Retinopathy – Absent	40	40 %
2	Diabetic Retinopathy	60	60%

Table 5

S. No.	Diabetic Retinopathy	No. of Patients	Percentage
1	Stage 1 Diabetic Retinopathy	29	29 %
2	Stage 2 Diabetic Retinopathy	19	19 %
3	Stage 3 Diabetic Retinopathy	8	8 %
4	Stage 4 Diabetic Retinopathy	4	4 %

Table 6

Sno.	Variables	Diabetic Retinopathy	No Retinopathy	T Value	P Value
1	Age	57.98 ± 12.86	59.22± 11.34	0.4948	0.6219
2	Duration of diabetes	9.46 ± 5.20	5.4 ± 3.44	4.3415	<0.0001*

Table 7

Sno.	Patients	Mean Platelet Volume	T Value	P Value	95% CI
1	Diabetic Retinopathy	8.73 ± 0.85	2.3199	0.0224	-0.7793 to -0.0607
2	Non Diabetic Retinopathy	9.15 ± 0.94			

Table 8

SNO.	Diabetic Retinopathy	Mean Platelet Volume	F Value	P Value
1	Stage 1 Diabetic Retinopathy	9.16 ± 0.95	1.446	0.239
2	Stage 2 Diabetic Retinopathy	9.41 ± 0.99		
3	Stage 3 Diabetic Retinopathy	8.78 ± 0.67		
4	Stage 4 Diabetic Retinopathy	8.57 ± 0.83		

Table 9

Variable	R Value	P Value
Stage of Diabetic retinopathy Vs Mean Platelet Volume	0.0976	0.3340

Table 10

SNo.	Patients	HbA1c	T Value	P Value	95% CI
1	Diabetic Retinopathy	9.87 ± 2.39	3.0477	0.0030	0.5093 to 2.4107
2	Non Diabetic Retinopathy	8.41 ± 2.28			

Table 11

SNO.	Diabetic Retinopathy	HbA1c Values	F Value	P Value
1	Stage 1 Diabetic Retinopathy	8.76 ± 1.42	7.437	<0.0001*
2	Stage 2 Diabetic Retinopathy	11.13 ± 2.63		
3	Stage 3 Diabetic Retinopathy	11.5 ± 2.24		
4	Stage 4 Diabetic Retinopathy	8.7 ± 3.06		

Table 12

Variable	R Value	P Value
HbA1c VALUES Vs Mean Platelet Volume	0.3036	0.00213*

Table 13

Variable	R Value	P Value
Duration of diabetes Vs Mean Platelet Volume	0.2152	0.03153*

4. Discussion

Our study supports growing evidence that platelet hyper-reactivity plays a key role in the pathogenesis of diabetic microvascular complications. MPV, a reflection of platelet size and activity, was elevated in patients with DR, consistent with other studies.

MPV in patients with and without diabetic retinopathy was estimated to be 9.15±0.94 and 8.73 ±0.85 respectively. The mean platelet volume in patients with diabetic retinopathy is more than those patients without retinopathy. This difference is statically significant with pvalue <0.05 . As HBA1C value increases , MPV also increases significantly. This indicates that MPV is a reliable marker of vascular compications i.e Diabetic retinopathy.

Pathophysiology Insight:
Chronic hyperglycemia alters platelet membrane dynamics and promotes glycation of surface proteins, enhancing platelet activation and aggregation. This contributes to endothelial injury and thrombogenesis, setting the stage for microvascular complications like DR.

Comparison with Literature:

- Studies by Dindar et al., Madhavan et al., and Sumanraj et al. have all reported significantly higher MPV in DR patients.
- A positive correlation between MPV and HbA1c has been consistently demonstrated, including in our study.
- Khalid M et al., Garg et al., and Lind et al. observed that poor glycemic control (high HbA1c) is closely associated with the development and progression of DR.

While our study did not find a significant association between MPV and DR staging, this might be due to smaller sample sizes in advanced DR stages. Nonetheless, the overall elevation in MPV in DR patients supports its role as a potential early biomarker.

5. Summary

- This study demonstrates that:
- MPV is significantly higher in diabetic patients with retinopathy.
- MPV positively correlates with HbA1c and duration of diabetes.
- Higher HbA1c levels are associated with more severe DR.
- Clinical Implication: MPV could be used as an adjunct marker to monitor vascular risk in diabetes. Its inclusion in standard diabetic monitoring protocols may help in early detection of complications like DR.

6. Conclusion

Elevated MPV correlates with poor glycemic control and the presence of DR. MPV could serve as a simple, cost-effective marker for the early detection and monitoring of microvascular complications in patients with Diabetes mellitus.

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