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To determine the relation of mean platelet volume with diabetes mellitus

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ABSTRACT

Background: Diabetes mellitus (DM) is a complex metabolic disorder portrayed by chronic hyperglycemia bringing about intricacies influencing the peripheral nerves, kidneys, eyes, and macrovascular structures. Mean platelet volume (MPV) is also considered to impact the advancement of microvascular complications of diabetes mellitus which has been looked for in this study. **Aims and Objectives:** The aims of this study were as follows: (1) To study association of MPV with Nephropathy and Retinopathy in Diabetes. (2) To Study correlation of MPV with hemoglobin A1c (HbA_1C), fasting blood sugar, post-prandial blood sugar, and body mass index (BMI). **Materials and Methods:** This was an observational study conducted over 18 months period on patients (both males and females) seeking medical attention for newly diagnosed or previously diagnosed DM. Selective sampling technique was used and 200 diabetic patients were enrolled in the study during the study period. **Results:** (1) The incidence of retinopathy and increased Hba1c was significantly higher in poorly controlled diabetics as compared to controlled diabetics. (2) In good glycemic control group, mean MPV was 8.58 fL and, in poor glycemic control group, mean MPV was 10.21 fL. **Conclusion:** There was a positive correlation between MPV and HbA1C, microalbuminuria, BMI, fasting, and post-prandial blood sugar levels. There was no significant association between MPV and retinopathy.

Key words: Diabetes mellitus; Hemoglobin A_1C; Mean platelet volume

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INTRODUCTION

Diabetes mellitus (DM) is a complex metabolic disorder portrayed by chronic hyperglycemia bringing about intricacies influencing the peripheral nerves, kidneys, eyes, and smaller scale and macrovascular structures.[1,2]

It is a chronic disease which is posing as one of the major public health problems facing mankind.[1]

India (19 million) has the highest number of diabetics, followed by China (16 million), and the United States (14 million).[3]

The macrovascular complications of diabetes include cardiovascular, cerebrovascular, and peripheral arterial disease. Adverse coronary events occur at a much younger age in diabetic individuals and the incidence is almost the same in both men and women.

Apart from the macrovascular complications, they are at risk of developing microvascular complications such as retinopathy, nephropathy, and neuropathy associated with high morbidity.[4]

Numerous mechanisms could be sought to explain this increased risk; however, the most important among all would be the presence of a proinflammatory and prothrombotic state.

The increased in platelet reactivity and insulin resistance can be believed to be the primary cause of all the vascular complications in diabetes.

Platelets have an important role in maintaining hemostasis.

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The dimensions of platelet size and volume are considered as important factors of platelet function. Recent studies point to the role of mean platelet volume (MPV) to be an important marker for thromboembolism, MI, and ischemic stroke.[5]

Larger platelets are more reactive with increased prothrombotic factor thromboxane A2 release and therefore an increased thrombogenic potential.[6]

The MPV was found to be higher in diabetic population than the non-diabetics and it was found to improve with good glycemic control.

MPV is also considered to impact the advancement of microvascular complications of DM which has been looked for in this study.

Aims and objectives

The aims of this study were to determine the relation of MPV with DM.

The objectives of this study were as follows:

1. To study association of MPV with Nephropathy and Retinopathy in Diabetes.
2. To Study correlation of MPV with hemoglobin A1c (HbA1C), fasting blood sugar, post-prandial blood sugar, and body mass index (BMI).

Criteria for the diagnosis of DM[7]

- Symptoms of diabetes + random blood glucose ≥11.1 mmol/L (200 mg/dL) or
- Fasting plasma glucose ≥7.0 mmol/L (126 mg/dL) or
- Hb A1c ≥ 6.5%c or
- 2-h plasma glucose ≥11.1 mmol/L (200 mg/dL) during an oral glucose tolerance test.

MATERIALS AND METHODS

This was an observational study conducted over 18 months period on patients (both males and females) seeking medical attention for newly diagnosed or previously diagnosed DM. Selective sampling technique was used and 200 diabetic patients were enrolled in the study during the study period.

The ethical committee clearance was taken on November 23, 2017.

Inclusion criteria

The following criteria were included in the study:

- Age ≥18 years and ≤80 years
- All patients with DM
- All patients giving the written consent for participation in the study.

Exclusion criteria

The following criteria were excluded from the study:

- Any patient below 18 years and above 80 years
- Patients with abnormal platelet count
- Male patients with hemoglobin <11 g% and female patients with hemoglobin <10 g%
- Pregnant patients
- Patients with known case of any malignancy and myeloproliferative disorder
- Patients with acute illness
- Patients on anti-platelet drugs.

Methodology

The patients and their legally acceptable representative were given complete information about the study, its benefits, and its future prospects. After getting their approval for participation in the study, a voluntary written informed consent was obtained.

Patient's detailed physical and clinical examination, history was taken.

Each of the subjects were evaluated for body weight, height, and BMI. Bodyweight was recorded while standing motionless on a digital weighing scale on firm horizontal surface without shoes (To the nearest of 0.1 kg).

Height was measured while standing erect against a vertical scale of a portable stadiometer without shoes (To the nearest of 0.1 cm).

BMI is calculated by the, BMI = Weight (Kilograms)/ height (meter^2) formula.

Venous samples were collected for Hb, WBC, Platelets, MPV, HbA1C, FBS, PPBS, and Creatinine.

HbA1c was measured by high-performance liquid chromatography.

Measurement of MPV was done using an automatic blood counter.

Plasma glucose estimation (FBS and PPBS) was carried out by the glucose oxidase method in the autoanalyzer.

Microalbuminuria was examined using spot urine albumin creatinine ratio (ACR). Patients with ACR of <20 mg/g for men and <30 mg/g for women were categorized as microalbuminuria negative and those with >20 mg/g and >30 mg/g, respectively, as microalbuminuria positive.

Diabetic retinopathy was defined by direct ophthalmoscopic examination.

Table 1: Mean age distribution in both glycemic groups

Age Distribution	Good Glycemic Control Group	Poor Glycemic Control Group	P value Unpaired t-Test
Mean	56.3	53.1	0.053
SD	10.87892	10.68	

Table 2: Mean FBS distribution in both glycemic groups

Fasting Blood Sugar Distribution	Good to Moderate Glycemic Control Group	Poor Glycemic Control Group	P value Unpaired t-Test
Mean	141.14	193.05	<0.0001
SD	46.69	74.21	

Table 3: Mean PPBS distribution in both glycemic groups

Post Prandial Blood Sugar Distribution	Good to Moderate Glycemic Control Group	Poor Glycemic Control Group	P value Unpaired t-Test
Mean	185.15	269.94	<0.0001
SD	56.48	103.71	

Table 4: Mean BMI distribution in both glycemic groups

BMI Distribution	Good to Moderate Glycemic Control Group	Poor Glycemic Control Group	P value Unpaired t-Test
Mean	25.76	25.59	0.513
SD	1.79	1.77	

Table 5: Nephropathy status in both glycemic groups

Nephropathy Status	Good to Moderate Glycemic Control Group	%	Poor Glycemic Control Group	%
Yes	25	26.3	70	73.7
No	39	37.1	66	62.9
Total	64	32.0	136	68.0

Table 6: Mean HbA1c in patients with positive and negative nephropathy status

Nephropathy status	Mean Hba1c	P value
Yes	10.0809	0.077
No	9.3748	

After baseline evaluation, the patients were divided into two groups based on HbA1C levels: diabetics with good to moderate glycemic control (patients with HbA1c <8%)

Table 7: Retinopathy status in both glycemic groups

Retinopathy Status	Good to Moderate Glycemic Control Group	%	Poor Glycemic Control Group	%
Yes	2	3.8	51	96.2
No	62	42.2	85	57.8
Total	64	32.0	136	68.0

Table 8: Mean HbA1c in patients with positive and negative retinopathy status

Retinopathy Status	Mean Hba1c	P value
Yes	12.34	<0.0001
No	8.76	

Table 9: Mean MPV in both glycemic groups

Mean Platelet Volume Distribution	Good Glycemic Control Group	Poor Glycemic Control Group	P value Unpaired t-Test
Mean	8.58	9.21	0.002
SD	1.11	1.4	

Table 10: Correlation statistics – HBA1C versus MPV

Pearson's R	0.228
R Square	0.052
P value ANOVA	0.001

Table 11: Correlation statistics – HBA1C versus FBS

Pearson's R	0.087
R Square	0.008
P value ANOVA	0.221

Table 12: Correlation statistics – HBA1C versus PPBS

Pearson's R	0.156
R Square	0.024
P value ANOVA	0.027

Table 13: Correlation statistics – HBA1C versus Microalbumin

Pearson's R	0.143
R Square	0.021
P value ANOVA	0.043

Table 14: Correlation statistics – MPV versus BMI

Pearson's R	−0.085
R Square	0.007
P value ANOVA	0.232

Table 15: Mean MPV in patients with positive and negative retinopathy status

Retinopathy Status	Mean MPV	P value
Yes	9.11	0.518
No	8.97	

and diabetics with poor glycemic control (patients with HbA1c >8%).

All the parameters were compared between both the groups. These groups were further sub grouped based on the presence or absence of complications. The MPV in each group was compared.

The data from the customized proforma were entered into the Microsoft Excel sheet and, then, transferred to relevant statistical software package for analysis.

A descriptive analysis of the population was carried out. The continuous variables with a normal distribution were described as the mean ± SD. Correlation analysis was carried out using Karl Pearson's coefficient of correlation.

RESULTS

While analyzing age distribution, it was observed that, in good glycemic control group, mean age is 56.3 years and, in poor glycemic control group, mean age is 53.1 years (P=0.053) (Table 1).

While analyzing FBS distribution, it was observed that, in good glycemic control group, mean FBS is 141.14 mg/dl and, in poor glycemic control group, mean FBS is 193.05 mg/dl (P<0.0001) (Table 2).

While analyzing PPBS distribution, it was observed that, in good glycemic control group, mean PPBS is 185.15 mg/dl and, in poor glycemic control group, mean PPBS is 269.94 mg/dl (P<0.0001) (Table 3).

While analyzing BMI distribution, it was observed that, in good glycemic control group, mean BMI is 25.76 and, in poor glycemic control group, mean PPBS is 25.59 (P=0.513) (Table 4).

While analyzing nephropathy (microalbuminuria) status, it was observed that, in good glycemic control group, incidence of was 26.3% and, in poor glycemic control group, incidence of retinopathy was 73.7% (Table 5).

The mean Hba1c in patients with nephropathy is 10.08% and in patients without retinopathy is 9.37% with P=0.077 (Table 6).

While analyzing retinopathy status, it was observed that, in good glycemic control group, incidence of retinopathy was 3.8% and, in poor glycemic control group, incidence of retinopathy was 96.2% (Table 7)

The mean Hba1c in patients with retinopathy is 12.34% and in patients without retinopathy is 8.76% with P<0.0001 (Table 8).

This was in accordance to studies carried out by Demirtunc et al.[8] and Hekimsoy et al.[9]

While analyzing MPV distribution, it was observed that, in good glycemic control group, mean MPV is 8.58 fL and, in poor glycemic control group, mean MPV is 9.21 fL (P=0.002).

This was in accordance to various other studies (Table 9).[3,8,11,12,14]

There is a strong positive correlation between Hba1c levels and MPV levels. This is indicated by the Pearson's R Correlation value of 0.228 with P=0.001 (Table 10).

There is not a correlation between FBS and MPV levels. This is indicated by the Pearson's R Correlation value of 0.087 with P=0.221 (Table 11).

There is a strong positive correlation between PPBS and MPV levels. This is indicated by the Pearson's R Correlation value of 0.156 with P=0.027 (Table 12).

There is a strong positive correlation between microalbumin and MPV levels. This is indicated by the Pearson's R Correlation value of 0.143 with P=0.043 (Table 13).

There is no correlation between BMI and MPV levels. This is indicated by the Pearson's R Correlation value of −0.085 with P =0.232 (Table 14).

This was in accordance with Papanas et al.[10]

The mean MPV in patients with retinopathy is 9.11 and in patients without retinopathy is 8.97 with P=0.518 (Table 15).

DISCUSSION

This was an observational study carried out from December 2017 to May 2019.

The study comprised of 200 diabetic patients out of which 96 were males and 104 females with an average age of 54.17 years.

We found that the mean MPV in poor glycemic control patients was 9.21 fL which was significantly higher than

mean MPV in good glycemic control patients which was 8.58fL (p=0.002).

This was in accordance to the studies carried out by Demirtunc et al.(10), Manoj Saluja et al(11), Rajesh Kanna et al.[12], Kodiatte et al.[13], Zuberi et al.[14].

There was also a strong positive correlation between HbA1c and MPV with r = 0.228 and p = 0.001. Hence it can be concluded that due to chronic hyperglycaemia, platelets are overwhelmed with glucose and are subjected to synthesis of glycogen and glycosylation of certain proteins. The increased glycogen content in turn contributes to a small percent of increase in the size of the mean platelet volume. Other possibilities are that the platelets undergo osmotic swelling due to raised levels of some glucose metabolites and there may be high turnover of platelets in chronic hyperglycemia.

The MPV was higher in diabetics with proteinuria than in those who lacked it. And there was a significant positive correlation between proteinuria and MPV with r = 0.143 and p = 0.043. Thus indicating a correlation between MPV and diabetic nephropathy.

This is in accordance to Madhavan K et al.[15] were the r value was 0.199.

The mean MPV in patients with retinopathy was 9.11 which was higher than the mean MPV in patients without retinopathy which was 8.97 but was not statistically significant.

This was in accordance with the studies of Demirtunc et al.[10], Hekimsoy et al.[12].

Thus, from our study we conclude that by good glycemic control, a reduction in (MPV) can be achieved resulting in a decrease or delay in the development microvascular complications like nephropathy (microalbuminuria) and retinopathy.

Limitations of the study

1. The patients selected were between 18 to 80 years. Hence, in the future new studies can be carried out narrowing this vast age gap difference.

2. The sample size can be increased in future studies.

CONCLUSION

On the basis of our study done on 200 diabetic patients, we conclude.

On internal comparisons between good and poor glycemic control patient groups:

- Higher fasting blood sugar levels in poor glycemic control patients.
- Higher post prandial blood sugar levels in poor glycemic control patients.
- Higher incidence of proteinuria in poor glycemic control patients.
- Higher incidence of retinopathy in poor glycemic control patients.
- Higher MPV levels in poor glycemic control patients.

On correlation with MPV:

- There was positive correlation with HbA1c.
- There was positive correlation with post-prandial blood sugar.
- There was positive correlation with microalbumin.
- There was no correlation found with BMI and fasting blood sugar.

There was no significant association found between MPV and retinopathy.

Significant positive correlation was found between MPV and HbA1c, PPBS, and microalbumin.

Patients with poor glycemic control have higher MPV than patients with good glycemic control, they also have higher incidence of retinopathy and microalbuminuria.

Emphasis should be laid on a strict glycemic to prevent the vascular complications associated with diabetes.

MPV can serve as a cost effective marker of micro vascular complications and helps monitor platelet activity.

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Authors' Contributions:
MJM- Concept and design of the study; **RSR**- Interpretation of results and preparation of the manuscript; **VMJ**- Statistical analysis and interpretation; **AKBB**- Concept, coordination, revision of the manuscript.

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